Cooperative
Research Centre
for
Viticulture

Grape and Wine
Research and
Development Corporation

Spray Application in Viticulture: Research to Practice®

FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT

Project Number: **CRV 99/19a**

Principal Investigator: **John Lopresti**

Research Organisation: **CRC for Viticulture**
Date: **30th June 2003**

Victoria The Place To Be

Spray Application in Viticulture: Research to Practice®

Project number: CRV 99/19a

Final report for the Grape and Wine Research & Development Corporation

30th June, 2003

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Abstract

Strategic agrochemical application remains an essential component of an integrated approach to pest and disease management in viticulture. A spray application workshop program was developed to facilitate a move away from routine use of pesticides by providing targeted and practical training in a positive learning environment based on the Research to Practice® model. The program gives vineyard managers and growers the confidence and capacity to make strategic management decisions, and adopt the best available disease control options. This is achieved by providing accurate, up-to-date information, practical diagnostic tools and scientific research that has been translated into methodologies that work in the vineyard.

Research to Practice®: Spray Application in Viticulture workshops have brought together the various components of pesticide application and disease management, and successfully delivered the latest information to over 700 growers, vineyard managers, extension staff from wine companies, consultants and educators. Through this program, researchers were also provided with a structured avenue for technology transfer related to their work, as well as feedback on their work and insights into industry needs and priorities. Evaluation of participant feedback to date demonstrates that there have been a number of direct benefits from this program, including adoption of improved spray evaluation practices resulting in more consistent disease control, reductions in pesticide use and spraying costs, and a better understanding of industry research priorities.

Executive Summary

The Research to Practice®: Spray Application in Viticulture workshop program was modelled on the successful Research to Practice®: IPM Viticulture workshop. The program for the spray application workshops was developed to improve pest and disease control by properly managing the timing and targeting of pesticide applications in the vineyard and effective use of spray equipment. It is designed to introduce key concepts in relation to spraying vines and then moves into sessions on specific management issues such as sprayer set up, evaluation and selecting chemical rates. The three-day workshop is split into an initial two days and then a third, follow-up day, after harvest. Research to Practice® workshops are developed using adult learning principles and groups dynamics. They are designed to create a training environment where participants actively participate in the learning process. Information is delivered in a credible and practical manner and participants are encouraged to take on a new or changed practice at the end of the workshop.

The key to the success of each workshop is a commitment, known as a 'promise', made by each participant at the end of the first two days. This encourages vineyard managers and growers to make a real commitment to adopting and trialing at least one new practice, with the opportunity to discuss successful implementation and any problems encountered at the follow-up day. These 'Day 3' meetings allow participants to assess the success of their pesticide application programs including their 'Promises', to explore other aspects of spray application in their vineyards, and further examine issues they may have considered since the workshop.

A total of 33 spray application workshops were delivered in 18 wine regions of Australia to 750 participants between 1998 and 2002. Thirty-three presenters from various research agencies and companies were involved in development and delivery of the workshop program throughout Australia. The workshop structure and content was continuously improved during the project based on participant and presenter feedback. Recent research in the areas of timing and targeting pests and disease, low volume application, optimising spray equipment, interpreting label rates and adjuvant use have been interpreted and incorporated into the program. The changes were designed to increase the relevance of the information to growers and improve the content format, making it more practical and easier to understand. This was achieved while still providing enough technical and strategic management information to give growers sufficient confidence to implement changes without significantly increasing risks.

The workshop program proved to be a successful and effective method of disseminating relevant information and research outcomes that could be easily implemented in the vineyard. Participant response to the workshops was generally positive with most satisfied with the approach taken in delivering technical information and with the content presented. Based on 2001 workshop evaluations, 63% of participants disliked none of the presentations while 15% liked all of the modules delivered. This is a very positive outcome considering the many regional differences encountered and the variety of speakers presenting the material. Analysis of evaluation results over four seasons indicated that 81% of participants changed their pesticide application and disease management practices as a direct consequence of attending the first two days of the workshop. This was an extremely pleasing outcome as adoption of improved practices was the major objective of the project. Many growers also indicated that they changed more than one practice during the season. The workshop manual proved to be a valuable resource with 83% of participants indicating they used the manual an average of three times during the season.

The most significant impact of the workshop was to demonstrate the importance of sprayer set up to target a particular canopy and disease, evaluating spray coverage, and accurate calibration

as part of a management strategy. Again, feedback from participants suggested that these key practices had been clearly presented, understood and implemented in the vineyard. In 2001, 80% of growers and vineyard managers adjusted spray volumes, air direction, air quality and travel speed based on the pest or disease being targeted and the growth stage of the vine canopy. Sixty-six percent (66%) of growers also calibrated their sprayers more often after attending the workshop. A further 35% of participants began monitoring their spray coverage using evaluation tools such as water sensitive cards. Feedback at the third day indicated that a number of growers had improved their spray coverage and disease control as a result of targeting sprays, using more accurate pesticide rates and better spray evaluation.

These results were reinforced by the significant number (21.2%) of participants who promised to commence monitoring and assessing spray coverage. The next most common promise made was to improve application and chemical use efficiency (18.5%). This was a general category encompassing major components of the pesticide application process including sprayer set up, chemical selection, matching water volumes to the target and calculating chemical rates. This was followed closely by adjust sprayer set up (16.5%), begin regular sprayer calibration (13.5%), adjust chemical/water rates and commence using rate/100L (9.8%) and transfer knowledge gained to others (9.0%). More than 50% of participants made multiple promises. Feedback from the first two days in 2000 and 2001 indicated that 93% of participants felt that the information presented could be applied to their vineyard and 92% felt that the workshop was good value for money. Many also indicated that the workshop often gave them the confidence they needed to implement a change they had been considering or confirmed that they were already doing some things correctly.

Overall the objectives of the project were achieved and in many cases exceeded. The continued support of the industry for the Research to Practice® program indicates that it is highly valued by grape growers, wine companies and allied industries. Planned improvements and continued development will ensure that the Research to Practice®: Spray Application in Viticulture workshop program continues to meet the needs of industry. This should result in the continued adoption of more efficient and effective pesticide application practices by the grape and wine industry. The focus will continue to be on providing growers with a sound knowledge base and capacity to implement more strategic and efficient pest management practices.

The principal author wishes to thank the following colleagues and researchers for their patience, support, scientific guidance and contribution to the development and delivery of workshops over the last three years:

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Introduction

Project background

Effective chemical application remains an essential component of improved pest and disease management in viticulture, but inefficient use of pesticides can increase chemical usage and production costs, reduce yield and quality, impact on residue levels and the environment, and increase the potential for pesticide resistance. The wine grape industry is under increasing pressure from customers, regulatory authorities and the wider community to reduce chemical inputs so as to meet stringent export market MRLs and minimise spray drift and off-target contamination. Many companies are also implementing more sustainable pest and disease programs as part of a QA program or Environmental Management System that requires efficient and strategic use of pesticides as part of an integrated pest management approach.

Over the past decade the Grape and Wine Research & Development Corporation has invested in research projects within the field of spray application and pest and disease management to address some of these issues. This has resulted in a number of technologies and new information in the areas of timing applications and targeting pests and disease, low-volume application, optimising spray equipment, interpreting label rates and use of adjuvants. Many of these are sufficiently developed to enable more efficient spray application in the vineyard if implemented correctly.

Integration of research outcomes into vineyard operations can be difficult. Growers are often unsure about the ways to implement new management strategies and adoption of complex research results can be daunting. A 3-day training course was developed to meet industry requirements for the delivery of new technologies in a practical form and positive learning environment. The ultimate aim of the program was to give participants enough confidence to change current practices and adopt the best available production and management methods to increase efficiency and reduce costs without increasing the risk of yield loss or disease outbreaks. The training package was designed to enable researchers and experts to provide information in a standardised format while also allowing the inclusion of region-specific issues and topics through a flexible delivery system. Workshops also provided researchers with a structured avenue for technology transfer related to their work, as well as feedback on their work and insights into industry needs and priorities. A follow-up session after harvest provided participants with the opportunity to discuss, analyse and re-enforce the practices and principles covered on the first two days.

The Research to Practice®: Viticulture model has been developed to facilitate the incorporation of research outcomes into practical and economically viable strategies and practices for vineyard management and grape production in Australia. The concept was developed at the Institute of Horticultural Development, Knoxfield (DPI) with the support of researchers from participating agencies of the Cooperative Research Centre for Viticulture, as well as Australian and international experts and consultants.

This training package was modelled on the successful IPM Viticulture: Research to Practice® program consisting of a structured, practical and interactive workshop series. The IPM workshop focussed on current knowledge and then challenged each participant to commit to adopting a new technique based on greater confidence in scouting and monitoring and a strategic approach, as opposed to the traditional calendar approach to pest and disease management. A key focus of the IPM Viticulture: Research to Practice® project was to develop a training delivery model that successfully presented scientific research and technical information to participants from diverse backgrounds with a range of skill levels. The outcome was a participatory learning model

underpinned by sound adult learning principles and effective presentation of expert information that increased participant confidence in making management decisions appropriate for their enterprise.

Positive industry and researcher response to the Research to Practice® series of workshops resulted in the development of a number of programs including Research to Practice®: Spray Application in Viticulture in 1998. Many of the principles used in the IPM workshop series were directly transferable to these other programs. Industry had already identified a number of application related problem areas that were only briefly covered in the limited time available during IPM workshops. It was apparent that a separate workshop series was required to address complex spray application issues such as sprayer set up, evaluation and label rates in the necessary detail. The workshops were developed to address the key concerns of the viticulture industry and improve practices by increasing participant's knowledge and skills in the areas of:

- Matching pest and disease life cycles and appropriate spray timing for effective control;
- Optimising sprayer set up to effectively target the vine canopy;
- Effects of the tank mix on pesticide performance and appropriate use of adjuvants;
- Correctly interpreting chemical labels and using the right pesticide rate;
- Matching water volumes and chemical rates to a growing vine canopy to achieve the correct coverage and dose;
- Determining appropriate spray volumes and chemical rates when concentrate spraying;
- Assessing spray application results to determine if a biologically effective coverage has been achieved.

The principles of Research to Practice® are detailed in "Demonstrating Best Practice in Vocational Education and Training", developed by the former Department of Natural Resources and Environment. This manual is part of the final report for the IPM Viticulture: Research to Practice® project (CRV 94/4) and can be obtained from the Grape and Wine Research and Development Corporation.

Project objectives

1. Develop certificate level, field-based training workshops for Australian wine grape growers to enable greater uptake of spray application best practice in vineyards.

2. Establish and coordinate a network of researchers, experts and trainers for development of workshop manual, presentations and support materials.

3. Facilitate regional delivery of spray application workshops providing an avenue for improved and broader access to the outcomes of spray application R&D in a consolidated, practical training format.

4. Enhance the decision-making capacity and confidence of wine grape growers in initiating improved spray application practices.

5. Improve pest and disease management, yield and quality while reducing chemical use and off-target impacts through the adoption of spray application best practice.

Project aims & Performance targets

Original project proposal (1997/1998 – 1999/2000)

Outputs	Performance Target
Collect material	Material collected and collated for literature review/workshop manual by June 30, 1999.
Establish network of collaborators	Network of Australian & overseas collaborators/presenters established by September 31.
Produce manual & content	First draft of manual and course content developed by March 31, 1999.
Promote course	Workshop series promoted to selected participants by September 31, 1999.
Run pilot workshops	Two pilot workshops conducted by June 30, 1999.
Refine course	Manual and workshop content revised by September 30, 2000 & 2001.
Collect data from participants	Current practice and evaluation data collected from participants during workshops by June 30, 2001
Hold follow-up sessions	Workshop third-days conducted for 1999 and 2000 by June 30, 2001.
Deliver workshops in different regions	Spray application workshops conducted in main wine regions by June 30, 2001.
Evaluate the adoption rate and program success through survey	Adoption rate determined and evaluation of workshop series completed by June 30, 2001.

Continuing project proposal (2001/2002)

Outputs	Performance Target
Accredit training providers	Evaluate performance of trained presenters in Research to Practice® workshops by April 2002.
Training manual	Manual reviewed and updated by June 2002.
Standardised presentations and training support materials	PowerPoint® presentations and photographic slides reviewed and updated, and new products developed by June 2002.
Research to Practice® workshops	10 workshops conducted representing 250 participants before June 2002.

Methodology

The information package

A major component of the initial stages of the project before pilot workshops began was sorting, translating and synthesising the volumes of detailed, complex scientific information into a package that did not include unnecessary information and provided an 'appropriate' knowledge base in a format that was accessible to participants. Research results were drawn together from available resources, incorporating published data, and data from work-in-progress, and built into a series of 'how-to' options for pesticide application in Australian viticulture.

The compiled material was developed from textbooks, published papers and reference books such as *Pesticide Application in Vineyards* (Kent & Early, 1997). Researchers, chemical company representatives, consultants and viticulturists reviewed information in their specific areas of expertise. The manual and presentations were prepared in a comprehensive and clear fashion, using as little technical 'jargon' as possible. None-the-less, it was considered important to include a certain level of scientific terminology given the complexity of some of the information presented. In developing manual contents it was assumed that participants had a basic understanding of pesticide application principles and some experience in viticulture.

Standardised presentations, a comprehensive manual and support materials were developed and tested in pilot workshops and then expanded for use in the regional workshops. Scientists and others working in viticultural pesticide application and pest management assisted at all stages to develop and present the workshop training package. The Research to Practice®: Spray Application in Viticulture training workshop manual contains the complete range of information modules, however not all modules are presented at any one workshop. Topics and content considered for delivery in each workshop are tailored to meet the needs of that group and include information on spraying particular vine canopies or specific pest and disease problems encountered in that region.

Workshop program

Spray Application in Viticulture: Research to Practice® is a three-day workshop designed to facilitate the adoption of new pest and disease management strategies with a focus on effective and appropriate use of pesticides. The training and education team at the Institute for Horticultural Development, Knoxfield, Vic., developed the program concept with support from the Cooperative Research Centre for Viticulture. The three-day workshop is split into an initial two days and then a third, follow-up day, after harvest. The key to the success of each workshop is a commitment (known as a 'promise) made by each participant at the end of the first two days. It is an important tool that assists and encourages participants in making a 'real' commitment to adopting and trialing at least one new practice, with the opportunity to discuss successful implementation and any problems encountered at the follow-up day. These 'Day 3' meetings allowed participants to discuss the success of their pesticide application programs including their 'Promises', to explore other aspects of spray application in their vineyards, and further examine issues they may have considered since the workshop.

The two-day workshop format was designed to allow presentation of complex information simply and clearly while permitting interaction between participants and presenters. Based on best practice Adult Learning Principles, this approach provided the opportunity for growers within a region to collaborate with researchers and each other to consider regional strategies for

controlling pests and disease. A pre-course survey was used to gather information on current pesticide application practices and pest and disease issues. The outcomes of these surveys were often used as a basis for discussion during the 'Targets', 'Powdery mildew' and '*Botrytis*' sessions, as well as in group sessions. The workshop program included information presentation, group discussions, problem-solving exercises and a field session. Where possible, the field session and demonstrations were used to make information directly relevant to participants' spray application experience. Support materials, such as pest identification guides, reference materials, pH meters, water sensitive cards and spreadsheet tools were introduced and their use demonstrated where appropriate.

An important part of the workshop process is ensuring that participants are comfortable during the learning process. Where venues are uncomfortable due to climate (both hot and cold), or there are distracting noises around the venue, participants understandably find it difficult to concentrate. To address this and other potential problems, 'Maslow's hierarchy' was used to pinpoint adult's needs eg. A well-ventilated, well-lit room at the right temperature. These were incorporated into the workshop program via a set of protocols developed by the Research to Practice® team and communicated to host organisations before each workshop.

The workshops were delivered in 18 Australian viticultural regions, with grape grower organisations, wine companies and others assuming the responsibility for hosting the workshops. This involved coordinating the participants, booking the venue, organising spray equipment, catering and liaising with the workshop facilitator. The workshop facilitator was responsible for organising the schedule, presenters, workshop audio-visual equipment, travel and accommodation, as well as other details as they emerged. The project coordinator developed the presentations in consultation with expert collaborators, discussed the presentations with speakers highlighting possible questions and regional issues and kept the manual up to date. In this program the workshop facilitator and project coordinator was the same person, simplifying the process of organising and conducting workshops.

A team of 33 spray application experts, plant pathologists and consultants has contributed to the workshop content and program between 1998 and 2001. The project coordinator has worked closely with this team to ensure that each presenter had a clear understanding of the workshop format, regional issues and the most effective method of communicating technical information to participants. Where possible, use of "local" pest and disease experts have been used to give each workshop a regional perspective.

While this structure is beneficial to the workshop program, the reliance on one individual to coordinate and facilitate the program is a risky strategy. In a few cases problems arose with the availability of the project coordinator/facilitator that created subsequent problems with workshop delivery. This issue was partially dealt with by utilising a number of facilitators familiar with the program and topics presented. Options to overcome this potential problem include accessing facilitators from non-traditional areas ie. Outside the viticulture industry and sublicensing workshop materials to registered training providers and TAFE's for delivery.

Workshop evaluation sheets, written 'promises', and written and oral reports, especially those discussions led by participants at the Third Days, have all provided a valuable source of feedback. Many points raised or 'discovered' by participants have been incorporated into further development of the workshop program, as well as development of a number of viticulture research programs, and are consequently contributing to the development of more effective application techniques in vineyards.

Workshop structure

The workshop structure is based on the IPM and Water Management for Grape Production: Research to Practice® workshops. When developing the workshop content and program, the aim was to create an even balance between sound adult group learning principles and the effective presentation of expert information. Of critical importance was to ensure that the program included a number of activities that enabled participants to interact, discuss issues and participate in 'hands-on' learning. Many of the participants were growers who were generally active during the working day and for whom a classroom approach was not the most effective learning environment. Timely breaks were also introduced into the schedule to provide participants with the opportunity to interact with others in the group and discuss information presented in the workshop.

First two days

The first two days of the workshop (Table 1) are highly structured and very intensive. Participants are required to concentrate for extended periods of time and it is usually obvious by the end of the second day that their level of concentration has diminished. In response, increased focus was placed on group sessions that change the focal point and pace on the afternoon of the second day. This also provided the opportunity to implement problem-solving sessions, providing participants with the opportunity to focus closely on problems and issues they would find in their own vineyards and possible management scenarios they could implement after the workshop.

Table 1. The 2001 program for the first two days of the spray spplication workshop.

Day 1	Workshop sessions*	Day 2	Workshop sessions
8:15 am	**Registration**	8:30	**Sprayer set up (inc. review of Day 1)**
8:30	**Introduction**	9:15	**Spraying grape bunches**
9:00	**Focus on Targets**	9:30	**Spray quality – From tank to target**
9:45	**How chemicals work**	*10:30*	**Break**
10:30	**Break**	10:45	**Spraying for Powdery Mildew**
10:45	**Improving pesticide performance**	11:30	**Spraying for Botrytis**
12:00	***Adjuvant demonstration*****	12:00	***Other Pests and Diseases - Discussion***
12:15	**Lunch**	*12:15*	**Lunch**
1:00	**Spray Equipment**	1:00	**Labelling Issues – Interpreting label rates**
1:30	***Sprayer selection discussion/calculations***	1:45	***How much chemical goes in the tank – Group discussion***
2:00	**Spray Evaluation**	2:15	**Break**
2:30	***Field session – Sprayer set up, calibration and evaluation***	2:30	***Group session - Disease/Sprayer/Canopy case study***
4:45	**Drinks**	3:00	**Calibration - Vine row volume calculations**
		3:40	***Group Discussion - Off target impacts, Spray records & Legislation***
		4:00	**Workshop summary and Action plan**
		4:15	**Finish**

* Optional modules provided: Spraying for Downy mildew, Herbicide application, Off-target impacts.

** Group discussions/sessions in italics.

An informal 'Drinks' session at the end of Day 1 allows more relaxed interaction in between participants and with presenters and often results in identification of issues to follow up during the 2nd Day of the workshop.

At the end of the two days participants are asked to evaluate the structured content of the workshop and their comments and criticisms are used to further develop the presentations (See Appendix 1.5). An industry leaflet providing a brief description of each topic can be found in Appendix 1.7.

Third day

The third day starts with an introduction outlining the evaluation results from the first two days. This is followed by an informal discussion that gives participants the opportunity to discuss the 'promises' that they made from first two days and/or share their experiences or ask any questions that they may have arising during from the growing season. In addition there is a local industry expert available to help field questions. After lunch there is a structured presentation again in response to feedback from the first two days. This works well to reinforce the messages from the first two days and allows participants to discuss ideas in a relaxed forum.

Workshop content & development

The Research to Practice® process is dynamic in that it is designed to allow changes in workshop content and structure based on feedback from participant's and availability of new information and technologies. Presentation content as well as the modules actually presented change from one workshop to the next not only to take regional variations and specific group requirements into account but also in response to evaluation by previous participants and presenters.

The program for the Spray Application workshop has evolved continuously over the final three years of the project to the point where it now focuses on critical aspects of pesticide application in much more detail than during the pilot series of workshops. The changes between the original program and current program are described in Table 2.

The major changes to the program occurred after the pilot series of workshops in 1999. Some of the changes made to the presentation structure and content were primarily cosmetic to improve the flow of information or assist newer presenters requiring more prompts and information on slides. Both days of the workshop have been significantly revised during the project to reflect changing participant needs and a demand for more detailed information in some key areas such as adjuvant technology, determining chemical rates and disease management.

Probably the most significant change made to the program was to the order of presentations to better reflect the pesticide application 'step-by-step' approach promoted in the workshop. Participants were able to understand this methodology more clearly by going through the process over the two days. In 2001 the program begins by focusing on targeting pests and disease and then moves on to consider chemical selection, improving pesticide performance and using adjuvants correctly. In the afternoon of the first day the focus shifts to selection of spray equipment, tools to evaluate spray coverage and a sprayer set up field session.

Table 2. Changes to the workshop structure and content during the final three years of the project.

Development of workshop program	
1999 Program	**2001 Program**
Day 1	
Registration	Registration
Introduction	Introduction
Focus on the target	Focus on the target
Spray droplets - From tank to target	How chemicals work
Morning Tea	
Chemicals	Improving pesticide performance
Labelling issues - Interpreting label rates	
Lunch	
Weed management	Spray equipment
Herbicide application	Evaluation tools
Afternoon tea	
Spray equipment	Outdoor session - Sprayer set up and evaluation
Group session - Regional issues	
Drinks	
Day 2	
Sprayer set up & modifications	Sprayer set up & modifications
Sprayer calibration	Spray quality - From tank to target
Morning Tea	
Outdoor session - Sprayer set up and evaluation	Powdery mildew
	Botrytis
	Other pests/diseases
Lunch	
Calibration calculations	Labelling issues - Interpreting label rates
Off-target impacts	Group discussion - How much chemical goes into the tank?
Afternoon tea	
Group discussion - Off target impacts	Group session - Disease/Sprayer/Canopy case study
Legal issues, Record keeping and QA	Calibration - Vine row volume calculations
Workshop summary and Action plan	Group Discussion - Off target impacts, Spray records & Legislation
	Workshop summary and Action plan
Workshop conclusion	

The outdoor session was moved from the second day to the afternoon of the first in 2001 to enable participants to put into practice some of the concepts discussed in the workshop by setting up a sprayer and evaluating spray coverage using water sensitive cards. A group session in the vineyard at this stage in the workshop allowed participants to discuss and try out different sprayer configurations and assess the results as each spray run was completed. It also provided the opportunity for presenters to introduce key concepts such as the importance of air as a carrier and demonstrate the use of evaluation tools in the field. Feedback from participants also indicated that they preferred to spend most of the afternoon of the first day in the vineyard rather than in a workshop environment.

Analysis of workshop evaluations also demonstrated that having completed the field session participants were better able to digest the information on sprayer set up, air manipulation, bunch spraying, spray quality and nozzle selection presented the following morning.

On the second day, several presentations were introduced into the workshop program focusing on the effective and correct use of pesticides, as part of an integrated approach to pest and disease management. Unlike similar modules in the IPM workshop these presentations aimed to provide comprehensive and detailed knowledge of the pesticides used for each disease and the correct timing and targeting required in achieving control. At this stage in the workshop the presentation of relatively familiar topics usually contributed to an increase in group interaction and discussion that in some ways provided a 'circuit-breaker' before the workshop moved into the more technical interpreting labels and calibration modules in the afternoon.

Participant feedback demonstrated that although the interpreting labels information was presented at a point in the workshop where the group were starting to feel tired, they benefited by being able to relate the selection of chemical rates to previous information on sprayer set up, spray quality and coverage evaluation. In this way they gained a better understanding of how each factor impacted on the amount of pesticide used for a specific target and the dose actually landed on the vine. The original program did not provide the opportunity for participants to make the connection between these various factors by scheduling this presentation on the morning of the first day.

The removal of the herbicide application, weed management, off-target impacts and legislation presentations from the workshop program seemed to have little impact on the success of the workshop series. Participant feedback indicated that a group discussion concerning legislative and off-target issues at the end of the second day was preferable to relatively 'dry' presentations. Many of the participants had covered these topics in detail in a farm chemical users course previously.

Although the weed management and herbicide application modules continued to be offered to groups on request it seemed to be of low priority in comparison to improving the effectiveness of participant's vine spraying and disease control.

Other important changes to the program schedule, content and information delivery included:

- An introduction to the integrated, step-by-step approach required for effective pesticide application in viticulture is now delivered during the "Introduction" presentation.
- A group discussion component incorporating a slide presentation of biological and application targets was introduced to obtain feedback on regional pest and disease issues. This information was then utilised to ensure that the participant's key concerns were always considered foremost during the workshop program. The original group session on regional issues was no longer required.
- A new "Improving pesticide performance" module was developed to address issues that impact on the efficacy of pesticides used in viticulture such as chemical compatibility, water quality, tank agitation and adjuvants. This expanded on basic information provided in the original "Chemicals" presentation that now focused in more detail on pesticide modes of action and resistance management.
- The "Spray evaluation" presentation was also developed to introduce the various tools available to assess spray coverage and dose. The original program lacked a specific topic covering this important area.
- A short module "Spraying grape bunches" was introduced into the second day program based on participant feedback for more information on spraying for *Botrytis* and wetting bunches. Results from trials assessing the effects of air speed and water volumes on bunch coverage and retention conducted by Kieran Murphy (AFISC) and David Riches (IHD, Knoxfield) were incorporated into the presentation.

- The “Interpreting labels” module was comprehensively revised to include a more detailed analysis of the techniques currently available to determine dilute and concentrate water volumes for different vine canopies. Practical examples of the various methods available to participants to determine chemical rates including Unit Canopy Row and AVCARE recommendations were also incorporated into the delivery of this module.
- A separate group session “How much chemical goes into the tank?” was also introduced into the program, so the participants could work through relevant case studies and examples with the guidance of the presenter.

Workshop development and changes in presentation content are discussed further in the following section.

Results and Discussion

Workshop presentation overview

Participants are asked to evaluate the structured content of the workshop and their comments and suggestions used to further develop the presentations. This section summarises and discusses the results of the workshop evaluation sheets (See Appendix 1.5) filled out by participants at the end of day 2 of the workshop during 2000 and 2001.

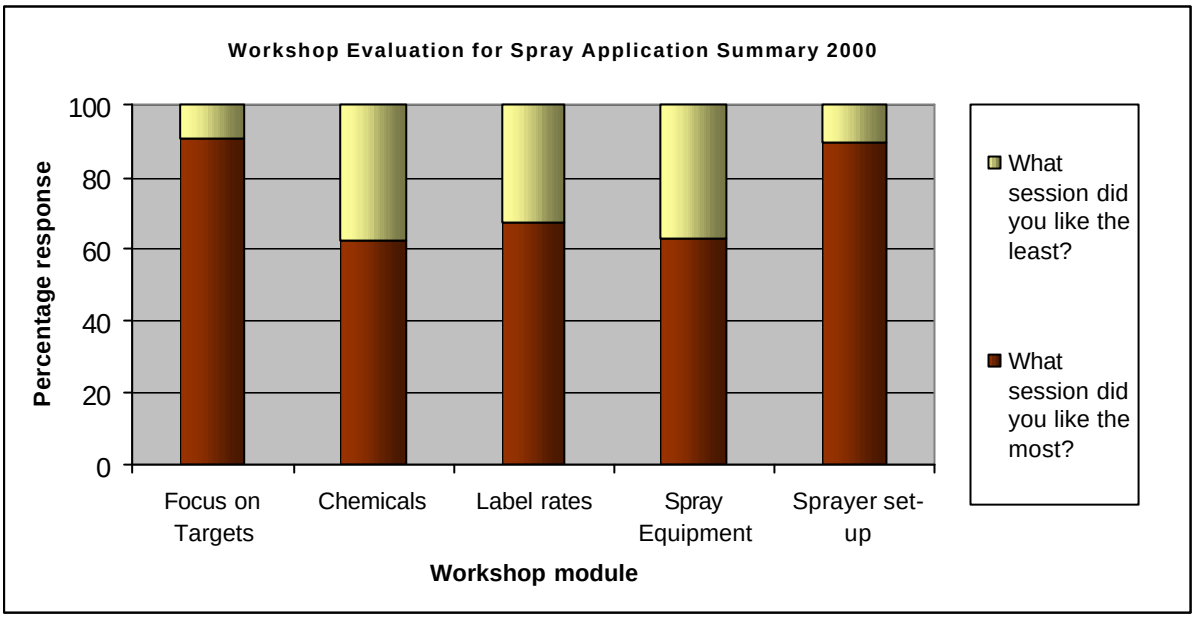


Figure 1. Spray application workshop evaluation 2000 – Day 1 (For the "Most liked" category, percentage response is the *positive number of responses obtained as a proportion of the total responses received for that presentation*).

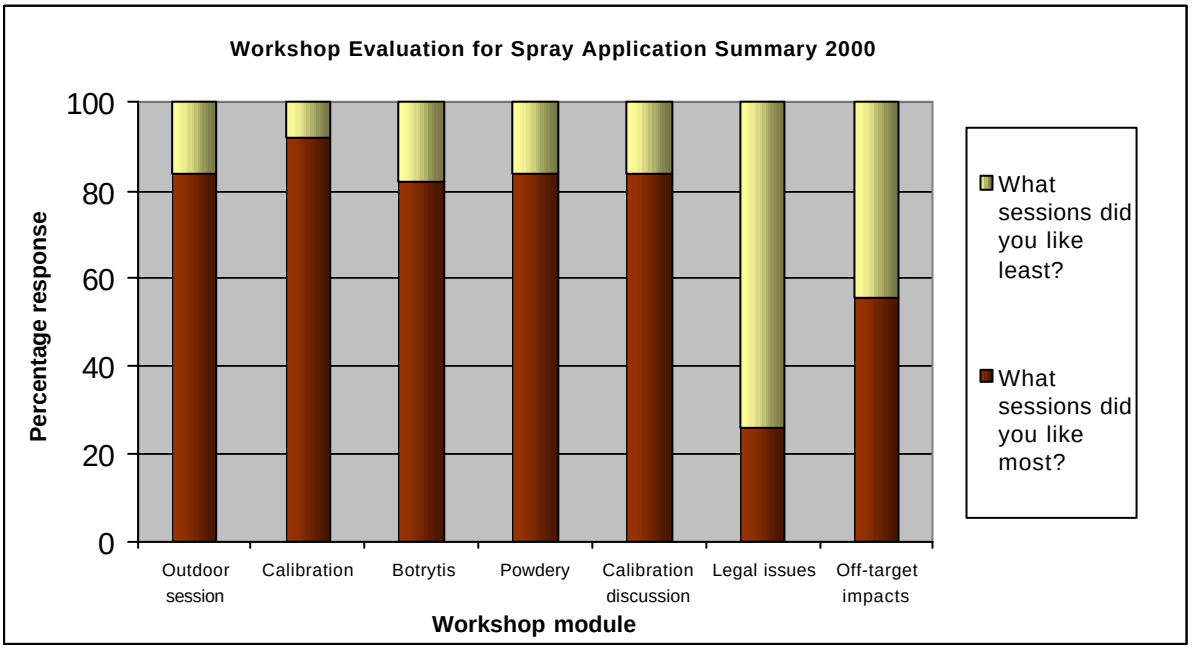


Figure 2. Spray application workshop evaluation 2000 – Day 2 (For the "Most liked" category, percentage response is the *positive number of responses obtained as a proportion of the total responses received for that presentation*).

It should be noted that in both 2000 and 2001 the 'Introduction' and 'Spray Quality' presentations, as well as the group sessions were not evaluated. In most cases the workshop feedback was extremely positive with 7 out of 12 modules liked by over 75% of participants in 2000 (Figure 1&2), and 10 out of 13 modules in 2001 (Figures 3&4).

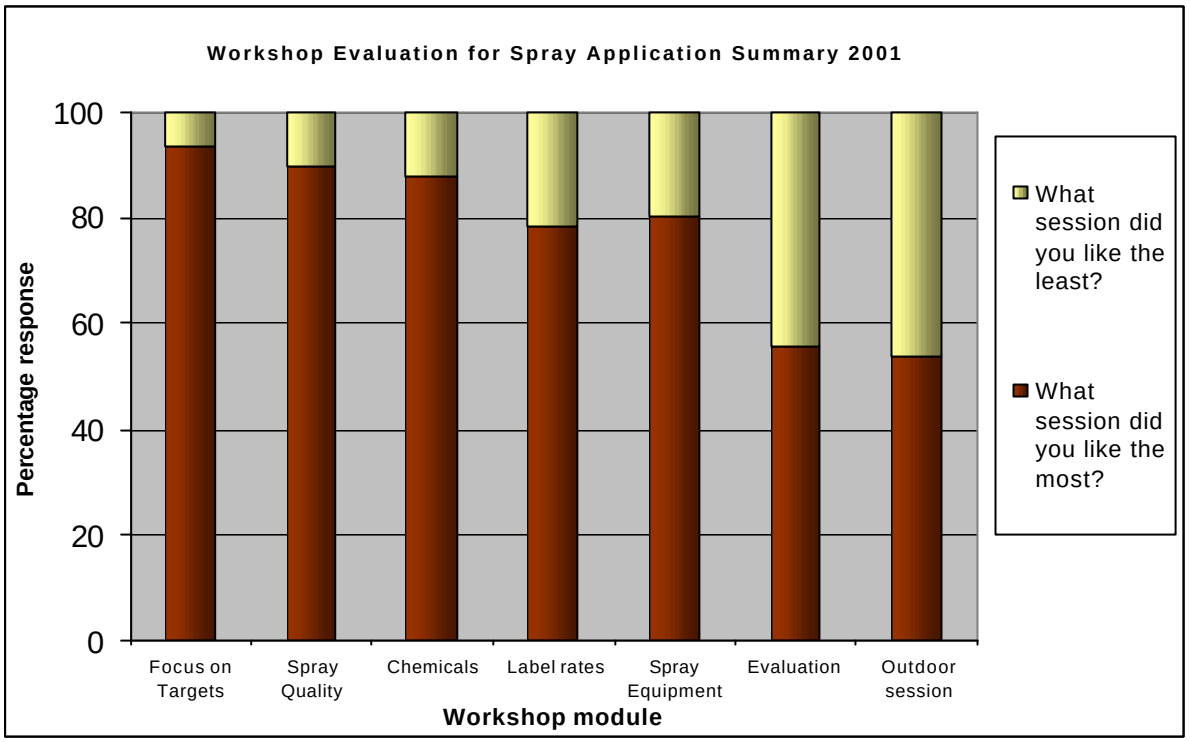


Figure 3. Spray application workshop evaluation 2001 – Day 1 (For the "Most liked" category, percentage response is the *positive number of responses obtained as a proportion of the total responses received for that presentation*).

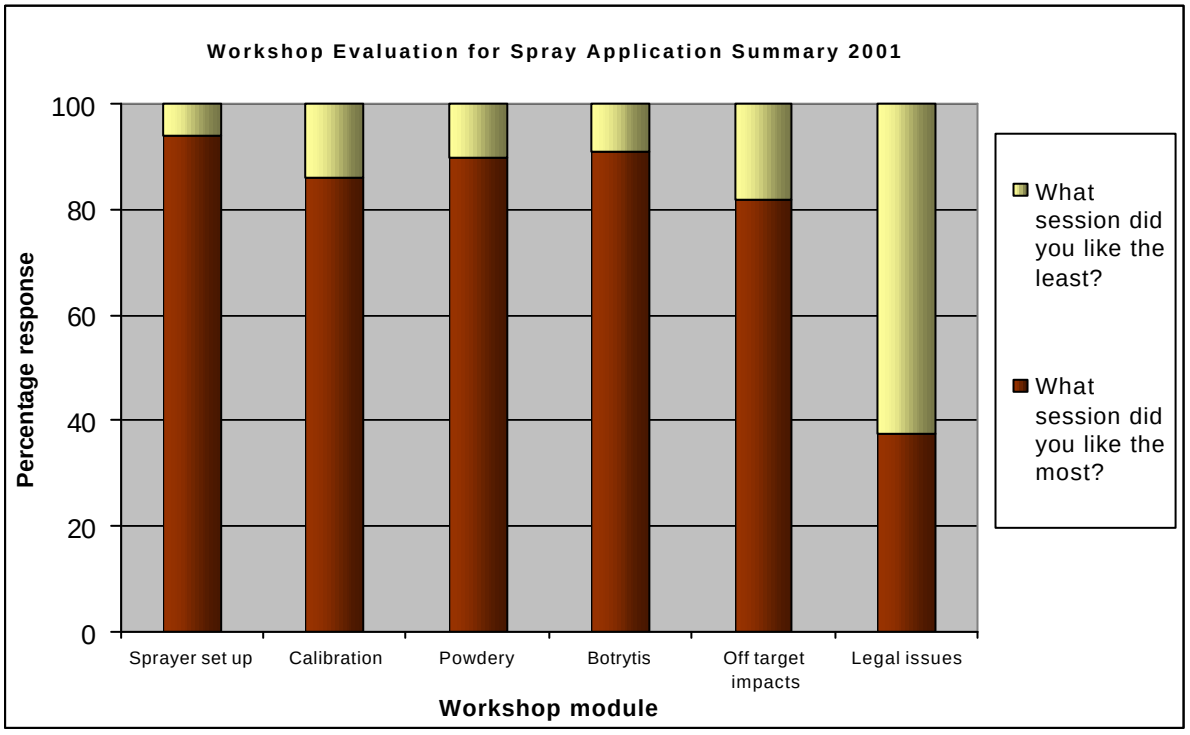


Figure 4. Spray application workshop evaluation 2001 – Day 2 (For the "Most liked" category, percentage response is the *positive number of responses obtained as a proportion of the total responses received for that presentation*).

The workshop evaluations indicate that generally, changes made to the workshop structure and content between 2000 and 2001 improved participant response to eight of the presentations while 'Focus on targets' and 'Sprayer set up' continued to be two the most popular modules. Overall approval of the workshop content increased from 58% in 2000 to 77% in 2001. In comparing workshops conducted over the two seasons it should be noted that:

- An increase was recorded in the positive response to the 'Chemicals' presentation of 28% from 2000 to 2002. This was an important topic that was expanded to include detailed coverage of resistance management, water quality, tank agitation and use of adjuvants. These were important issues that were also considered extremely important by growers but were not discussed in much detail during the 2000 workshops.
- An improvement of 10% was recorded in the response to the 'Labels' presentation, the result of moving the module to the second day after other key presentations such as 'Sprayer set up' had been delivered. Participants at this stage were able to understand how to determine spray volumes and chemical rates in the context of the whole pesticide application process and thus understand the interaction between each component.
- The 'Spray equipment' module increased in popularity by 20% between 2000 and 2001. This was mainly the result of an update in the content to include new spraying technologies as well as more attention being paid to individual group requirements when discussing sprayer selection and use. Participants also found a sprayer selection demonstration based on spreadsheet calculation valuable.
- In 2001 'Off-target impacts' was changed to a group session, allowing participants to raise issues of relevance to their vineyard and wine region and discuss these with experts. This was found to be a more interesting and valuable learning experience than having the relatively 'dry' and technical module delivered late on the second day when participants' concentration was often lapsing.
- A 30% decrease in positive responses to the 'Outdoor session' from 2000 to 2001. This was due to a combination of factors not related to content as this was only changed marginally. During the 2001 season delays to the field session due to inclement weather and sprayer malfunction, and delivery by machinery manufacturers in some cases, generated some negative feelings towards this module.

In terms of total nominations for presentations delivered during 2000 and 2001, it is interesting to note that there is no distinct pattern in the popularity or importance placed on any session or group of sessions delivered (Figures 5&6). The 'Powdery mildew' module was the most liked in 2001, nominated by 55% of participants compared to 38% in 2000. Another module focusing on pest and disease, 'Focus on targets' was also rated highly by over 40% of participants in both years. It is no surprise that pests and disease were important issues in 2001 as the 2000 season was a high pressure year for Powdery mildew and many participants placed a high value on understanding how to control this economically important disease.

'Calibration' and 'Labels' modules were both liked and disliked in each season by a relatively large proportion of participants. Many growers recognised the importance of properly interpreting label directions in improving application efficiency and effectiveness. But it was obvious during workshops that some growers became frustrated with the fact that, at present, there is no simple and straightforward method to accurately calculate chemical rates that will land a sufficient dose on a specific canopy. It is important to note that the 'Calibration' session in 2000, that was highly rated (nominated by 48% of participants), did not include calculations as this was a separate group session and not evaluated. In 2001 the calculation session was combined with the 'Calibration' module with a subsequent decrease in popularity (down to 32%) due to some participants finding the calibration calculations too complicated. In response, the calculations have been simplified for the 2002 season.

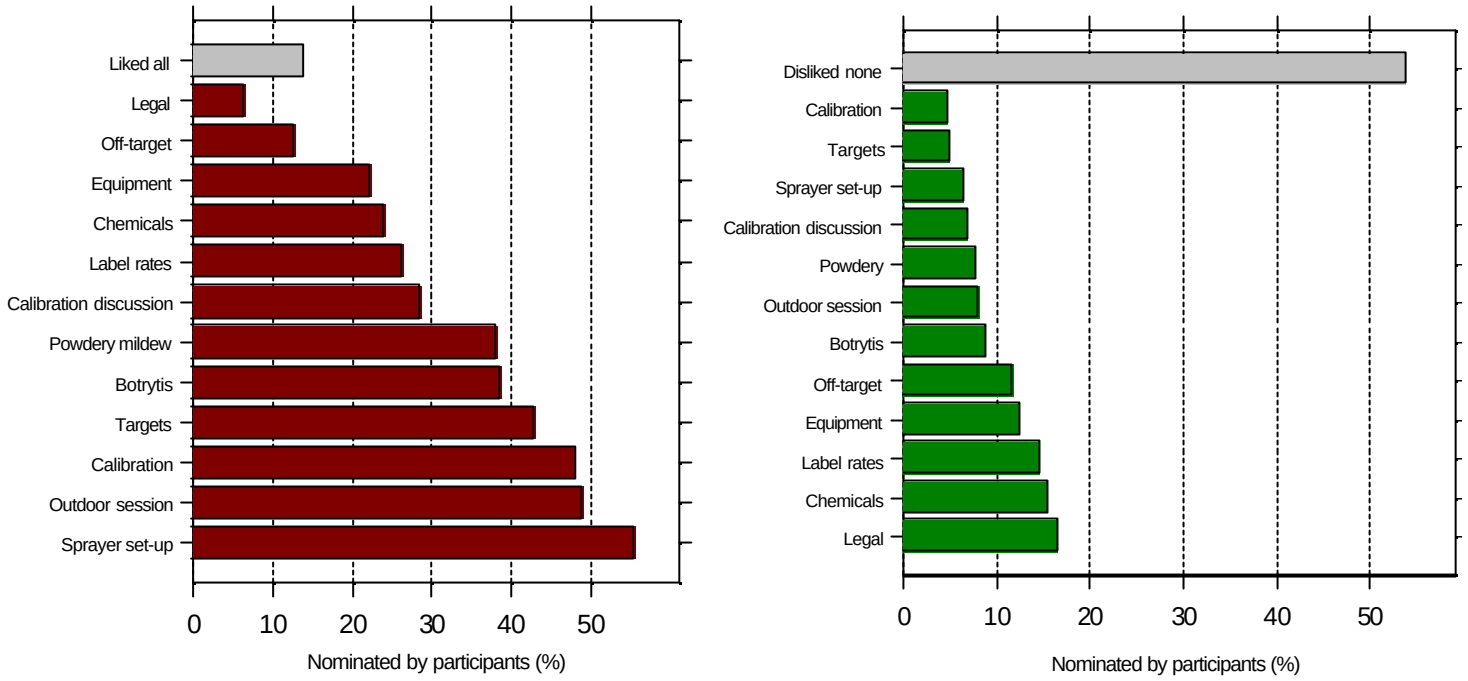


Figure 5. Most (left) and least (right) liked spray application workshop sessions in 2000. "Nominated by participants (%)" is the *nominations for that session as a proportion of total nominations in that season*. Only sessions that were delivered more then two times are listed and multiple nominations were allowed.

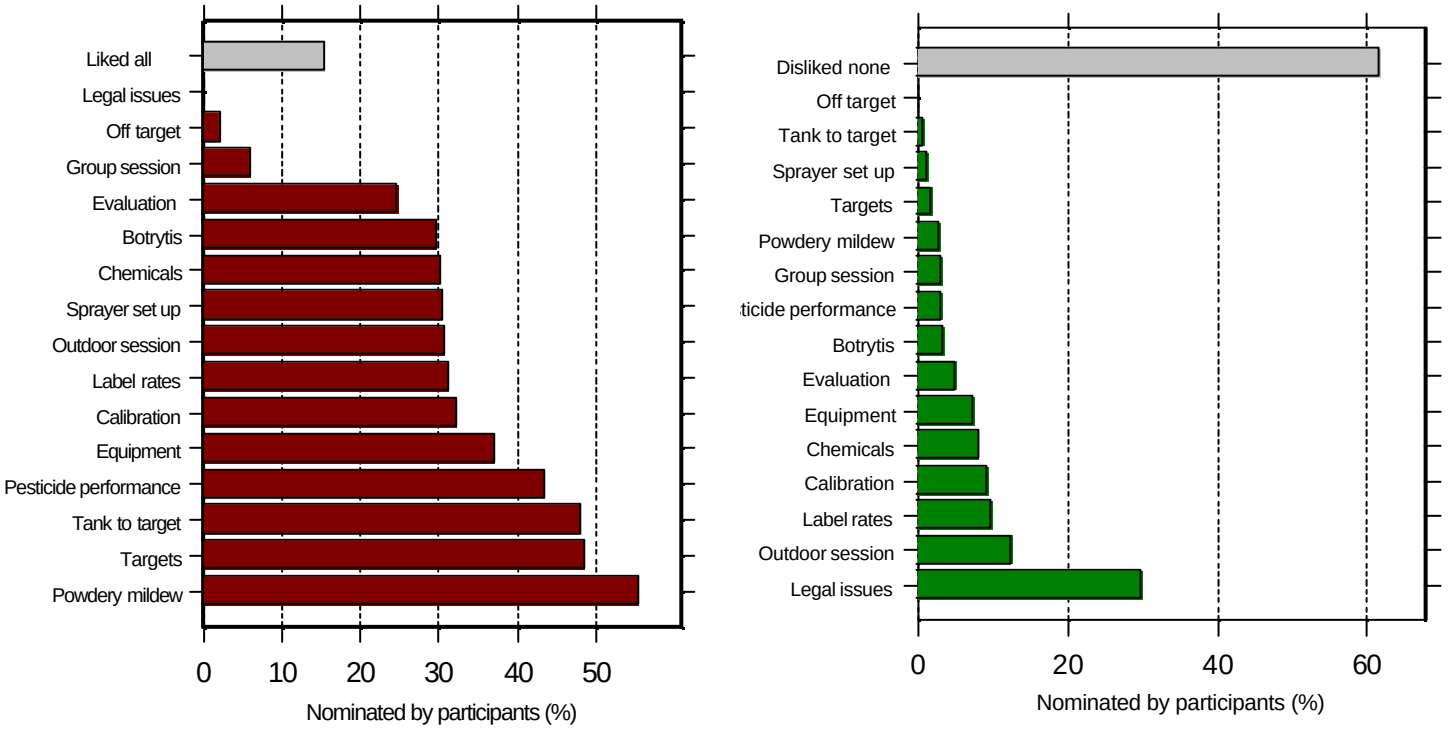


Figure 6. Most (left) and least (right) liked spray application workshop sessions in 2001. "Nominated by participants (%)" is the *nominations for that session as a proportion of total nominations in that season*. Only sessions that were delivered more then two times are listed and multiple nominations were allowed.

Although significant changes were made to the 'Legal issues' presentation during 2001 its unpopularity actually increased from 16% in 2000 up to 29%. Most participants attending the spray application workshop had already completed a Farm Chemical Users Course and thus found this session repetitive and inappropriate for this particular workshop. It was decided to incorporate this session into the off-target impacts group session at the end of day 2.

On a positive note, more than 14% of participants in both years liked all the presentations and 54% didn't dislike any sessions in 2000 increasing to 62% in 2001. This suggests that, for the majority of participants, all sessions were of some value and importance. In response to participant requests an "Improving pesticide performance" session was piloted in the 2001 season and was favourably received. This session allowed growers to focus on the effects of the tank mix on chemical performance, an often over-looked aspect of spray application. Specific topics covered included tank agitation, water quality, understanding and using adjuvants and chemical compatibility. This addition to the workshop program meant that more time could be spent on topics such as pesticide mode of action and resistance management in the 'Chemicals' session. This proved to be successful with participants demonstrated by an increase in its rating of 8% above the 2000 score.

Further positive and negative comments, as well as suggested improvements raised by participants regarding the workshop presentations and format, are documented by workshop and year in Appendix 5.

Group sessions and case studies

Generally there are three group sessions during the workshop as well four 15-30 minutes group discussions during and between presentations. These provide an opportunity for participants to look at issues in more detail than is possible during delivery of information by speakers. The group sessions on the afternoon of the first day include *Sprayer selection and calculations* and *Sprayer set up field session*. The session *Disease/Sprayer/canopy case study* was conducted during the afternoon of Day 2 and was developed to look at case studies of real life pest and disease situations that participants might have to deal with. Growers broke up into four groups of 4-6 depending on the total number of participants and each group was provided with a relevant case study, an example of which can be found in Appendix 4. A total of eight case studies were developed for this session. They were then asked to comment on the difficulties in managing the sprayer/canopy/disease combination and to determine how these problems could be overcome. This session helped tie the two days together and focused participants on management options they may have to consider with their future pesticide applications. In reporting back to the whole group, participants provided feedback to presenters on their understanding of the information presented, that enabled individual group members to immediately recognise potential changes they could make to their own pesticide application practices.

Feedback regarding the group sessions was generally positive with 71% (2000) and 74% (2001) of participants finding them useful and only 9% (2000) and 11% (2001) finding them not useful at all (Figures 7&8). Comments about the group sessions indicated that many participants enjoyed the interaction and opportunity to discuss issues with others in the group. Where there were negative responses to the sessions, these were usually due to personality issues eg. Overbearing members in discussion groups, and frustration with the lack of basic knowledge of some group members. Others preferred greater interaction with presenters than with other growers while quite a few participants commented that the time would have been better spent having presenters deliver information.

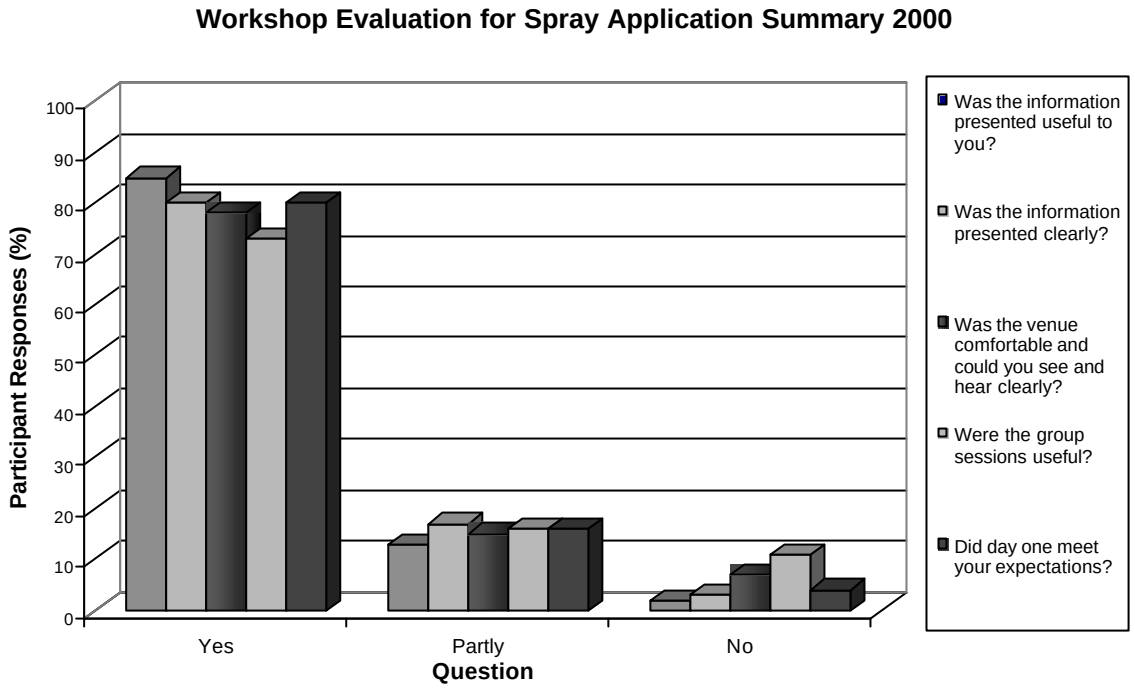


Figure 7. Spray application workshop evaluation 2000 – Usefulness of group sessions and information presented.

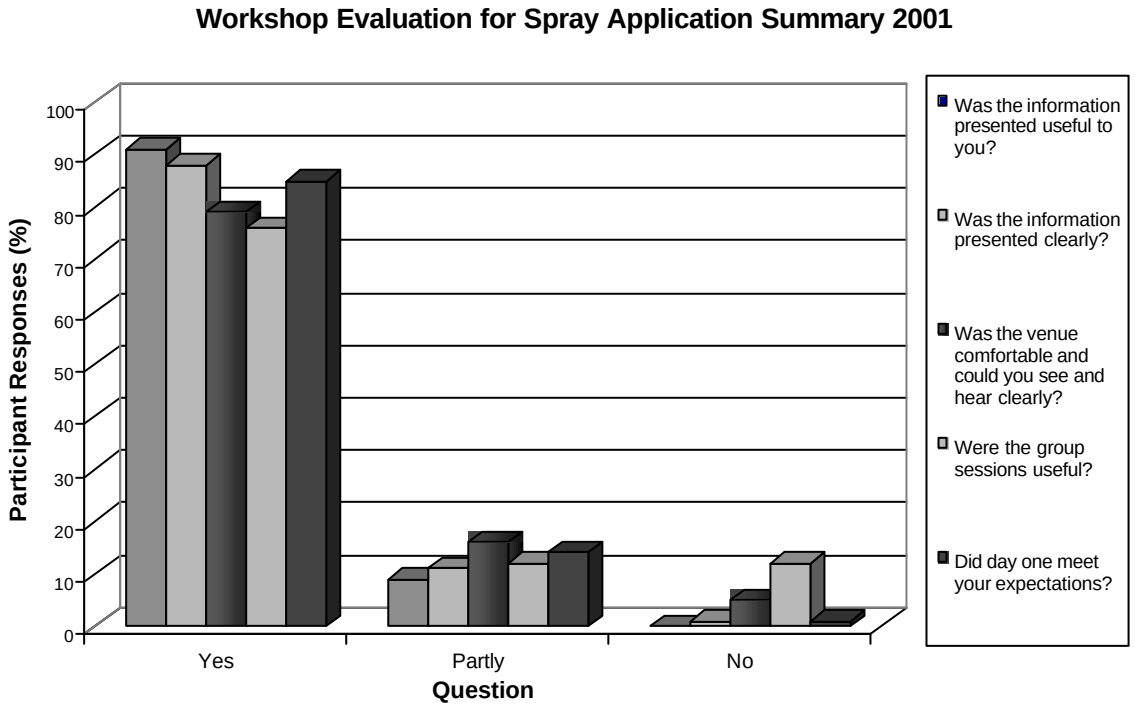


Figure 8. Spray application workshop evaluation 2001 – Usefulness of group sessions and information presented.

Variable response to the group sessions may also have been a consequence of the incorporation of a number of group discussions during the workshop that allowed the group to interact and discuss issues and situations directly relevant to them. Under these circumstances there may have been a lesser requirement for "formal" group sessions as such. For example during the *How much chemical goes in the tank?* discussion, growers provide anecdotal information that is then used by the presenters to demonstrate the methodology required to determine chemical rates and this generally generates constructive discussion and practical solutions.

Originally the group sessions were very similar to those used by the IPM and Water Management workshops (See Appendix 4). They focused each small group on one issue and asked the following questions:

- What are you currently doing?
- What would you like to change?
- What do you need to make that change?

The group sessions and discussions changed as the workshop progressed to cater more specifically to participant needs. For example in 2001 the 'Off-target impacts' group discussion began with the presenter describing a scenario that involved a vineyard situated at the rural-urban interface. Participants were then asked to discuss the environmental and legislative issues raised by the use of pesticides in this situation. This session generates much discussion and debate as well as providing some relaxation and fun at the end of the workshop. The group is then split into four and asked to discuss spray drift and off-target impact issues of importance to their vineyard operation based on guidelines provided (See Appendix 4). In 2001 group discussions were formally incorporated into the workshop program and used to break up each day and allow participants to consider, criticise or ask questions about the information delivered by presenters. These sessions were particularly beneficial during the afternoon of day 2 when many participants felt that enough information had been presented and that they were now in a position to be able to discuss the consequences, risks and benefits of implementing changes in their pesticide application practices.

Field session

The field session of Research to Practice® workshops is used to demonstrate how the concepts and methodologies discussed during presentations can be applied in the vineyard. In the spray application field session participants have an opportunity to setup spray equipment for a specific vine canopy and growth stage and assess spray coverage using evaluation tools such as water sensitive cards and spray poles. Important aspects of sprayer calibration are also discussed and demonstrated. Concepts such as air quality are also introduced at this stage and discussed in more detail on the second day. Use of evaluation recording sheets (See Appendix 4) to compare various sprayer set ups is also demonstrated. The field session is generally popular as it gives growers an opportunity to use practical tools and techniques that will assist them in their own vineyards. The familiar learning environment also seems to suit many of the participants while anecdotal evidence suggests that a 'hands-on' approach followed by theory delivered the following morning increases understanding of this critical area.

Weather was the main problem encountered with the field session in 2001 with rain causing interruptions or delays in a number of workshops. These were overcome by conducting the session under cover eg. In a farm shed and setting up a sprayer without actually spraying vines or rescheduling it for the following day.

Workshop locations

In the first year of the project 10 workshops were delivered including four pilots while in the following three years, 12, 7 and 4 workshops were conducted. There were a total of 33 workshops delivered over the four-year life of the project (including 2002). The total number of participants who filled out enrolment forms was 750. There were also a number of participants who attended as part of their training to become presenters as well as researchers from state agricultural departments. At least one workshop was delivered in every state with the majority of workshops held in South Australia, Victoria and NSW (Table 3), the largest wine-producing states in Australia. A total of four workshops were conducted in McLaren Vale, South-East SA, Sunraysia and North East Victoria (Table 4).

The support of the major wineries, grower associations or research/extension agencies were important factors contributing to significant grower participation in these regions. In McLaren Vale, company viticulturists from two major wineries organised and hosted workshops as well as contributed to presentations and general discussion. This input was valuable to participants, as they were able to find out more about the procedures and requirements of the company to which they were supplying grapes. Again, strong wine-company support as well as interest from relatively new growers in South-East SA contributed to high participation in this region.

In Victoria, high participation rates were mainly due to close linkages between researchers, grower associations and GrapeCheque extension officers, particularly in Sunraysia and some areas of Northeast Victoria. Interest in improving pesticide application techniques was also high in Sunraysia due to consistent problems encountered with control of powdery mildew in their relatively large vine canopies. In the other states, workshops were held in each of the major wine grape growing regions with many of these organised and hosted by grower associations usually in response to a high disease pressure and poor control in the district the previous year.

Table 3. Breakdown of number of workshops conducted in each state and corresponding number of participants (1999-2002).

State	Number of workshops	Number of participants
South Australia	13	284
Victoria	10	224
New South Wales	7	149
Queensland	2	42
Tasmania	1	27
Western Australia	1	24
Total	**33**	**750**

Table 4. Number of participants and workshops in each region on a state-by-state basis.

State	Region	Number of workshops*	Number of participants
South Australia	McLaren Vale	4	84
	South East	4	85
	Barossa Valley	2	50
	Langhorne Creek	1	23
	Riverland	1	20
	Adelaide Hills	1	22
Victoria	Sunraysia	4	98
	North East Victoria	4	89
	Swan Hill	1	19
	Yarra Valley	1	18
New South Wales	Griffith	2	47
	Cowra	1	19
	Orange	1	22
	Hunter Valley	1	22
	Tumbarumba	1	22
	Mudgee	1	17
Queensland	Stanthorpe	1	21
	Mundubbera	1	20
Tasmania	Tamar Valley	1	27
Western Australia	Pemberton	1	24

*Includes 4 pilot workshops

Workshop participants

A broad breakdown of workshop participant's involvement in the wine grape industry is presented in Figure 9.

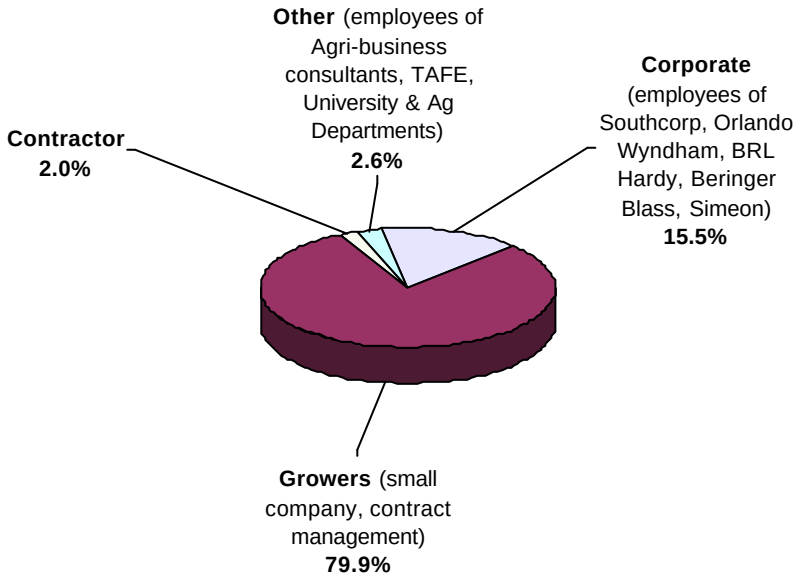


Figure 9. Breakdown of the occupation of participants attending workshops sourced from their enrolment forms.

The high participation rate of growers and employees of smaller wine companies (79.9%) was a positive aspect of the workshop program. Anecdotal evidence suggests that a majority of the grower group came from privately owned vineyards who generally have relatively limited access to scientists and technical experts. A significant number of workshops were also hosted by grower associations representing these smaller growers demonstrating that this sector of the market is being catered for to some extent. It would be of interest though to determine what percentage of the owner/growers we are not reaching as this would assist with the development of programs to target this potentially important group.

Employees of the large corporate wine companies including Southcorp, Orlando Wyndham, BRL Hardy, Beringer Blass (formally Mildara Blass) and Simeon also made up a significant proportion of workshop attendees (15.5%). These included vineyard managers, technical personnel, spray operators and growers. Many of these employees were in positions where they could pass on much of the information presented in the workshop to others in the organisation often increasing the dissemination of the information many fold. Companies such as Southcorp, Rosemount and Orlando Wyndham have hosted workshops specifically for their employees while others preferred to attend with growers from other companies. We have found that participants from different vineyards have generally worked well together to address pesticide application and disease management issues in a region. A high proportion of participants in the 'Other' category were made up of chemical representatives and resellers, consultants and educators who recognised the importance of improving their knowledge base to address pesticide application issues. Many in this group deal with growers on a daily basis and are thus in a position to assist in the adoption of improved practices.

Workshop evaluation

There are two aspects of evaluation that have been incorporated into the workshop program:

- Assessing the success of the program in fulfilling a range of participant expectations; and
- Measuring whether growers incorporate or improve their pesticide application practices as a result.

A number of methods were developed to collect data to evaluate the success of workshops. These included questionnaires on the structure and presentation of the workshops themselves, surveys of current spraying and disease management practices used by growers and their perceptions of pests and diseases in their region, and 3rd day reporting on participants' 'Promises'. During the first two days of the workshop there were also reports collected from group discussions concerning the management of major pests in each region. In many cases, the results of these surveys and reports have been used to continually improve and expand the information package for workshop participants, and to provide feedback to the research community.

The evaluation for the first two days was focused on the information presented, how relevant and useful it was and whether participants viewed the workshop as good value. The third day evaluation focused on the changes in practice that participants had made during the previous season. There was also information gathered about how they viewed the process of making, completing and reporting back on their promises.

The following three sections analyse the key results obtained from the questionnaires and evaluation sheets completed by participants before, and at the end of the first 2 days, as well as at the conclusion of the third day of the workshop.

Current practices - Workshop questionnaire

As a component of the pre-workshop preparation participants were asked to respond to a questionnaire specifically developed for the spray application program (Appendix 2). The facilitator used the data gathered from these to determine the key regional issues that the group would want addressed in the workshop. It also provided an indication of current pesticide application practices, equipment use and evaluation techniques. This information was also used to adapt the workshop structure and presentations to the needs of participants and provided presenters with valuable background knowledge. Questionnaire responses obtained from participants between 1999 and 2001 highlighted some important deficiencies in practices before participants attended workshops. These results were used as a benchmark to assist in determining whether this Research to Practice® program significantly changed pesticide application practices in the viticulture industry.

Vertically shoot-positioned (VSP) canopies were the most common trellising system encountered by participants during their spraying operations followed by 2-wire vertical and single-wire ie. Minimally pruned (Figure 10). Discussion in many workshops tended to revolve around the proper targeting of pesticide sprays to these canopy types. Most growers found VSP canopies relatively easy to target but many had difficulty with spray penetration due to high foliage density once wires were lifted. It is interesting to note that 27% of participants did not respond to this question. The most likely reason for this being, that many of the spray operators were unfamiliar with the various trellising systems.

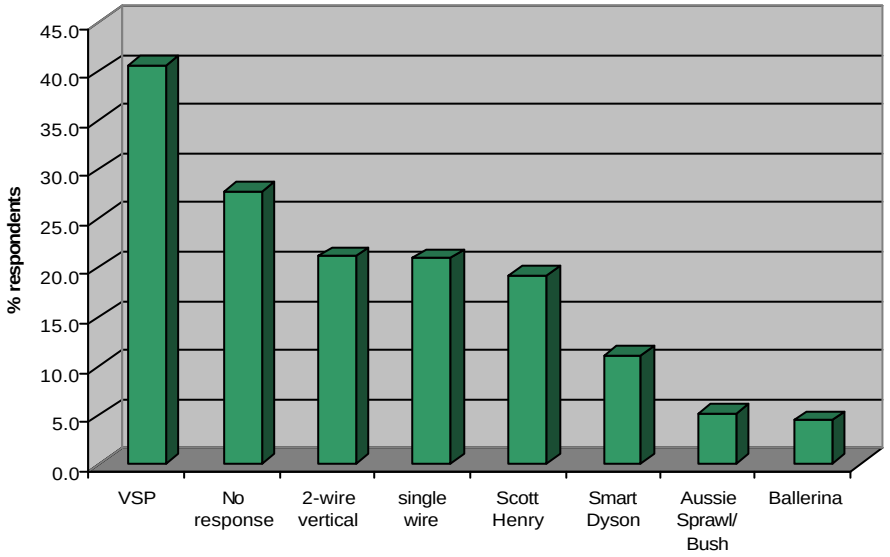


Figure 10. Most common trellising systems used by spray workshop participants in 1999-2001 (multiple responses allowed).

The type of spray equipment used by the majority of participants is identified in Figure 11. Most growers and spray operators used air blast (45%) or air shear (33%) machinery with larger companies sometimes using both types in spray operations. Thirty-one percent of participants also used boom sprayers, mainly for their herbicide applications but also for early season vine sprays. In many workshops the sprayer set up presentation and field session focused on possible adjustments to this type of equipment to improve spray targeting and coverage.

There were a variety of methods used by participants to select appropriate water volumes (Figure 12). The most common technique was to increase spray output during the season as the canopy grew by opening more nozzles on the sprayer (Figure 12). Surprisingly 26% of participants did not respond to this question, possibly suggesting that this process was out of some participant's hands ie. Spray volume selection was a management decision.

Of greater concern is that it may also represent a lack of understanding by some growers of the importance of matching water volumes and chemical rates to the size of the target. Over 17% of participants did increase water volumes for different targets such as early season cordon sprays and grape bunch applications but a significant number (15%) still depended on water volume recommendations on the chemical label which were phased out in mid-2001.

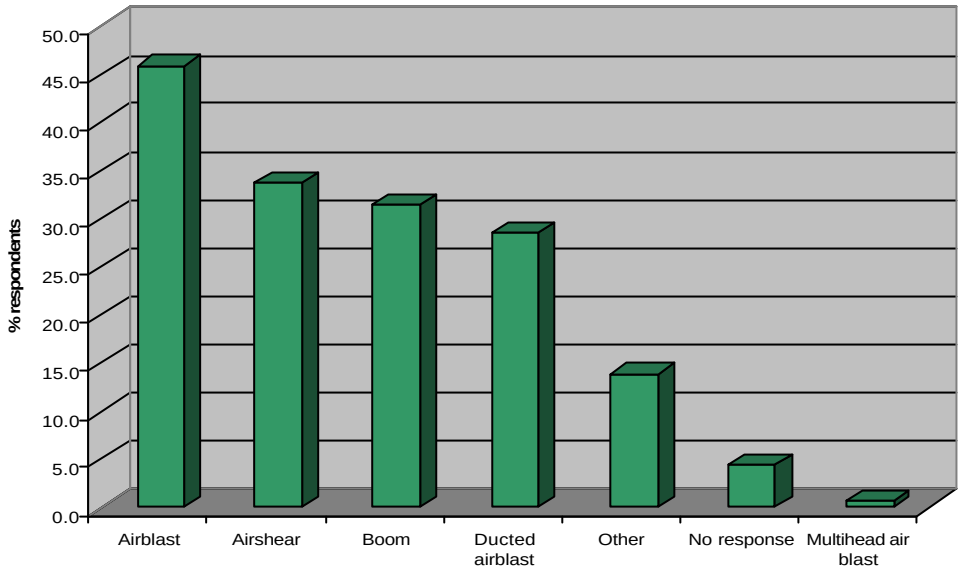


Figure 11. Most common spray equipment used by spray workshop participants in 1999-2001 (multiple responses allowed).

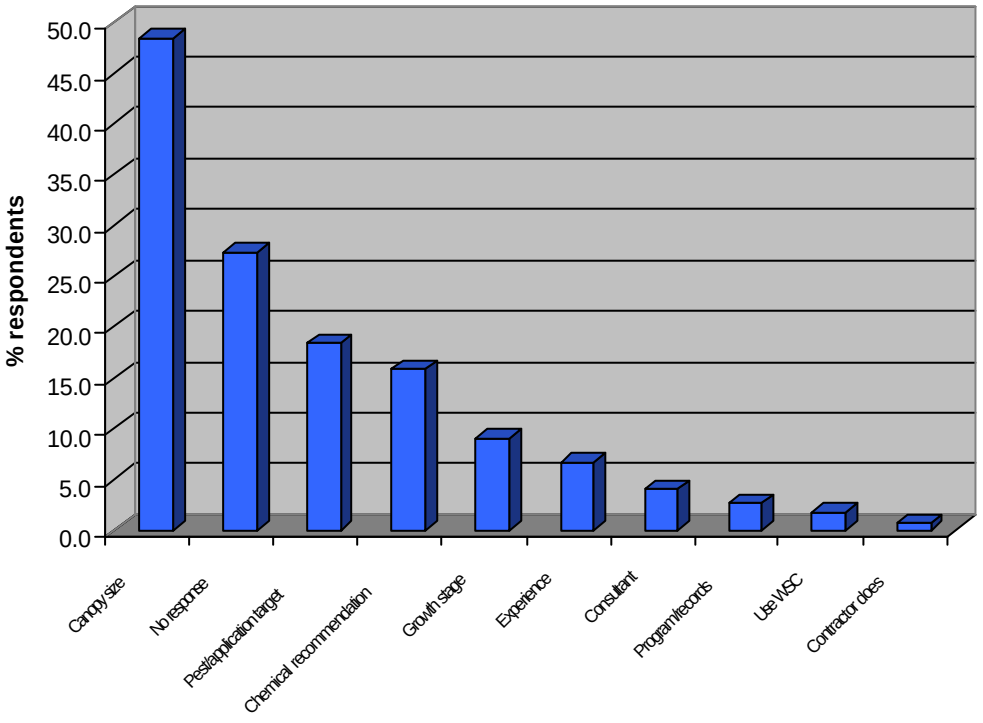


Figure 12. Most common method used by spray workshop participants to selec water volumes in 1999-2001 (multiple responses allowed).

Figure 13 demonstrates that a high proportion of participants (70.6%) used the chemical rate per hectare from the pesticide label while 54.7% used the rate per 100 Litres of water. This was an important result suggesting that many growers were unaware or did not understand the new changes to pesticide labels being progressively introduced by AVCARE that removed rates per hectare in preference to a rate per 100 Litres. This component of spray application was a consistent source of frustration and misunderstanding for growers, especially those that used concentrate spraying with air shear equipment.

A major focus of the workshop was to demonstrate why the rate per hectare expression was inappropriate for spraying vines and to take participants through a step-by-step process for correctly calculating chemical rates using the new pesticide labels.

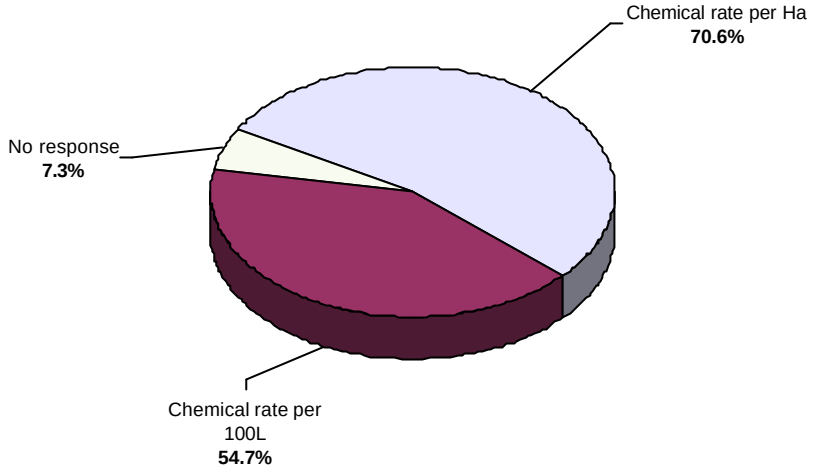


Figure 13. Most commonly used chemical rate from pesticide labels by spray workshop participants in 1999-2001 (multiple responses allowed).

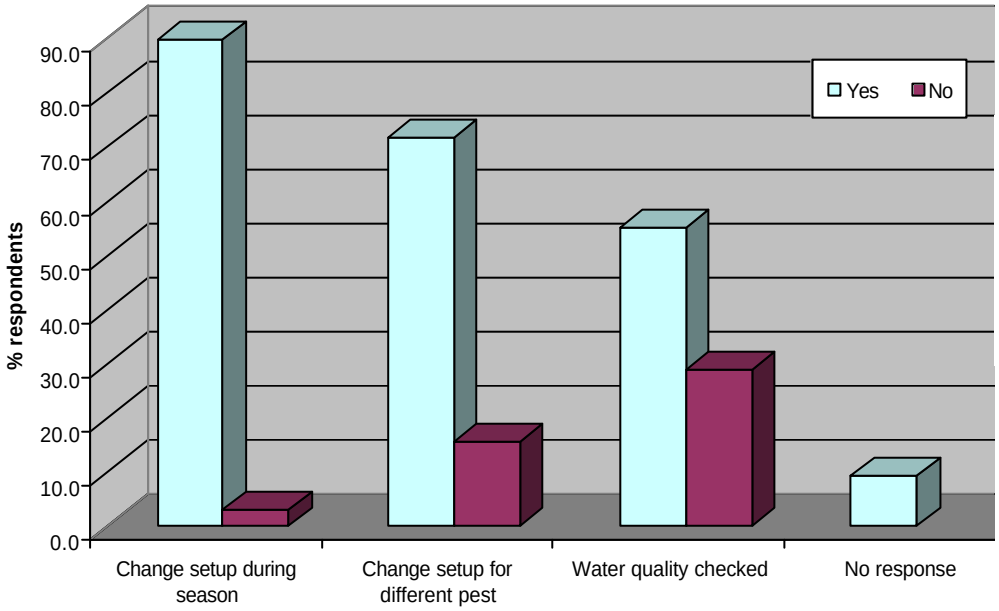


Figure 14. Percentage of spray workshop participants who changed sprayer set up and checked their water quality during each season in 1999-2001.

Eighty-seven percent (87%) of participants modified their spray equipment set up in some manner during the season to suit the canopy they were spraying while 69% also changed the sprayer set up for different pests and disease eg. *Botrytis* bunch sprays (Figure 14).

Although these results are relatively high, a more detailed study of the questionnaire indicated that the majority of growers only changed water volumes during the season by increasing nozzle number (62%), nozzle size (45%) or changing travel speed (62%) (Figure 15). This was important information to have before each workshop, as it was obvious that many participants did not consider manipulation of air direction, speed and volume to improve coverage during sprayer set up. A small percentage of growers changed travel speed to increase or decrease air volume at the canopy and 43% stated that they modified the air direction from sprayers as the vine grew. Again, a significant proportion of the workshop was devoted to demonstrating and discussing the benefits of modifying air quality from spray equipment to maximise coverage.

It was also clear from the questionnaire results that just under half of the participants did not check their water quality and that many did not consider the affect of low quality water on the pesticide effectiveness (Figure 14). In response to this situation a new module "Improving pesticide performance" was developed for the 2001 season that considered water quality and adjuvant issues in some detail.

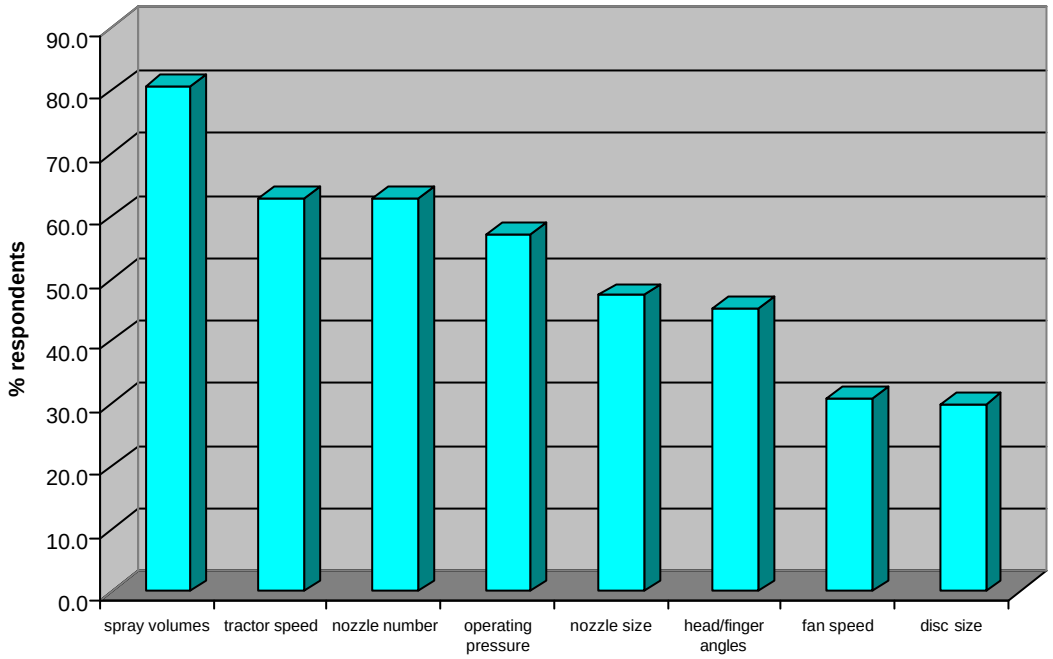


Figure 15. Most common modifications made to spray equipment set up by spray workshop participants in 1999-2001 (multiple responses allowed).

Probably the most important results obtained from the pre-workshop questionnaire concerned the methods and tools used to evaluate spray coverage during pesticide application. Over the three seasons the data showed that on average only 24% of participants consistently used evaluation tools such as water-sensitive cards (WSC) to determine whether they were maximising spray coverage (Figure 16). Overall, only 43.7% of growers had tried WSC at least once and 12.4% had used fluorescent dyes to test the effectiveness of spray equipment (Figure 17).

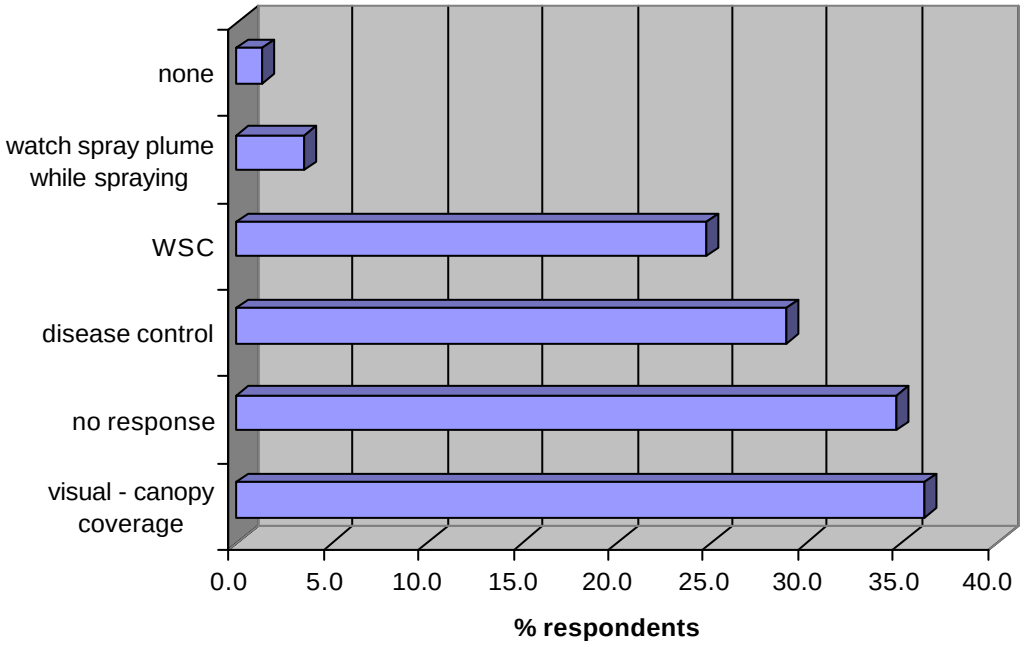


Figure 16. Most common evaluation methods used by spray workshop participants in 1999-2001 (multiple responses allowed).

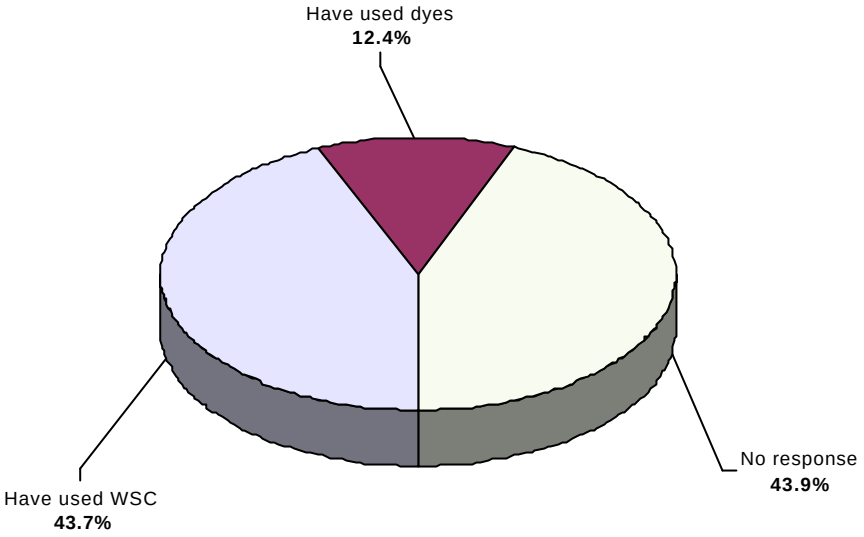


Figure 17. Percentage of spray workshop participants who have used water-sensitive cards or fluorescent dyes at least once to evaluate spray coverage.

The most common method used to evaluate coverage was to visually assess the sprayed vine canopy (36%) (Figure 16). Although this is an acceptable but not very accurate approach when spraying to run-off and wetting foliage, this system is almost impossible to use when concentrate spraying due to rapid drying of fine droplets. Effective disease control was used as an indicator of acceptable spray coverage during the season by 28% of participants. Again, this approach has its limitations, as in many cases it may have been other factors such as low disease pressure, climatic conditions or cultural practices that resulted in good disease control rather than effective pesticide application.

Worryingly, 34% of growers did not use any method at all to evaluate spray coverage before the workshop and thus this was seen as an area where significant improvements could be made to current practices. A standardised, step-by-step process for evaluating spray coverage using WSC and spray poles was developed and presented in workshops to address this important issue.

First 2 days evaluation

Feedback obtained from the first two days of the workshop program indicated an overwhelmingly positive response to the workshop content, structure and cost. A majority of participants (86%) believed that they would be able to use the information delivered in the workshop to improve spray application operations in their vineyard (Figure 18). In three seasons of workshops not one participant felt that none of the information presented was useful to them. Regarding the cost of the workshop with a FarmBis subsidy ranging from 50-75%, 84% of participants considered it good value for money.

As part of the workshop evaluation participants were also asked to comment on why or why not they believed the workshop was useful and good value. Not all participants provided responses to these questions but of those that did, 23.3% indicated that they had gained a greater knowledge of spray techniques by attending the workshop (Figure 19). Other benefits that consistently came up included ‘More effective/efficient spraying operations’ (17.0%), ‘Better understanding of application components’ (8.2%), and ‘More informed decision-making’ (6.9%).

It was clear from these comments that many participants left the workshop with a better understanding of the components that need to be integrated to improve pesticide application, and with greater confidence to make disease management decisions and implement changes.

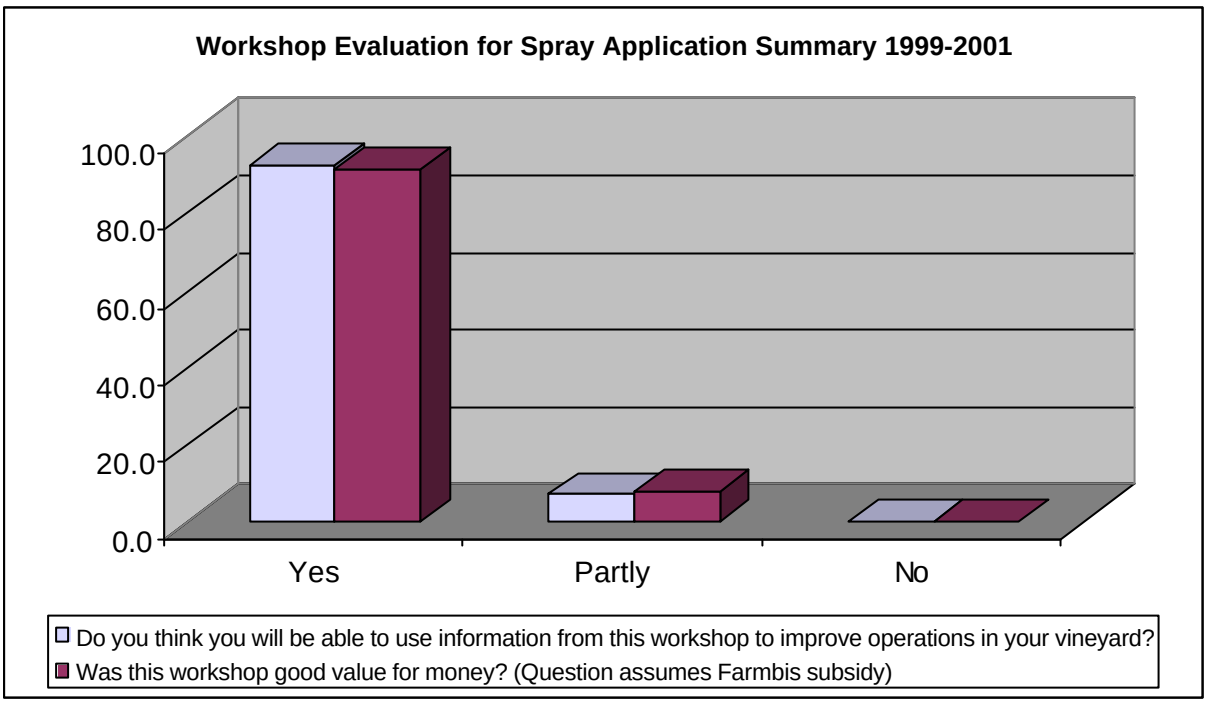


Figure 18. Overall success of spray application workshops as evaluated by participants at the end of day 2.

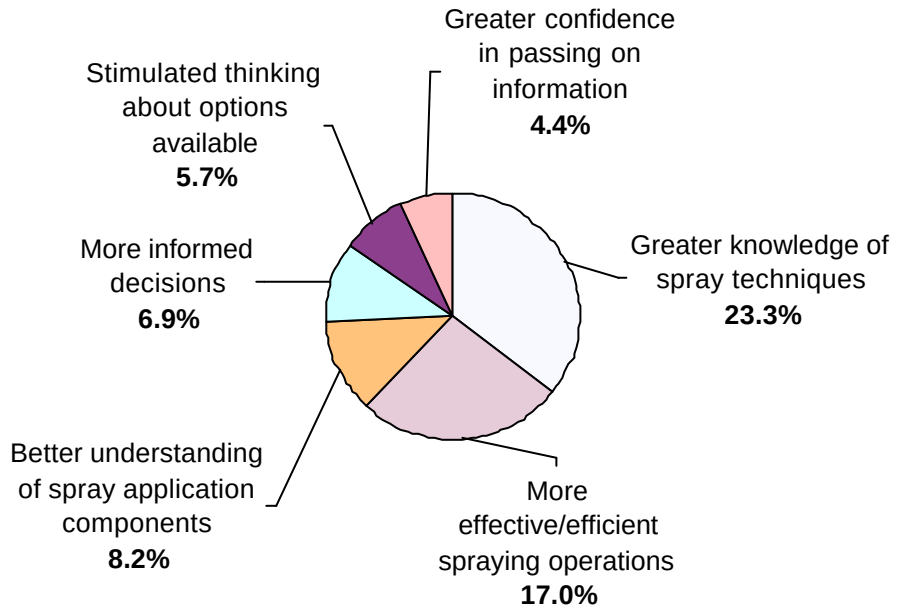


Figure 19. Most common comments made in response to the evaluation question *Do you think you will be able to use information from this workshop to improve operations in your vineyard?*

Of participants who considered the workshop to be good value for money and that outlined their reasons, 24.1% believed that this was due to the fact that it was very informative and provided practical and useful information (Figure 20).

Thirteen percent (13.0%) of comments indicated that the workshop was good value due to the quality of the presenters and content while 8.3% felt that they would easily recoup the money spent by being able to reduce spraying time and wasted over-spray.

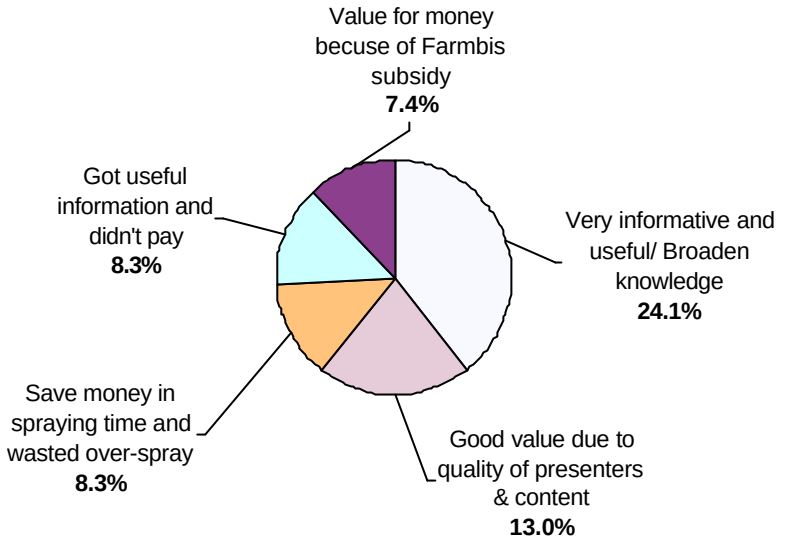


Figure 20. Most common comments made in response to the evaluation question *Was this workshop good value for money (with a FarmBis subsidy)?*

A small percentage of participants provided some constructive criticism of the workshop program and these were used in some cases to refine the content and structure. A few spray operators (1.3%) felt that although the information was useful they were not in a position to make management decisions (Table 5). Some also commented that their managers should have attended the workshop rather than themselves. In a few cases (2.8%) wine company employees and vineyard managers that already had good knowledge of the area found some modules of the program a little basic. This was probably unavoidable as the knowledge base of participants usually spans across a wide range of viticulture skills and experience and it sometimes difficult to meet every participant's needs.

Table 5. Suggestions and negative comments made by participants regarding the success of the workshop at the end of day 2

Do you think you will be able to use information from this workshop to improve operations in your vineyard?	**% respondents**
Don't make management decisions	1.3
Vineyard managers already have good spray efficiency	0.6
Some sections not relevant	0.6
Not sure point of run off can be found with air shear	0.6
Was this workshop good value for money?	**% respondents**
Some repetition of information/covered at university/good knowledge already	2.8
Useful more as a guide or check/revision	1.9
Expensive when including employer costs but worthwhile	1.9
Don't know the cost	1.9
Too expensive	0.9
Should be designed to obtain relevant information	0.9
Looking for more practical skills	0.9
Better value when definitive answers can be given ie. Labels	0.9

The 'promise'

Participants fill out a promise at the end of the first two days, an important tool developed to facilitate transfer of learning. It is an integral part of the Research to Practice® model as it assists participants in making a real commitment to adopting at least one new practice prior to the third day of the workshop. The promise provides them with an opportunity to consider, plan and implement new pesticide application procedures or processes in their vineyard. This activity proved very successful with the majority of participants having no difficulty finding something from the workshop that they would like to try out in their vineyard.

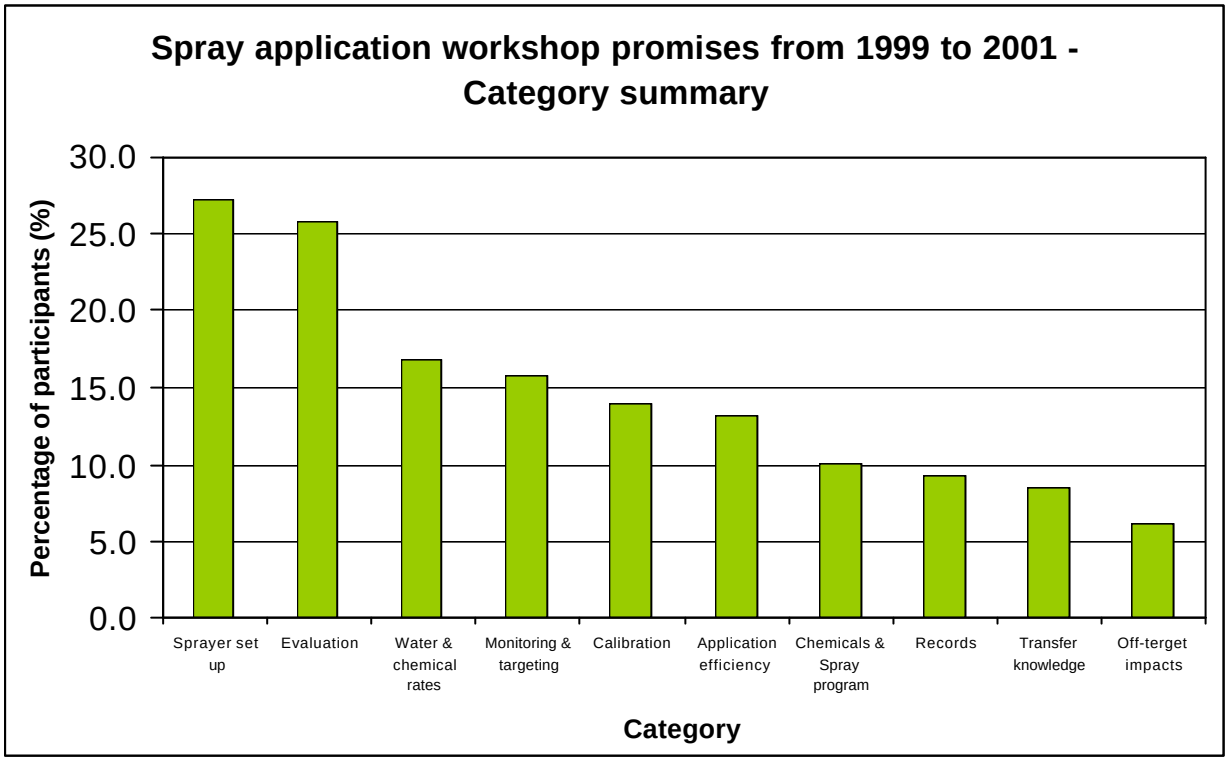


Figure 21. Summary of promises made by all participants by category.

The promises from all workshops between 1999 and 2001 have been collated and grouped into broad categories (Figure 21). The most common types of promise included in each category are described in Table 6. Figure 22 describes the most common **specific** promises made by participants while Figure 23 lists other popular promises within the broad categories used. The two highest rating promise categories were *Sprayer set up* (27.2%) and *Evaluation*. This was an extremely positive outcome as one of the major aims of the workshop was to demonstrate and emphasise the importance of continually adjusting sprayer set up to suit the canopy sprayed and evaluating the effect on pesticide coverage. It was also significant that another 13.2% of participants indicated that they would improve pesticide *Application efficiency* by commencing or continuing to set up, calibrate, monitor and evaluate spraying operations throughout the season.

This procedure is considered to be a critical component of any process by which growers make significant improvements in the effectiveness of spray application in their vineyards. As previously discussed a majority of participants did not properly evaluate spray coverage or set up equipment beyond changing water output during the season before attending the workshop (Figures 15&16). These results demonstrated the potential of the workshop program to significantly impact on the strategic management decisions made by many of the participants attending the course.

Table 6. Description of most common promises made under each broad category.

Promise Category	Description
Sprayer set up	- Adjust sprayer set up (air volume, speed and direction) as canopy changes to maximise coverage and dose - Correctly target vine canopy - Select nozzles to optimise droplet size
Evaluation	- Monitor and assess coverage using evaluation tools such as water-sensitive papers - Determine point of run off when dilute spraying
Water & chemical rates	- Increase/reduce water and chemical rates to match vine canopy - Use chemical rate/100 L instead of rate/ha - Use water rates/100m rather than rate/ha
Monitoring & targeting	- Implement IPM & monitor regularly for pests and disease to reduce number of sprays - Improve pest targeting and timing of sprays - Target bunches for *Botrytis* sprays
Calibration	- Calibrate sprayer more often and better maintain records - Check accuracy of calibration/nozzle outputs
Application efficiency	- Set up, calibrate, monitor and evaluate throughout season to improve pesticide application efficiency
Chemicals & spray program	- Use pesticides more effectively, safely and reduce use - Develop new spray program, consider alternative chemicals/adjuvants - Minimise number of chemicals in tank/check water quality
Records	- Improve accuracy and details of spray records - Improve O,H & S and chemical storage records
Transfer knowledge	- Transfer knowledge gained in workshops to growers, vineyard managers, operators and colleagues
Off-target impacts	- Minimise spray drift by better targeting of sprays and application under suitable conditions - Reduce off-target impacts and costs/consult neighbours and develop vineyard records

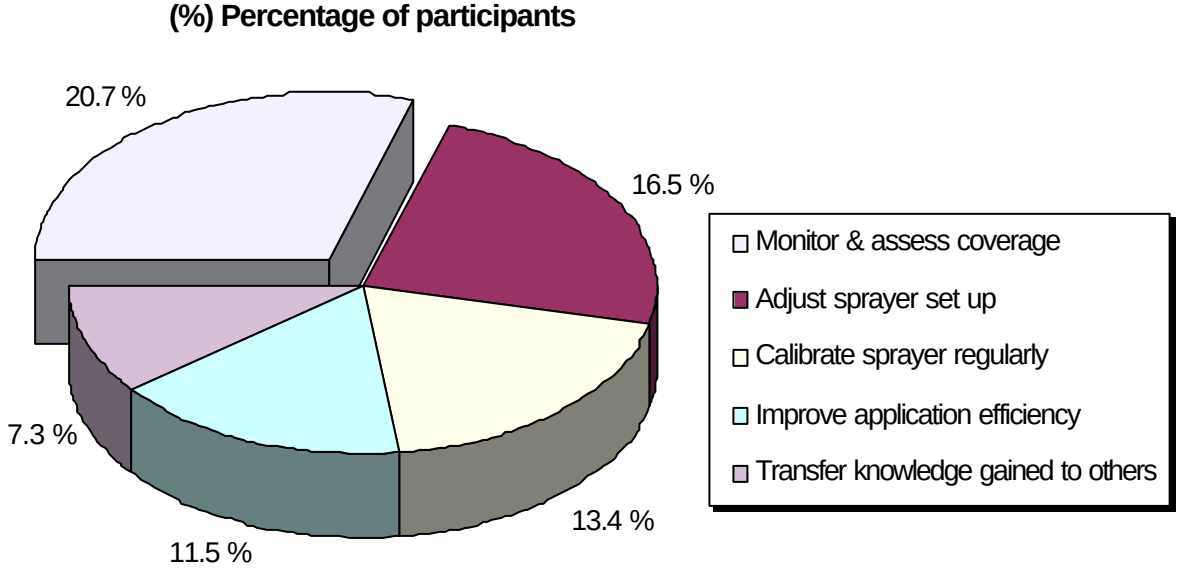


Figure 22. Five most common specific promises made by participants of Research to Practice® spray application workshops (multiple nominations allowed).

Greater accuracy in matching water and chemical rates to the size and growth stage of vine canopies was also considered important in reducing pesticide use and spraying costs by 16.8% of participants.

A majority of growers in this group promised to commence using a chemical rate per 100 L rather than a rate per hectare. This is a significant change in approach, correct implementation will generally result in reduced pesticide use during most of the season. Most growers never use a spray volume of more than 1000 L/ha on which the rate/ha on pesticide labels is based. With the changes to the chemical label and removal of a rate/ha a number of participants making this promise also indicated that they would begin calibrating and determining water volumes required using rates per 100 metres of vine row, some even utilising Unit Canopy Row methods.

Strategic spraying based on pest and disease monitoring was also a high priority with 15.8% of participants making a promise in this category. A move away from calender sprays and better targeting of early season sulphur applications for mites and bunch sprays for *Botrytis* control were also popular promises in this category. Pest and disease monitoring was a specific promise made by 6.4% of participants (Figure 23) while another 4.3% indicated that they would improve their spray targeting.

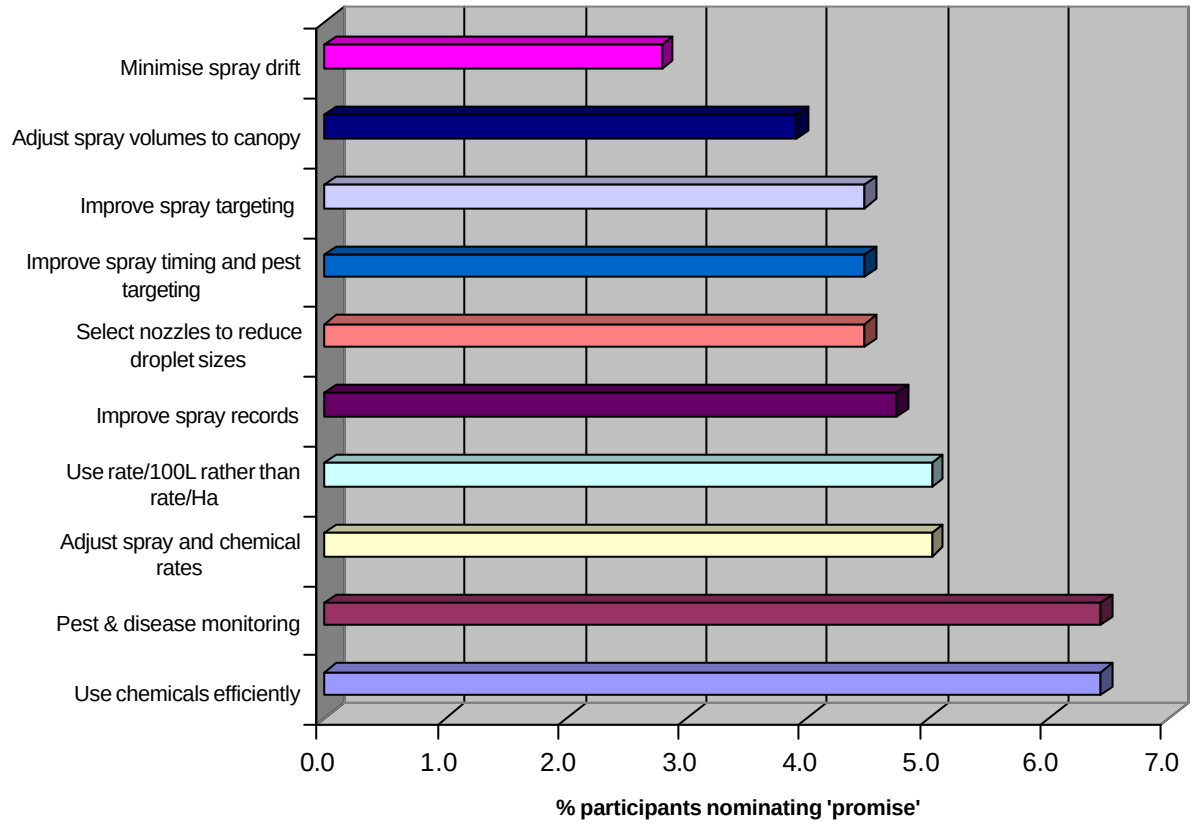


Figure 23. Specific promises made by **more than 2.5% of 750 participants** in Research to Practice® spray application workshops (multiple nominations allowed).

Other high rating categories that reflected the range of promises made by participants included more frequent or accurate calibration (14.0%), improving chemical efficiency and effectiveness (10.1%), increasing accuracy and detail of vineyard records (9.2%), transferring knowledge gained to others (8.4%) and minimising off-target impacts (6.2%). Within these categories minimising spray drift by correct sprayer adjustment and spraying under suitable conditions, as well as effective use of adjuvants and adjusting spray programs were considered to be of high priority. Appendix 5 lists specific promises made by less than 2.5% of participants.

Third day evaluation

The third 'report back' day is crucial to the successful adoption of improved pesticide application practices and uptake of new research and technologies with the aim of managing pests and disease with reduced inputs. It is held following harvest after the first two days by which time participants have been able to complete their promise and report back on how well the changed practice integrated into their vineyard management.

A re-occurring problem encountered with the third day was the number of original participants who actually attended. On average only about 52% returned for the third day even though it was emphasised at the end of the second day as being integral to the whole understanding and implementation process. This issue is currently being addressed by the Research to Practice® team that is investigating various options. These include better advertising of the benefits of returning for the third day including previous case studies, and even greater emphasis of its importance at the first two days and in information letters sent to participants notifying them about the third day. Another possible option includes developing 'third day kits' that enable host organisations to organise and conduct the third day themselves at a suitable time for the group. Removal of the third day from the workshop program is also an option to be replaced with an alternative feedback mechanism such as update days, an e-mail bulletin board or newsletter. The viability of these and other options is currently being assessed.

The participants who attend on the third day fill in an evaluation sheet that is used to determine the value of the session and indicates what changes they have made during the season. Specific changes made to current spraying practices and impact on adoption based on third day evaluations are discussed in detail in the next section.

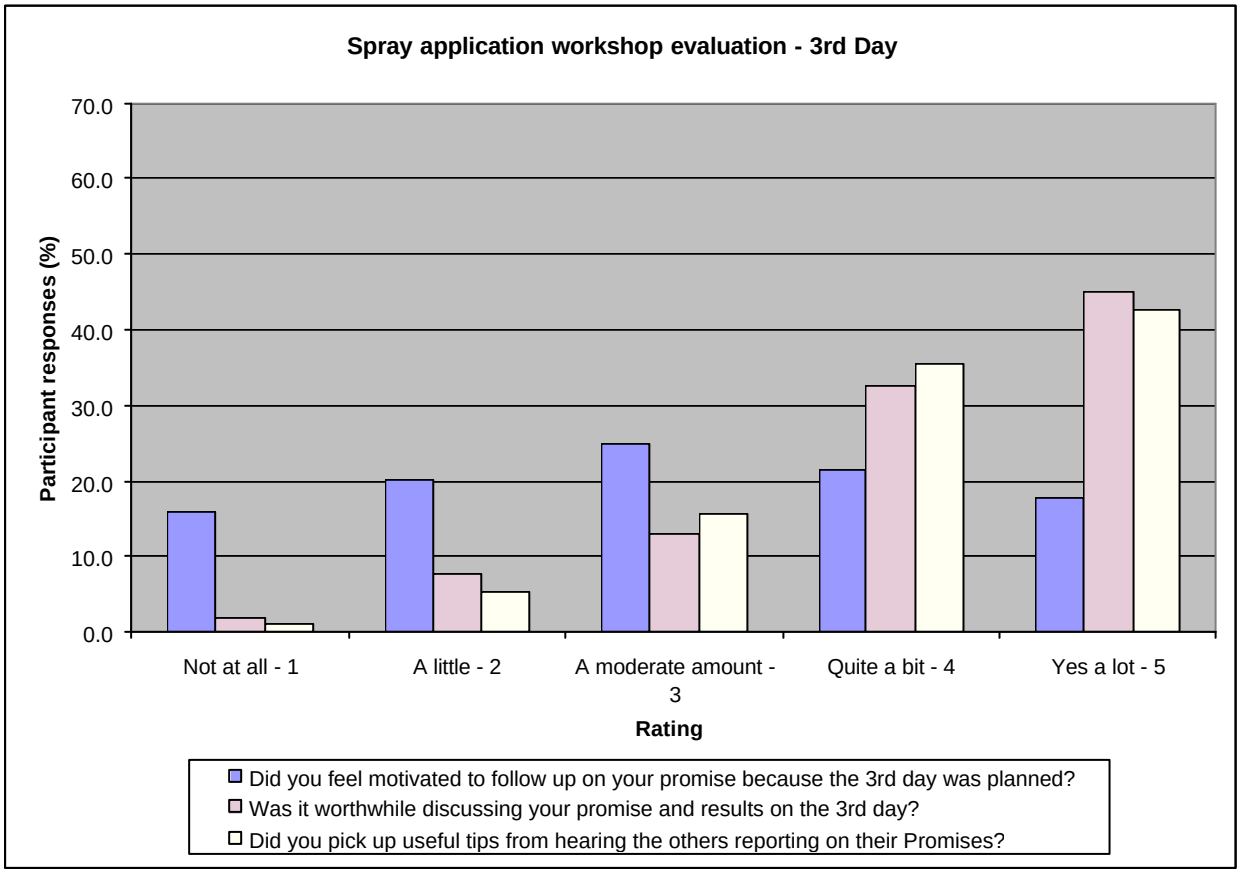


Figure 24. Evaluation summary of the relevance, content and value of the spray workshop third day – 1999 to 2001 (Questions 6-8).

The third day was not a major motivation for participants to follow up on their promise, with only 39% of participants' responses to this question rating a 4 (Quite a bit) or 5 (Yes a lot). Thirty-six percent indicated that the third day only motivated them a little or not at all to complete their promise (Figure 24). This suggests that the report back process is usually not the main reason for participants changing management practices. Assuming this result can be applied to the 50% of participants not attending the third day it seems likely that most growers and vineyard managers are implementing improved spray application practices irrespective of whether they participated in the third day. The program and information provided in the first two days of the Research to Practice® workshop seems to provide some participants with enough motivation to implement changes based on an action plan or promise without the need for a follow up day.

Of those participants returning for the third day the majority felt it was worthwhile having the opportunity to discuss their promise and results with 77% of responses to this question rating a four or five (Figure 24).

Participants also found the discussion generated during the third day highly valuable with 93% picking up useful tips from hearing others reporting on their promise.

Of those participants commenting about the third day, 33% indicated that it was valuable to hear what others had done and achieved (Figure 26) demonstrating that the informal atmosphere, ability to interact and participate in discussions with others was very important to participants.

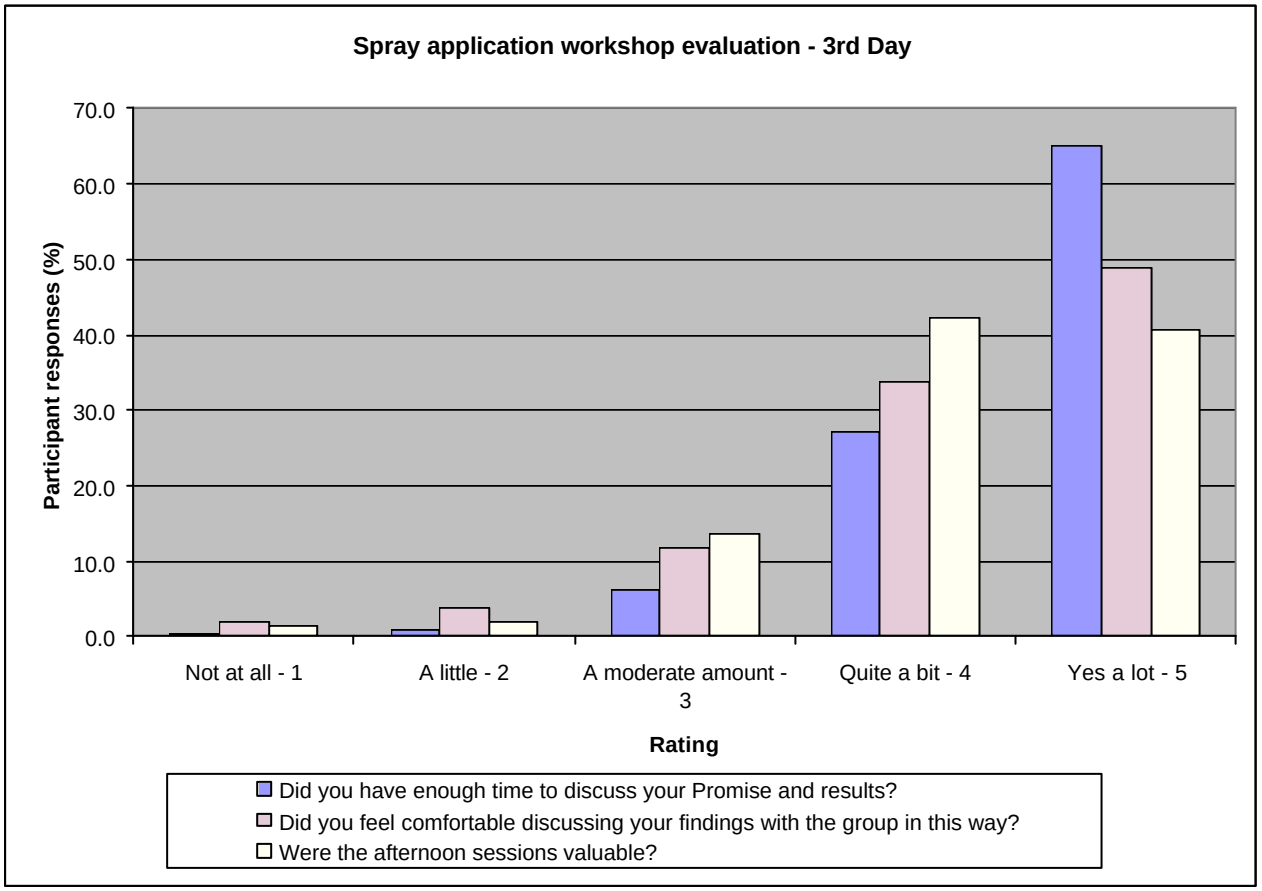


Figure 25. Evaluation summary of the relevance, content and value of the spray workshop third day – 1999 to 2001 (Questions 9-11).

Ninety-one percent (91%) of participants felt they had enough time to discuss their promise and responded to the evaluation question with a four or five rating (Figure 25) while 82% of respondents were very comfortable discussing their findings with the group. This was no surprise as in most workshops the participants were well acquainted with each other, many belonging to the same grower association or employees of one wine company.

The afternoon sessions were also considered valuable by many of the workshop participants with 83% of respondents giving the presentations covered a rating of four or five. Some of the topics covered during the third days that supplemented information provided on the first two days included "Spraying for LBAM and rust mite", "Use of sulphur for powdery mildew control", "*Botrytis* control using KMS" and a sprayer set up example based on spray application trials. A review of "Interpreting labels" information was also provided on request and this usually generated valuable discussion as participants were able to get feedback on changes to chemical rates and spray volumes used.

A number of participants commented that the third day provided an opportunity to consolidate the information provided in the workshop with 28% of respondents considering it to be very worthwhile and an excellent debriefing (Figure 26). Thirteen percent of third day participants also felt that the presenters used were very informative while 12% indicated that this day was necessary to reinforce concepts covered in the first two days.

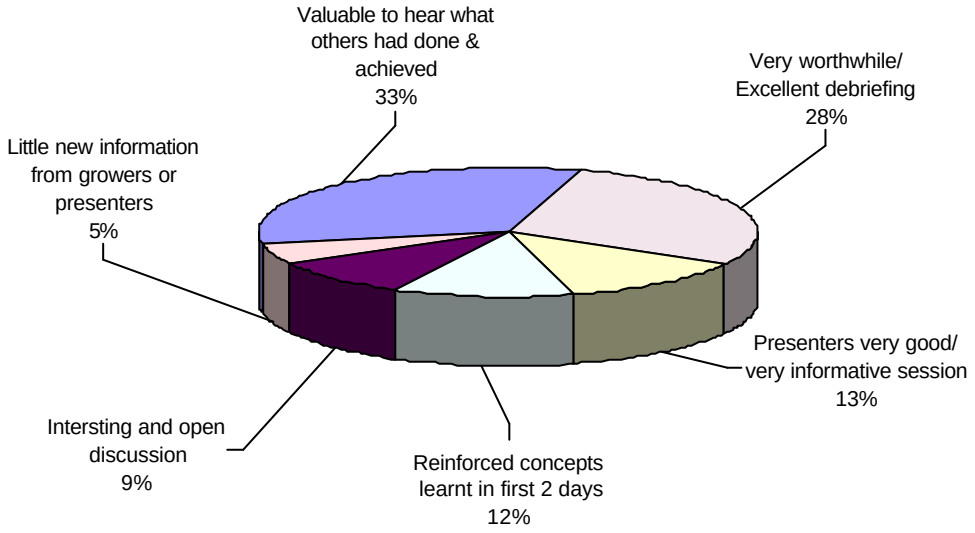


Figure 26. Most common comments made by participants regarding the value of the spray workshop third day - 1999 to 2001 (as a percentage of total comments made).

Outcomes

Evaluation of impact and adoption

Participant feedback on the workshop program was obtained through evaluation sheets filled out during the first two days of the workshop and at the end of the third day. In combination with the pre-workshop questionnaire results, and direct feedback and comments from participants during workshops, this information was used to:

- Continually improve the program structure and content to ensure that participant's needs were met during the three seasons of workshops; and
- Assess the impact of the workshop on the management of spray operations on participants' vineyards and determine the level of adoption and benefits to industry resulting from this project.

Although the 'before and after' management practices of individual participants cannot be directly compared, the evaluation data in combination with promises made and questionnaire results provide a relatively accurate overall picture of significant changes implemented by vineyard managers and growers, and their level of success. It is difficult to put an economic and environmental value on the changes made based on the data gathered although some participants did comment on the savings in chemicals and spraying costs achieved, as well as indicating that pesticide wastage and over-spray had been reduced. A few vineyard managers did attempt to determine direct cost savings resulting from changed practices and the results are detailed in the Performance against planned objectives' section of the report.

As part of the third day evaluation in 2000 and 2001 participants were also asked to respond to a number of questions (Appendix 1.6) based on Bennett's Hierarchy (Fisher *et al*. 2001 & Appendix 6) in an attempt to capture more information on changed practices and resulting economic and environmental outcomes. This would enable the validation of the Research to Practice model in terms of successful transfer of knowledge and adoption. Components of this type of evaluation aim to answer the following questions:

- Were there changes in knowledge? What did they learn?
- Were there changes in attitudes regarding pesticide application and in participant aspirations?
- Were there any improvements in skills regarding control of pests and diseases in vineyards?

Third day results

A key measure of the success of the workshop program is the number of participants who changed at least one pesticide application practice as a result of attending the first two days. Feedback at the third day indicated that the spray application workshop content and format gave participants the information and confidence they needed to implement a change. Specifically the evaluation results (Figure 27) show that:

- **81% of 3rd day participants changed their spray application practices after the initial 2 days of the workshop.** This was an excellent outcome indicating that the Research to Practice® format does empower growers and vineyard managers with the knowledge and practical skills to make changes. The remaining participants who did not make any changes more than likely included consultants, wine company employees who

did not make management decisions and a small number of vineyard managers who were already implementing best practice strategies.

- **57% of 3rd day participants calibrated their spray equipment more often after the initial 2 days of the workshop.** An adoption rate of this magnitude was expected as 43% of workshop participants already calibrated their equipment before every spray or when changing spray volumes based on the 2-day workshop questionnaire (results not shown). This implies that most of the remaining participants increased calibration frequency from only once at the beginning of the season or from no calibration at all.

- **65% of 3rd day participants adjusted their equipment to target sprays at specific pests or diseases after the initial 2 days of the workshop.** Of the growers adopting this practice, 37% specifically targeted flowers or bunches when applying *Botrytis* sprays to managed canopies such as VSP (Figure 28). A further 13% of this group improved their targeting for powdery mildew by ensuring all green tissue was sprayed while another 12% adjusted spray direction to better target Light Brown Apple Moth at various stages during its life cycle.

- **68% of 3rd day participants made changes to water and/ or chemical rates applied during the season after the initial 2 days of the workshop.** This was a positive and significant outcome as 71% of participants still used the chemical label rate per hectare before the workshop (Figure 13) and 27% did not have a method of adjusting spray volumes (Figure 12). A key aim of the workshop was to provide participants with methods and tools to be able to correctly interpret chemical labels, use the chemical rate per 100 litres and adjust spray volumes to match a changing vine canopy.

- **74% of 3rd day participants used their spray application manual at least once during the season after the initial 2 days of the workshop.** Participants referred to the manual an average of three times after the workshop demonstrating that many growers and vineyard managers regarded it as a practical and informative working tool.

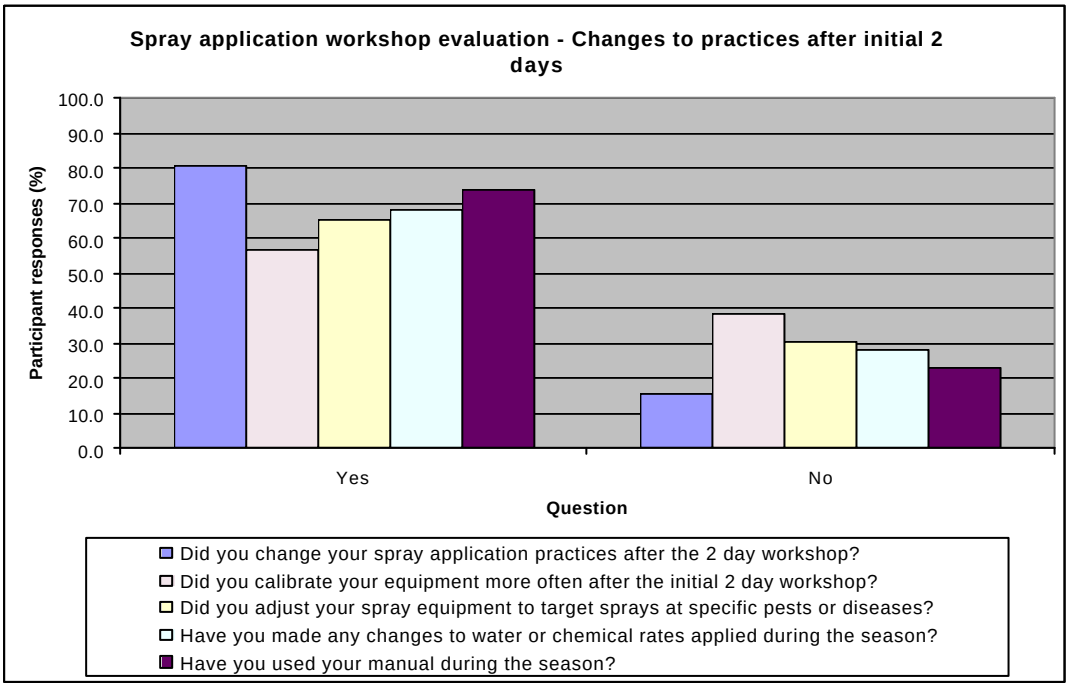


Figure 27. Third day evaluation summary – changes in spray application practices after the two-day workshop between 1999 to 2001 (as a percentage of total responses received).

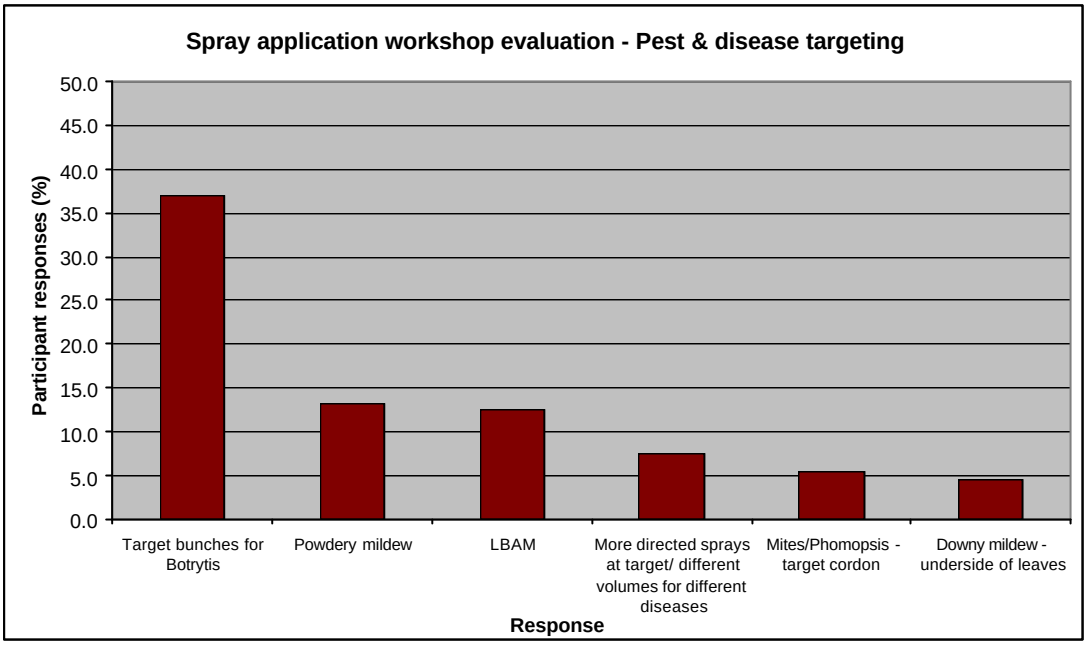


Figure 28. Third day evaluation summary – changes in pest and disease targeting spray after the two-day workshop between 1999 to 2001 (as a percentage of total responses received).

Third day participants were also asked to list the changes and improvements made to their pesticide application practices after the initial two days of the workshop. These have been categorised and describe in greater detail the major changes made by growers and vineyard managers. Many respondents also made multiple changes and some of the adopted practices are included in several categories.

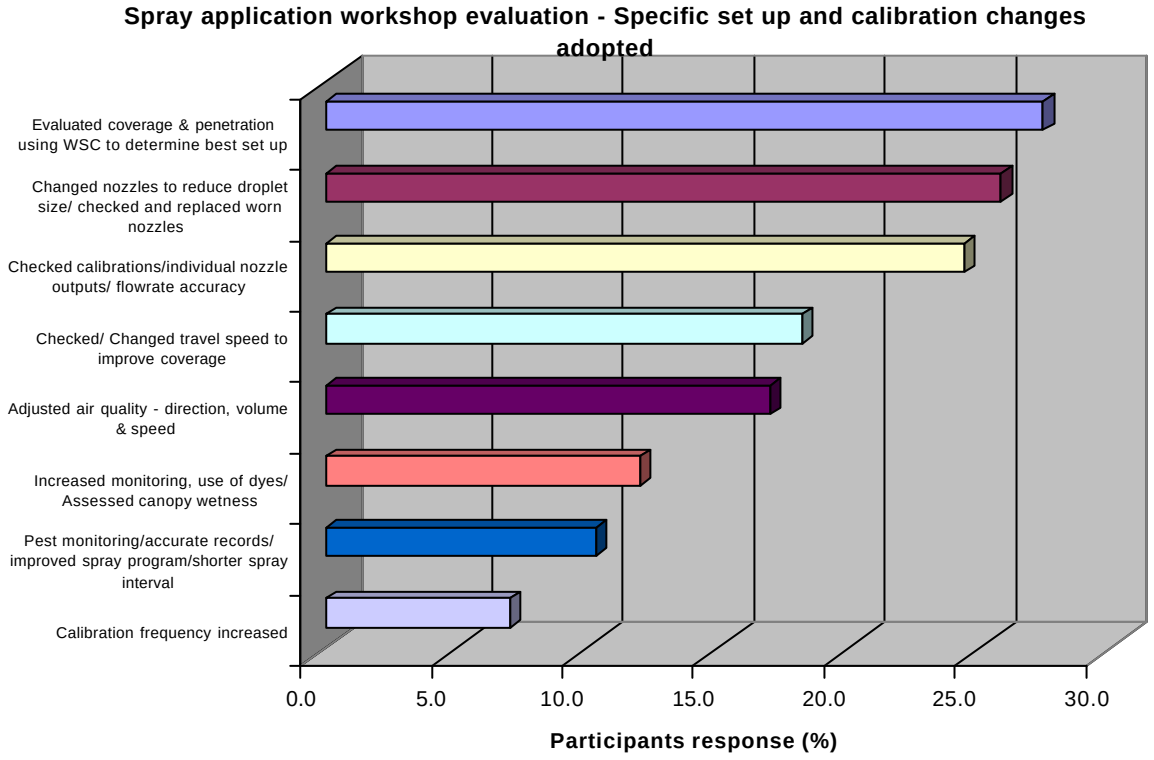


Figure 29. Third day evaluation summary – specific sprayer set up and calibration practices adopted by 3rd day workshop participants between 1999 to 2001 (as a percentage of total responses received).

Evaluation of spray coverage using water-sensitive cards (WSC) to determine the best sprayer set up for a specific vine canopy was a practice implemented after the initial two days by 27% of 3rd day participants (Figure 29). It can also be assumed that WSC were also used by some participants to adjust air quality from spray equipment (16%), and modify travel speed (17%), to improve coverage. These results demonstrate that many participants were not properly setting up spray equipment before the workshop and although a significant proportion had tried using WSC (Figure 17), most were not using them to optimise coverage at different stages in the season.

Achieving the optimum droplet size and spray nozzle maintenance were also significant changes made after the first two days with approximately 25% of participants replacing nozzles to reduce droplet size and another 23% checking and replacing worn nozzles. The importance of these practices in optimising spray coverage and accurate application of chemicals was emphasised in the workshop and the results demonstrate that many participants had not considered them before. Other specific practices adopted by vineyard managers and growers included checking of calibration calculations and sprayer output (23%), increased monitoring of spray coverage using dyes, WSC and visual assessment (11%), and more frequent pest and disease monitoring, accurate records and modification of spray programs (9%).

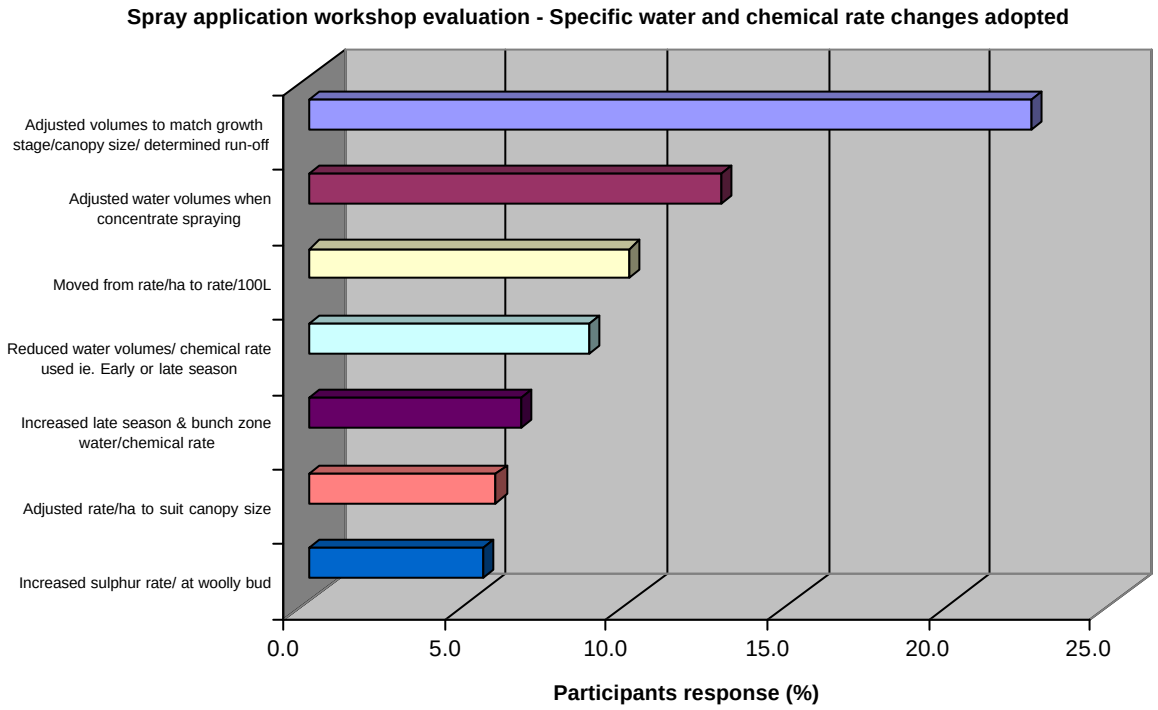


Figure 30. Third day evaluation summary – specific water and chemical rate changes made by 3rd day workshop participants between 1999 to 2001 (as a percentage of total responses received).

The most common water and chemical rate change made by participants after the initial two days was to adjust spray volumes to match the vine canopy size or growth stage (22%). This category included determination of the run-off point enabling the calculation of chemical rates for concentrate spraying (Figure 30). Results from the two-day workshop questionnaire show that 47% of participants were already adjusting water volumes during the season before the workshop but that 26% gave no response suggesting that this group may not have been (Figure 12). Many of these may have been in the proportion of participants who adopted this practice after the workshop. Another 12% of participants started adjusting water volumes when concentrate spraying.

This indicates that a number of participants were not changing concentrate water volumes significantly during the season or may have been using too little water to achieve good coverage late season on bigger canopies even when using small droplet sizes. A significant proportion of participants (9%) also moved away from using the chemical rate per hectare from pesticide labels all season and adopted the chemical rate per 100 litres allows the amount of pesticide applied to vary depending on canopy size. Another 5% of 3rd day participants varied the rate per hectare during the season to achieve the same result. In the majority of cases using the chemical rate per 100 litres would have reduced the amount of pesticide applied compared to previous seasons when a single rate per hectare was used all season.

Other specific changes made by vineyard managers and growers included reducing water volumes and/ or chemical rates used in comparison to previous seasons (8%), increasing rates late season on bigger canopies and for bunch sprays (6%) and increasing sulphur rates for woolly bud sprays (4%). These results indicate that after the first two days of the spray workshop participants were rethinking their pesticide application practices and giving greater consideration to the application target, pest or disease being sprayed, pesticide requirements, and canopy size and growth stage when determining appropriate spray volumes and chemical rates. For example a number of participants increased sulphur rates early season and *Botrytis* fungicide rates for bunch sprays as a result of information provided in the workshop demonstrating the difficulty in achieving sufficient coverage and dose on these application targets.

Performance against planned objectives

Objective 1

Develop certificate level, field-based training workshops for Australian wine grape growers to enable greater uptake of spray application best practice in vineyards.

The Spray Application in Viticulture: Research to Practice® training workshop was specifically designed to meet the requirements of the viticulture industry and increase the adoption of improved spray application practices. Workshops were continually refined over the four-year life of the project to ensure that the most up-to-date information and research was presented and developed for the target audience. A combination of group activities, field sessions and presentations conducted by experts provided participants with various means of accessing high-level but practical knowledge. In addition there was a strongly positive reaction to discussing promises and results in a relaxed atmosphere with access to industry experts with over 33% of participants picking up useful tips during the third day reporting process.

The program was very successful in increasing the uptake of improved pesticide application practices with over 80% of third day participants having changed at least one practice after the initial two days of the workshop. Feedback indicated that many of these growers and vineyard managers reassessed and modified more than one component of their spraying and evaluation program based on information provided in the workshop. In fact more than 50% of participants indicated that they made changes to their sprayer set up, pest targeting and, water and chemical rates after the workshop (See Figure 27).

Figure 31 indicates that there was a positive response to the key practices emphasised during the workshop resulting in the significant uptake of improved spray application practices. Approximately 60% of participants increased the time spent monitoring spray coverage and setting up their sprayer after the benefits of adopting these practices had been outlined in the workshop program.

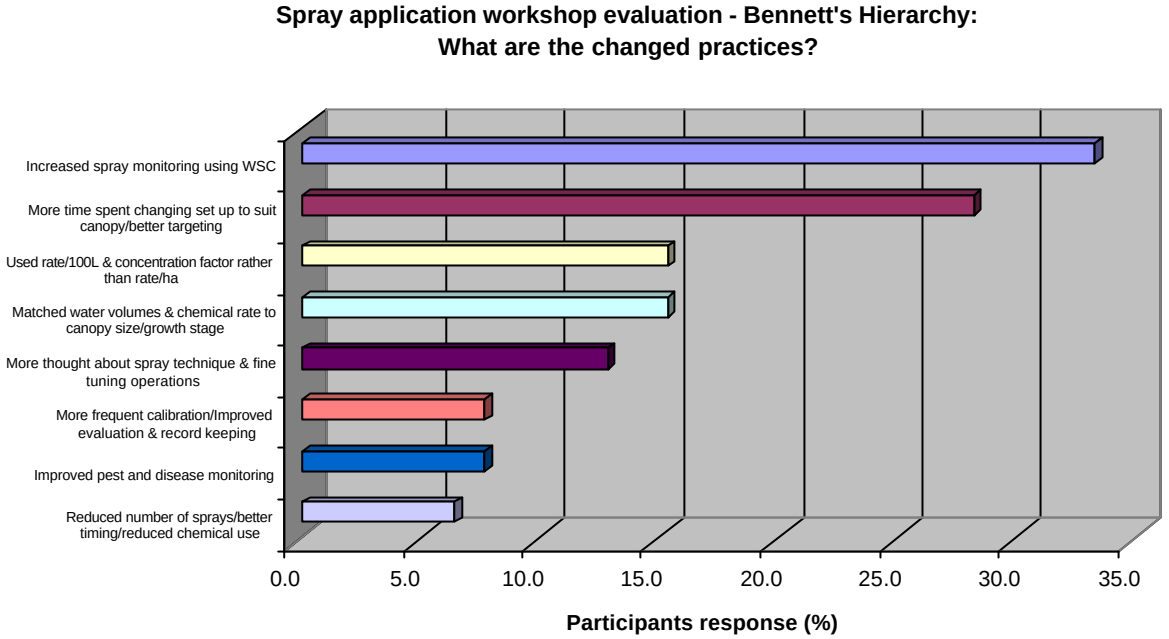


Figure 31. Third day Bennett's Hierarchy evaluation summary – What are the changed practices? (as a percentage of total responses received in 2000 and 2001).

Objective 2

Establish and coordinate a network of researchers, experts and trainers for development of workshop manual, presentations and support materials.

The Research to Practice®: Spray application in viticulture workshop was developed by a small group of core researchers and extension specialists. Various modules, presentations and support materials were also developed through a collaborative approach with a larger group of technical experts. Many of these researchers and consultants also presented information in a number of workshops. In many cases this ensured that experts that had conducted the research were able to communicate outcomes to participants directly. Even though comments and advice on the workshop content was gathered from many sources, the majority of the final development and consolidation of information was undertaken by the core group of researchers within DPI Victoria. As part of the program, efforts were made to involve and train as many presenters as possible in each state. In some cases this was quite difficult to do due to the limited availability of pesticide application experts in Australia.

The demand for the workshop during the first two years of funding was very high with a total of 22 workshops conducted and it was impractical to rely on a small group of presenters. Thirty-three speakers were involved in presenting workshop modules over the life of the project. Technical speakers were mainly sourced from state agriculture departments, wine companies, sprayer manufacturers, pesticide companies, CSIRO and private consultancies (Appendix 4.2). Many of these speakers had detailed knowledge of implementing pest and disease management strategies in a commercial vineyard. Participants were very receptive to these speakers and the ideas and pitfalls of implementation were a very valuable addition to many sessions.

One of the key strengths of the Research to Practice® program has been the quality and knowledge of speakers at the workshops. While some experts who have presented at workshops have been more successful than others at communicating their knowledge and obtaining

feedback, generally most presenters were well received and had the required extension and communication skills to get their information across to participants. Over the final two years of the program presenters brought on board have been provided with manual chapters, presentations and a module outline, while the facilitator has spent time talking through the presentation with that person. This enables them to ask questions about the presentation and allows the facilitator to provide information on some of the possible questions that might be raised. Presenters were also encouraged to contact the researcher who developed the topic for further clarification and information.

During the final years of the program a team of ten spray application experts, plant pathologists and consultants was assembled to present modules and provide expertise in further developing and updating workshop content. The project leader worked closely with this team to ensure that each presenter had a clear understanding of the workshop format, regional issues and the most effective method of communicating technical information to participants. Where possible, local pest and disease experts were used to give each workshop a regional perspective. In some respects the use of a small team of experts rather than many speakers who may only present material at one or two workshops has benefited the program. The high level of technical expertise and practical knowledge of these presenters, as well as a team approach where each expert is familiar with the knowledge base of other presenters and the workshop format has ensured that each workshop is of a high standard. It has also enabled the communication of consistent and clear information to all participants across all viticulture regions

Objective 3

Review, update and standardise workshop manual, presentations and support material for improved access to the outcomes of spray application R&D in a consolidated, practical training format.

Workshop evaluations provided by participants during the 2000 season workshop series were collated and reviewed. This information was then used to further develop the workshop program, presentations and accompanying training manual. Presenters with expertise in different aspects of spray application in viticulture continued to provide information on appropriate workshop content and structure.

The spray application in viticulture manual was completely revised prior to the start of the 2001 season. Spray droplets, pesticide labels and chemicals modules were redrafted to provide a greater level of detail and practical information. New manual sections developed as part of the revision included pesticide performance and adjuvants as well as a spray evaluation chapter. Grower self-assessment checklists and learning tools were also incorporated into the manual to ensure that it could be used as a working tool in the field. A glossary and, a list of relevant references, web sites and other information sources that give participants the opportunity for further self-education outside the workshop were also included in each module. Formatting changes such as breaking up large sections of text, including more diagrams, changing font style and incorporating a wide margin area for participants to record notes during presentations allowed participants to more easily understand and record information. Each page in the manual was numbered and cross-referenced to the appropriate PowerPoint® slide, so that participants could follow each presentation and link information presented to the specific section in their manuals.

Group sessions on adjuvants, sprayer selection, evaluation and equipment set up are now an integral part of the workshop program, with hands-on demonstrations being used to improve the understanding of key concepts. Participants are also provided with access to software allowing

them to optimise sprayer work rates and minimise spraying costs. The workshop program was also modified to allow more time out in the vineyard on the afternoon of the first day where participants could put spray application theory into practice. Further refinement of the content will continue and new information incorporated as it comes to hand to complement the workshop presentations.

Objective 4 and 5

Enhance the decision-making capacity and confidence of wine grape growers in initiating improved spray application practices.

Improve pest and disease management, yield and quality while reducing chemical use and off-target impacts through the adoption of spray application best practice.

Since objective 4 and 5 are interrelated they will be addressed together. An important aim of the Research to Practice® program was to enhance the decision-making capacity and confidence of growers and vineyard managers, empowering them to reassess or fine tune their pesticide application practices. In many cases improved pest and disease management as well as a reduction in chemical and spraying costs were directly attributable to the implementation of sound and practical advice provided to participants in the workshops.

Evaluation of the first two days of the workshop indicated that many participants felt they had gained greater knowledge and a better understanding of spraying techniques, were now able to make more informed decisions and had greater confidence in passing on information to others (See Figure 19).

The high proportion of participants who made changes after the first two days demonstrates that many growers identified information in the workshop that would improve their vineyard operations. A number of decision-makers in the workshops also commented that the information provided stimulated thinking about the available options to improve pesticide application and often gave them the confidence needed to implement a change they had been considering. As a grower from Langhorne Creek commented, “Before the workshop I allowed a consultant to make the decisions and I acted on them without knowing why”. He also noted that, “Previously I was setting up the sprayer following the specifications provided (by the manufacturer) without considering whether I was targeting the vine correctly”. As a result of attending the workshop he indicated that, “By spending more time monitoring on foot with the consultant we were able to detect pests and disease much earlier and so take action before it was too late”. Another changed practice resulting from his new knowledge was, “Using spray cards to evaluate coverage inside the vine canopy and modify the sprayer set up as required”.

The workshop program had a significant impact in changing practices that resulted in reduced pest and disease incidence, and reduced spraying and chemical costs, the most significant of these being monitoring and evaluation of spray coverage. Before the workshop over 60% of participants were not evaluating spray coverage and not setting up the sprayer to suit the canopy being sprayed (Figure 32). As demonstrated by the key results achieved by growers after the workshop (Figure 33) the process of evaluation and manipulation of sprayer components can have a considerable impact on pest and disease control. Of participants evaluated at the third day in 2000 and 2001, 40% achieved better and more consistent disease control while another 18% highlighted the fact that they improved their spray coverage. Other important outcomes highlighted in the evaluations included reduction in spraying cost (13%), improved powdery mildew control (8%) and reduced chemical use (8%). By matching water volumes (and chemical rates) to the changing vine canopy many participants were able to reduce chemical use during the

early stages of the season and through better targeting minimise over-spraying and off-target impacts.

It should be noted that many of the participants would not have determined actual cost savings made by implementing improved practices so that the economic and environmental impact was probably much greater than the evaluation results indicate. Greater yields and higher quality fruit were probably significant outcomes for many growers and vineyard managers as a result of better pest and disease control.

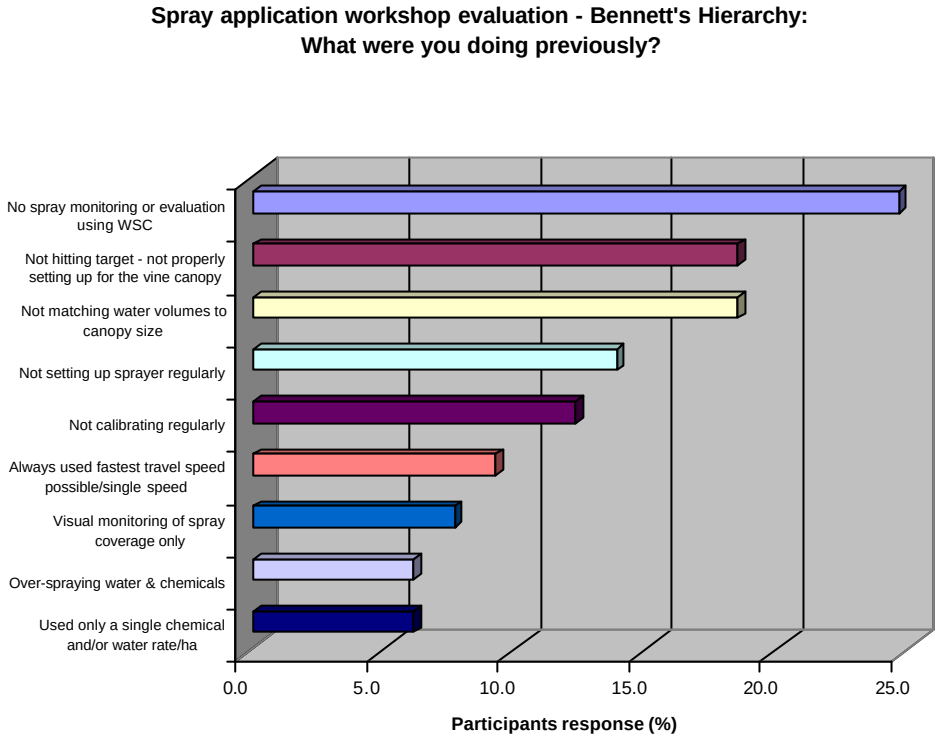


Figure 32. Third day Bennett's Hierarchy evaluation summary – What were you doing previously? (as a percentage of total responses received in 2000 and 2001).

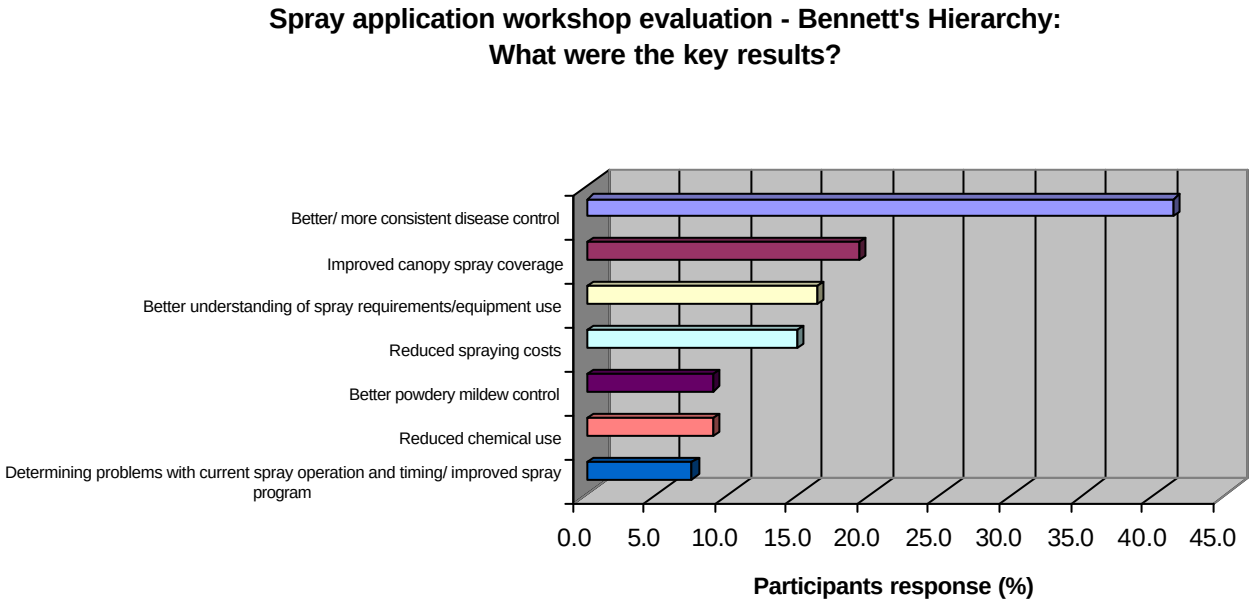


Figure 33. Third day Bennett's Hierarchy evaluation summary – What were the key results? (as a percentage of total responses received in 2000 and 2001).

Case studies

Presented below are two brief case studies of cost savings achieved by growers though the implementation of improved monitoring and application practices after the workshop as well as participant examples of the types of changes made and the key outcomes.

Case study 1
A vineyard manager was able to reduce pesticide usage over one season by 52% and total spraying costs by 33%, resulting in savings of $230 per hectare while still maintaining excellent disease control after attending a spray application workshop.

Case study 2
Another grape grower was able to reduce his copper sprays by 40% and sulphur sprays by 30% using practical advice provided in the spray workshop resulting in an estimated reduction in total spraying costs of 35%.

Duncan Kennedy (Langhorne Creek, 2001)
Changed practices:
"More emphasis on chemical concentrations per 100 litres rather than per hectare. This saved us dollars particularly in sulphur and copper sprays. Also more emphasis on total volume per hectare for different sprays eg. Matching to canopy growth stage."

Doing previously:
"Using rates per hectare. In the past total volume per hectare was the same throughout the season except emergency *Botrytis* sprays near harvest at twice the rate."

Key results:
"Sulphur use reduced by a third, Copper use reduced by 40%, this reduced sulphur burn dramatically. We also became more skilled in assessing spray equipment performance as a result of this workshop."

Bradley Case (Langhorne Creek, 2001)
Changed practices:
"Re-calibrated and changed the sprayer set up each time the vineyard conditions changed a considerable amount. Went back through and assessed the results both during and at the end of the season."

Doing previously:
"We were doing this but not regularly enough and we were not going back and assessing our results at the end of the season."

Key results:
"Better disease control and better understanding of not only the vines but the machinery also."

Graham Smith (Tumbarumba, 2001)
Changed practices:
"Adjusted spray nozzles on Turbomiser to suit vineyard growth, adjusted application rates – litres per hectare, checked spray penetration, IPM - monitor, monitor, monitor…"

Doing previously:
"Using Turbomiser all season at a fixed water rate and fixed nozzle position and an occasional walk through the vineyard."

Key results:
"No powdery mildew, downy mildew or *Botrytis*."

Tim Warren (Riverina, 2001)
Changed practices:
"Changed views on what is better coverage eg. Thoroughly wet - sprayed to the point of run off. Being more thorough with inspecting spray application results."

Doing previously:
"Wasn't as thorough with inspecting spray application result."

Key results:
"Better disease control, saving on chemical costs."

Adam Steer (McLaren Vale, 2001)
Changed practices:
"Calibration every spray, adjusting nozzles, direction and air for each canopy type, using a concentration factor and estimating run-off volume to calculate spray rates."

Doing previously:
"Not as concerned about maximising set up, less calibration, sometimes getting rates incorrect for chemicals not listing a rate per hectare."

Key results:
"Better disease control."

Participant feedback

Many positive responses and comments were received during and at the end of workshops through the evaluation sheets and directly from participants indicating the high value they placed on the information delivered and its benefits to them. Some of these are quoted here while others are listed in Appendix??

"Most relevant viticultural workshop I have ever attended." Kurri Kurri workshop 1999.

"Excellent. Great presenters with exceptional knowledge of topics. A must for all growers." Merbein South workshop, 2000.

"I've been in the (viticulture) industry 35 years and this is one of the best workshops I have ever attended." McLaren Vale 2000.

"Excellent, one of the best teams I have had the opportunity to listen to." McLaren Vale 2000.

"A worthwhile 2 days – I can feed information back to operators & technical staff." McLaren Vale 2000.

"The company paid for (the workshop) and will reap the benefits." Orange 2000.

"Excellent presenters, knew their topic, enjoyed their topic, were very diplomatic and persuasive with getting people to change their management – well done." Coonawarra 2000.

"I will save $50 (workshop cost) in chemicals in around half-a-day (of spraying)." Rutherglen 2000.

"This (workshop) will make a big difference to the way I use my sprayer and chemicals." Langhorne Creek 2000.

"A very informative workshop with plenty of relevant information.' Langhorne Creek 2000.

"All in all I think it was very helpful and I will pass on what I have learnt to my fellow employees." Langhorne Creek 2000.

"You always need to learn more and become more efficient! It may also save us money in spraying time and wasted over-spray." Langhorne Creek 2000.

"I was unaware that changing little things could effect the end result so dramatically." Coonawarra 2001.

"It was great learning a lot and (I) look forward to getting out in the field to put it into practice." Robe 2001.

"Most informative spray seminar I've been to." Echuca 2001.

Recommendations

New research

Workshop participants have shown a great deal of interest in potential new technologies such as a 'Dose Kit' enabling measurement the pesticide dosage landed on a vine target in the field. Information regarding adjuvant formulations that improve droplet spread particularly for use in spraying grape bunches has also been keenly sought. Based on grower feedback over four seasons of workshops and discussion with wine companies, consultants and viticultural researchers potential areas of new research and extension include:

- Regional elaboration of the most effective IPM and spray programs by pest, disease and trellis systems including likely potential for reduction of in the number of sprays per season.
- Review of the effects of copper on disease resistance, flavour impacts, and extended ripening of grapes.
- The effect of adjuvants on the efficacy of curative /preventive pesticides with a particular focus on improving grape bunch coverage and *Botrytis* disease control.
- Pesticide compatibility field trials and development of compatibility guidelines.
- Curative and preventive pesticide degradation under warm and cool climate Australian conditions field studies.
- Efficacy of hitting the target – more information /extension materials on pest and disease spray timing and targeting.
- Pamphlet on how to monitor for, and options to chemically control powdery mildew.
- Effectiveness of sulphur under various climatic conditions, growth stages and trellising systems.
- Simple, practical information on applying the Unit Canopy Row system to determine spray volumes and chemical rates.
- Guidelines for setting up specific sprayers for particular trellis /growth stage / pest target combinations.
- Guidelines and tools to assist in interpreting spray coverage when determined using water-sensitive cards and fluorescent dyes.
- Development of simple to use spray deposit assessment techniques based on food dye tracers and conductivity measurements.

It was found that in the workshops participants generally wanted more in depth information on certain topics that were of particular relevance to them including pesticide compatibility, effective adjuvant use, interpreting chemical labels correctly and on specific pests and diseases. Through CRCV and GWRDC there are a number of continuing research programs focusing on the control of major fungal diseases of wine grapes, powdery mildew and *Botrytis* through an integrated management approach. As of late 2002 there are a number of other research projects pending and that have already commenced with implications for pesticide application, disease management and technology transfer in viticulture including:

- Better disease control using adjuvants – Alison MacGregor (DPI VIC).
- The surface wax of the grape berry: Interactions with chemical sprays and subsequent susceptibility to *Botrytis* infection – Suzy Rogiers (CSU NSW)
- Enhancing adoption of best practice spray application in viticulture – John Lopresti (DPI VIC)
- SpraySmart: Interactive spray application CD-ROM for viticulture – John Lopresti (DPI

VIC)

Other medium-term strategic and applied research that should be considered that may have a considerable impact on improving the efficiency and effectiveness of the pesticide application process in viticulture includes:

- Mathematical modelling of airflow through grape bunches at different growth stages leading to a decision framework to optimise pesticide application.
- Micro sensor and network technologies for real-time detection of pesticide dosage in the field during pesticide application.
- Variable rate pesticide application based on disease pressure and, vineyard and vine canopy variation using precision horticultural systems.

Future changes to program

Many changes are planned for the Research to Practice®: Spray application in viticulture program in the future to ensure it continues to deliver leading edge research outcomes to the viticulture industry. Improvements to the workshop program and processes involved in the delivery of information are also planned. There are currently many issues, potential changes and new products under development that will significantly impact on the status of Research to Practice® as a leading source of research information for the Australian wine industry including:

- Mechanisms for increasing the number of trained expert presenters and facilitators.
- Addressing budgeting issues as part of the Research to Practice® (Viticulture) strategic plan.
- Commercialisation and sub-licensing the delivery of Research to Practice® (Viticulture) workshops to wine companies, consultants, RTOs etc.
- Evaluation of the current three-day format in response to participant feedback and budget constraints.
- Development of single-day and half-day workshop formats.
- Methods to improve the return rate of participants to third day of workshop.
- Improving market penetration and competitive pricing of the workshop program.
- Incorporating new research outcomes into the workshop format and quality assurance issues.
- Funding arrangements for the continuing review and updating of presentations and workshop manual.
- Development of a third-day kit and sub-licence package for commercialisation.
- Development of comprehensive presenters notes.
- Creating further tools for use by participants in determining the reduction in costs and chemical use due to changed practices, and to optimise spray operations.
- Conducting Research to Practice® update days to showcase latest research information not available to participants in previous workshops.
- Formatting of workshop information for delivery at VET certificate 3 level.
- Assessment of various media for delivery of workshop content including web-based information, peer-to-peer internet, CDROM and other publication formats.

Conclusion

Development of the Research to Practice®: Spray application in viticulture training workshop has provided a platform for delivery of the latest research information to the wine grape industry. The workshop program focused on providing an opportunity for participants to interact with expert presenters and with each other, participate in problem-solving and field sessions and identify new or changed practices that they could implement during the season. The third day provided participants with the opportunity to discuss what changes they had made, impact of the changes and enabled them to work through any problems they had with implementation. Overall the response to the information presented in workshops was very positive. The format used appeared highly successful with over 80% of participants implementing at least one change in their pesticide application practices. The types of changes that occurred were many and varied and included better disease monitoring, more effective use of chemicals and improved evaluation and sprayer set up, indicating that the majority of information in the workshop was valued.

Based on evaluation of workshop outcomes the main objectives of the project have been achieved with substantial improvements in spray application practices resulting in positive outcomes for individual growers, wine companies and the wine grape industry as a whole. In the process the confidence and decision-making capacity of growers and vineyard managers in implementing best practice was also enhanced. The impact of the workshop program on a significant proportion of the wine grape industry was significant, with evidence suggesting more consistent pest and disease control, reduced spraying costs and lower chemical use the outcome for many participants. Better spray coverage and effective application and targeting of pesticides achieved by many growers indicates that the workshop process also had some impact on minimising off-target impacts due to spray drift and run-off although it is not possible to quantify the environmental impact at this stage.

Most participants were motivated to make changes to current practices for reasons other than the fact that a follow up day was planned where their promises were to be discussed. Some of the most common reasons provided for making changes included improving the efficiency of the spray application process, to lower spraying costs and reduce the dependence on chemicals for disease control. The quality of speakers is also an issue that cannot be underestimated when considering the training framework. Participants were usually full of praise for speakers who interacted with them, presented credible information and were realistic with their management options. They also valued the opportunity to discuss issues with others in the group and expert presenters. The process of information gathering and instigation of changed practices occurs not only as a result of what participants hear from the workshops as individuals, but also from information they gather when talking to their peers. The majority of participants also consider the manual a valuable reference.

Many participants said that they foresaw major improvements in their vineyard pest and disease management as a result of attending the workshop, and comments from the follow up day indicated that this was generally the case. A significant number of participants began or increased the frequency of spray coverage evaluation and sprayer set up and observed improvements in disease control as a result. These findings indicate that the program was successful in providing a framework for the uptake of improved pesticide application strategies. It is also evident that many participants will continue to make changes that can only result in further beneficial economic and environmental outcomes.

Appendices

Appendix 1. Communication

Appendix 1.1: Technical Reports and Industry Journal articles (non-refereed)

Lopresti J. (ed.). *Improving vineyard spray application workshop*. Workshop notes. 2001 Australian Wine Industry Technical Conference, Adelaide, 66 pages.

Braybrook D. & J. Lopresti (ed.). *Managing Powdery Mildew Workshop*. CRCVT Pty Ltd - Research to Practice® (printed under sublicence). November 2001.

Lopresti J. *Workshops improve spray application*. Southern Farmer, April 2002.

Appendix 1.2: Leaflets/Brochures/Technical Guides

Lopresti J. & D. Braybrook. *Spray Application in Vineyards* in 2001-2002 Grapevine Management Guide, NSW Agriculture (ed. G. Small & T. Somers), p 65-70.

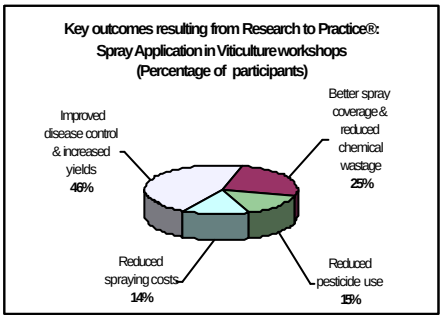
DPI's Research to Practice® Program – *An extension success story*

Spray Application in Viticulture: Research to Practice® is a three-day workshop designed to facilitate the adoption of new pest and disease management strategies with a focus on effective and appropriate use of pesticides. The training and education team at DPI's Institute for Horticultural Development, Knoxfield, developed the program concept with support from the Cooperative Research Centre for Viticulture. Over 800 viticulturists have benefited from workshops conducted over the last four years resulting in changed practices that have significantly contributed to positive economic and environmental outcomes in the grape and wine industry.

Case Study 1
A vineyard manager was able to reduce pesticide usage over one season by 52% and total spraying costs by 33%, resulting in savings of $230 per hectare while still maintaining excellent disease control after attending a spray application workshop.

Case study 2
Another grape grower was able to reduce his copper sprays by 40% and sulphur sprays by 30% using practical advice provided in the spray workshop resulting in an estimated reduction in total spraying costs of 35%.

Evaluation of the program outcomes demonstrated that **81% of workshop participants changed and improved their pesticide application practices after attending a Research to Practice®: Spray Application in Viticulture workshop**. Adoption of practices based on sound scientific information has resulted in significant reductions in pesticide use, improved disease control and related increases in yields and grower incomes. Through better spray targeting and strategic pesticide use environmental impacts have also been reduced while the cost-effectiveness of spraying has been improved.



These results were achieved as a consequence of growers moving away from calender spraying to more strategic pesticide application, adjusting chemical rates to suit vine growth and increasing monitoring for pests and disease. Financial support for this training program provided by the Department of Primary Industries and Grape and Wine Research and Development Corporation in collaboration with the Cooperative Research Centre for Viticulture has resulted in significant reductions in chemical inputs in the viticulture industry. Environmental, social and economic benefits will continue to flow from this investment as Victorian and Australian viticulturists continue to implement changes contributing to sustainable production in the grape and wine industry.

Research to Practice® Project Team: Mr John Lopresti, Ms Karen Green and Dr Robert Sward.

Victoria The Place To Be

Cooperative Research Centre for Viticulture

Grape and Wine Research and Development Corporation

Appendix 1.3: Links with Units of Competency

Components of ***Research to Practice*Ò*: Spray Application in Viticulture*** can be used towards the evidence of some learning outcomes for the following units.

NB: Attendance at a RtP workshop (with accompanying short report) will not independently fulfil the learning outcomes of the following units. Participants need to contact their local Registered Training Organisation (RTO) and organise for a skills assessment to fully document competency against each learning outcome within a specific unit.

Research to Practice: Spray Application in Viticulture

LEVEL 5

- **National Horticulture Training Package (Viticulture)**
  RUH HRT 529A Manage weed, pest and disease infestations

LEVEL 4

- **National Horticulture Training Package (Viticulture)**
  RUH HRT 431A Promote plant health
  RUH HRT 432 A Manage and notify a chemical spillage and/or leakage

LEVEL 3

- **National Horticulture Training Package (Viticulture)**
  RUH HRT353A Select chemicals and biological agents
  RUH HRT212 A Apply chemicals and biological agents

- **Certificate in Food Processing (Wine)**
  FDF WGGCBA A Apply chemicals and biological agents

Appendix 1.4: Research to Practice®: Spray Application in Viticulture workshop questionnaire

Spray Application in Viticulture: Research to Practice
Workshop Questionnaire
(to fill out and bring along to the workshop)

Name: _____

Company/vineyard: _____ **Vineyard size:** _____

Grape Varieties: _____

_____

Canopy management system/s _____

_____

Have you completed a Chemcert course recently? Yes ☐ No ☐

What spray equipment do you use?

- Boom spray ☐
- Airblast ☐
- Ducted airblast ☐
- Multihead ☐
- Airshear ☐
- Rotary atomiser ☐
- Other ☐ list _____

What are your main vineyard pests (includes insects, diseases, nematodes, weeds, mites)? (Choose no more than 4)

- Lightbrown apple moth ☐
- Mites ☐
- Powdery mildew ☐
- Downy mildew ☐
- Botrytis ☐
- Phomopsis ☐
- Other ☐ list _____
- Weeds ☐ list _____

_____

What is the range of spray volumes applied during the season?

- Lowest volume _____
- Highest volume _____
- Spraying grape bunches _____
- Mite sprays _____

How do you select your spray volumes?

_____

_____

Do you use chemical amount per hectare or amount per 100 L water?

- per hectare ☐
- per 100 L ☐

How often do you change your setup and operation during the season? _____

	Yes	No
Do you change your setup and operation for different pests?	☐	☐
Have you checked the quality of your spray water?	☐	☐

What adjustments do you make to your sprayer setup and operation during the season?

- ☐ tractor speed
- ☐ fan speed
- ☐ blade pitch (Air blast)
- ☐ nozzle number
- ☐ nozzle size
- ☐ nozzle type
- ☐ disc size (Air shear)
- ☐ operating pressure
- ☐ air deflectors
- ☐ head/finger angles
- ☐ cannons (Air shear)
- ☐ other list _____

_____

How often do you calibrate your spray equipment?

- ☐ never
- ☐ beginning of season
- ☐ every spray
- ☐ other list _____

How do you assess the effectiveness of your spray application?

_____

_____

Do you use water sensitive cards and dyes?

- ☐ Use water sensitive cards regularly (more than twice a season)
- ☐ Have tried using water sensitive cards
- ☐ Have used fluoro. dye

Thank you for filling in this form, it will provide valuable information about your region

Appendix 1.5: Research to Practice®: Spray Application in Viticulture workshop evaluation – First 2 days

EVALUATION

SPRAY APPLICATION IN VITICULTURE WORKSHOP - "RESEARCH TO PRACTICE®"-

Could you assist us by filling in this evaluation at the end of each day of the Workshop? We'd appreciate any comments, suggestions or constructive criticisms you might have. We'll collect this document at the end of the course.

(tick a box)

Day 1:		Yes	Partly	No
1.	Was the information presented in day 1 useful to you?	☐	☐	☐
	Comments.....			
	.....			
2.	Was the information presented clearly?	☐	☐	☐
	Comments.....			
	.....			
3.	Was the venue comfortable and could you see and hear clearly?	☐	☐	☐
	Comments.....			
	.....			
4.	Was the outdoor session useful?	☐	☐	☐
	Comments.....			
	.....			
5.	Did day 1 meet your expectations?	☐	☐	☐
	Comments.....			
	.....			

6. What sessions did you like most? (tick the box)

☐ Focus on targets	☐ Spray equipment
☐ How chemicals work	☐ Evaluation tools
☐ Improving pesticide performance	☐ Outdoor session

Comments.....
.....

7. What sessions did you like least? (tick the box)

☐ Focus on targets	☐ Spray equipment
☐ How chemicals work	☐ Evaluation tools
☐ Improving pesticide performance	☐ Outdoor session

Comments.....
.....

8. Any general comments about the workshop content, the presenters, the facilitators, or other aspects of day1?
.....
.....

Day 2: (tick a box) Yes Partly No

9. Was the information presented in day 2 useful to you? ☐ ☐ ☐
Comments.....
.....

10. Was the information presented clearly? ☐ ☐ ☐
Comments.....
.....

11. Was the venue comfortable and could you see and hear clearly? ☐ ☐ ☐
Comments.....
.....

12 Was the group session and discussion on Day 2 useful? ☐ ☐ ☐
Comments.....
.....

13. Did day 2 meet your expectations? ☐ ☐ ☐
Comments.....
.....

14. What sessions did you like most? (tick the box)

☐ Sprayer set up ☐ Botrytis ☐ Calibration
☐ Spray quality ☐ Labelling issues
☐ Powdery mildew ☐ Spray volumes discussion

Comments.....
.....

15. What sessions did you like least? (tick the box)

☐ Sprayer set up ☐ Botrytis ☐ Calibration
☐ Spray quality ☐ Labelling issues
☐ Powdery mildew ☐ Spray volumes discussion

Comments.....
.....

16. Any general comments about the workshop content, the presenters, the facilitators, or other aspects of day 2?
.....
.....
.....

17. Do you think you will be able to use information from this workshop to improve operations in your vineyard? (tick a box) Yes Partly No
Why / why not?..... ☐ ☐ ☐
.....

18. Was this workshop good value for money? (tick a box) ☐ ☐ ☐
Why / why not?.....
.....

Thank you for taking the time to fill this in. We appreciate it.

Appendix 1.6: Research to Practice®: Spray Application in Viticulture workshop evaluation – Third day

Spray Application : Research to Practice
"The Third Day"

2. Did you change your spray application practices after the 2 day workshop? Yes /No

If yes, what did you change? .....

.....

.....

4. Did you calibrate your equipment more after the initial 2 day workshop? Yes /No
If yes, what did this involve?
.....
.....

5. Did you adjust your equipment and spray operation to target sprays at particular pests/diseases? Yes /No
If yes, what pest/s? .....

.....

Have you made any changes to rates of water or chemicals applied during the season?
If yes, what did you change? Yes /No
……
……

4. Have you used your manual during the season ? Yes /No
If yes, how often?.....

Score
Please place a number in each score box

1	No - Not at all	**2**	A little	**3**	A moderate amount
4	Quite a bit	**5**	Yes - A lot		

Score

6. Did you feel motivated to follow up on your Promise because the 3rd day was planned? ☐
7. Was it worthwhile discussing your Promise and results on the Third Day? ☐
8. Did you pick up useful tips from hearing the others reporting on their Promises? ☐
9. Did you have enough time to discuss your Promise and results? ☐
10. Did you feel comfortable discussing your findings with the group in this way? ☐
11. Were the afternoon sessions valuable? ☐
12. Any other comments about the 3rd day?

.....

.....

.....

.....

Thank you for taking the time to complete this sheet for us.

Research to Practice
Grower Reports

Workshop: IPM ☐ Spray ☐ Water Management ☐ Nutrition ☐

'Promise':

Region:

Relevant Site Characteristics *(eg water source, irrigation, variety, canopy type etc)*

What is (are) the changed practice(s)?

What were you doing previously?

What were the key results?

Will further changes be implemented next season as a result of these results? YES/ NO

Contact person's name:
Contact person's phone number: ( )

Appendix 1.7: Workshop program information developed for hosting organisations

Agriculture Victoria
Private Bag 15
Ferntree Gully Delivery Centre,
Vic 3176
Telephone 03 9210 9222
Facsimile 03 9800 3521

Spray Application in Viticulture

This workshop will focus on practical methods for improving the efficiency of spray application in the vineyard. Participants will gain a clear understanding of how to correctly set up their spray equipment and best target sprays in a changing canopy while getting the right amount of pesticide to the target pest. An outdoor session is also conducted to demonstrate the principles of effective spray application including sprayer adjustments and evaluation.

Program:

Introduction
This unit introduces the course to the participants and participants to each other.

Focus on the target
This unit considers specific insects, mites and diseases as biological targets, as well as briefly identifying possible spraying strategies for particular pests. Changes in the application target as the vine canopy grows will also be discussed and cultural and management practices to improve spray penetration reviewed.

How chemicals work
This topic looks at the major groupings of chemicals used in viticulture, discussing their mode of action, barriers to effective use and management strategies to reduce or delay development of resistance to pesticides.

Improving pesticide performance
This unit addresses issues that may impact on the efficacy of pesticides used in viticulture such as chemical compatibility, water quality, tank agitation and adjuvants. Procedures and practices that may improve pesticide efficacy will be outlined. Herbicide compatibility and efficacy will be discussed.

Spray equipment
This module considers the types of equipment currently available for spray application in viticulture in terms of spray technology used, features, set up and maximising performance, versatility and cost. Factors to consider when purchasing a sprayer will also be outlined and the effect of travel speed, over-the-row spraying and tank-filling on spraying costs demonstrated.

Evaluation tools
The various tools available for evaluating spray coverage and effectiveness of changes to sprayer set up and operation are identified in this unit. Discussion will focus on the assessment of droplet density and distribution inside a vine canopy using water sensitive cards and fluorescent dyes.

Outdoor session - Sprayer set up and evaluation
The participants will have an opportunity to put into practice some of the concepts discussed in the workshop by setting up a sprayer and evaluating spray coverage

Optimising sprayer set-up
This unit identifies the major components (application target; air direction, volume and speed; and water volume) that impact on spray penetration and distribution. It outlines procedures for optimising sprayer set up to maximise and even out coverage through the vine canopy. Examples of the set up process for various sprayers and vine growth stages (budburst, flowering, bunches etc.) will be provided. Sprayer operation and set up to minimise off-target impacts will also be considered.

Spray quality - From tank to target
This module explains how spray droplets are formed and how their behaviour can be manipulated to optimise the spray application process. The various nozzle technologies used are described and nozzle selection discussed. The importance of droplet size in relation to coverage, spray deposition and retention will also be demonstrated.

Spraying for Powdery mildew
This unit focuses on the essential components for strategic management of powdery mildew including monitoring at appropriate times, understanding the disease cycle and using available fungicides at the right time. The various chemical control options are discussed in detail, resistance management strategies outlined and effect of climate and cultural practices on disease development identified.

Spraying for Botrytis
This unit describes the *Botrytis* disease cycle and outlines procedures to be used when monitoring for disease resistance and occurrence. The effect of weather and cultural practices on *Botrytis* incidence is discussed, and the various fungicide options considered. Spraying strategies, resistance management and targeting bunches to improve chemical efficacy are also described.

Labelling Issues - Interpreting label rates
This topic explains the changes in pesticide label directions and why the rate per hectare expression is inappropriate for spraying vines. The importance of applying a sufficient dose onto the spray target will be demonstrated and methods to achieve this discussed. The relationship between dilute and concentrate spraying will also be outlined. Examples of the new label directions and calculations required for determining chemical rates are provided.

Group discussion - How much chemical goes in the tank?
The various tools currently available for determining the spray volume and chemical rate for a particular vine canopy will be discussed including spraying to run-off, Unit Canopy Row and AVCARE recommendations.

Calibration
This module identifies common reasons for applying incorrect spray volumes and demonstrates the selection of nozzles using flow rate and pressure data. Procedures for determining travel speed and sprayer flowrate are also reviewed. Calibration charts will be used to demonstrate the conversion of litres/ha to litres/100m of row based on row width.

Grower group sessions
Group sessions during the spray application workshop will allow participants to discuss existing practices and experiences, as well as raise spraying issues not covered during presentations. A promise sheet will be filled in at the end of the workshop on which participants describe what management or spray application practice/s they will change during the season.

Appendix 1.8: Research to Practice®: Spray Application in Viticulture 'flyer'.

Each workshop covers a selection of topics from the list below, depending on regional requirements:

- Principles of spray application
- Droplet behaviour
- Matching water volume to canopy
- Off-target damage
- Targeting pests and diseases
- Weed management and herbicide application
- Chemical mode of action, resistance, formulations
- Tank agitation, adjuvants, compatibility
- Equipment types
- Machinery set up, calibration and modifications
- Maintenance and troubleshooting
- Interpreting chemical labels
- Application evaluation

The workshop also includes practical exercises on:

- Equipment set up
- Calibration
- Evaluation of performance of spray equipment.

Inefficient use of pesticides in viticulture impacts upon:

- production costs
- yield
- quality
- residue levels
- the environment

The *Spray Application Viticulture: Research to Practice*™ Training Workshop is designed to provide information and skills to optimise spray application in viticulture.

Improving the effectiveness of spray application involves:

- matching water and chemical rates to canopy size and structure.
- targeting specific pests and diseases.
- effective calibration and set-up of machinery.
- reading and interpreting labels correctly.

Workshops have a maximum of 25 participants to allow for interactive group discussion.

The workshop fee covers lunch, morning and afternoon teas, the post-harvest 3rd-day and a comprehensive workshop manual.

Spray Application Viticulture: Research to Practice®

Training workshops

A national training workshop program to assist viticulturists in achieving optimal spray application in vineyards.

Part of the Research to Practice ä Viticulture workshop series.

Victoria Department of Natural Resources and Environment

Cooperative Research Centre for Viticulture

Grape and Wine Research and Development Corporation

Appendix 2: References

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Appendix 3: Staff

Appendix 3.1: Key staff engaged on project

John Lopresti, DPI Victoria
Robert Sward, DPI Victoria
David Braybrook, Swinburne TAFE
Karen Green, DPI Victoria
Bernadette Swanson, DPI Victoria

Appendix 3.2: Technical staff and presentation/s delivered by each at workshops

Name	Organisation	Region	Presentations
National			
David Braybrook	DNRE (now Swinburne TAFE)	Yarra Valley	Targets, Powdery mildew, Botrytis,
Bruce Dawson	SST P/L	Victoria	Chemicals, Improving pesticide performance
DeAnn Glenn	DNRE (now GWRDC)	Melbourne	Introduction, Targets, Label rates, Botrytis, Off-target impacts
John Lopresti	DNRE	Melbourne	Facilitation, Introduction, Targets, Label rates, Calibration, Off-target impacts, Legal Issues
Alison MacGregor	DNRE	Mildura	Targets, Spray droplets, Label rates, Off-target impacts
David Manktelow	HortResearch	New Zealand	Spray droplets, Set up, Evaluation, Equipment, Calibration, Field session
Kieran Murphy	Food Science Australia	Melbourne	Spray droplets, Set up, Evaluation, Equipment, Calibration, Field Session
Bernadette Swanson	DNRE	Melbourne	Facilitation, Introduction, Chemicals, Off-target impacts, Legal issues
Robert Sward	DNRE	Melbourne	Facilitation, Introduction
Wayne Wilcox		USA	Powdery mildew, Botrytis
South Australia			
Sally-Jean Bell	AWRI	Adelaide	Chemicals
Geoff Furness	PIRSA, Loxton	Riverland	Set up, Label rates
Barbara Hall	PIRSA, Adelaide	South Australia	Powdery Mildew, Botrytis
Trevor Pfeiffer	Hardi	South Australia	Field session
Alex Sas	BRL Hardy	South Australia	Botrytis
Trevor Wicks	PIRSA, Adelaide	South Australia	Powdery Mildew, Botrytis

Victoria			
Ian Barber	Consultant	Victoria	Weed management, Herbicide application, Calibration, Field session
Peter Cole	DNRE	Melbourne	Spray droplets, Equipment
Bob Emmett	DNRE	Mildura	Powdery Mildew, Botrytis
Marcus Everett	DNRE	Rutherglen	Weed management
Graham Wilkinson	Silvan	Victoria	Field session
Ross Polglase	Consultant	Swan Hill	Targets, Powdery mildew, Botrytis, Phomopsis, LBAM
David Riches	DNRE	Melbourne	Spray droplets, Label rates
Erica Winter	DNRE	Melbourne	Chemicals, Botrytis
New South Wales			
Alex Banks			Off target impacts
Rob Ford		Hunter Valley?	Chemicals
Steve Gell			Weed management
Shayne Hackett	NSW Agriculture	Wagga	Targets, Powdery mildew, Botrytis
Peter Hayes	Southcorp		
John Kent	Charles Sturt University	Wagga	Herbicide application
Graeme Nicol			Chemicals
David Shearer	NSW Agriculture	Hunter Valley	Herbicide application, Legal issues
Western Australia			
Diana Fisher	Ag WA	Western Australia	Legal issues

Appendix 4: Workshop support materials

Appendix 4.1: Spray evaluation field work sheet

Water Sensitive Paper location record

Date
Block
Sprayer
Water Rate (l/ha)
Travel Speed (km/h)

Mark Pole Position
X marks trees **X** **X**
Indicate Wind direction with an Arrow **X** **Direction of sprayer** **X**

Weather **Wind speed** **X** **X**
Temperature

Write in height of target

Orientation

Facing/Upwind	**Distant/Downwind**	**Top Surface**	**Bottom Surface**
		…	
		…	
		…	
		…	
		…	

Ground alleyway **Ground drip line** **Ground trunk line**

Appendix 4.2: Off-target impacts group session work sheet and scenario

Spray Application **Group session**

Pest = ... **Group = ...**

How do I manage pest now?

.....
.....
.....
.....
.....

What I would like to change?

.....
.....
.....
.....
.....

What do I need to make the change?

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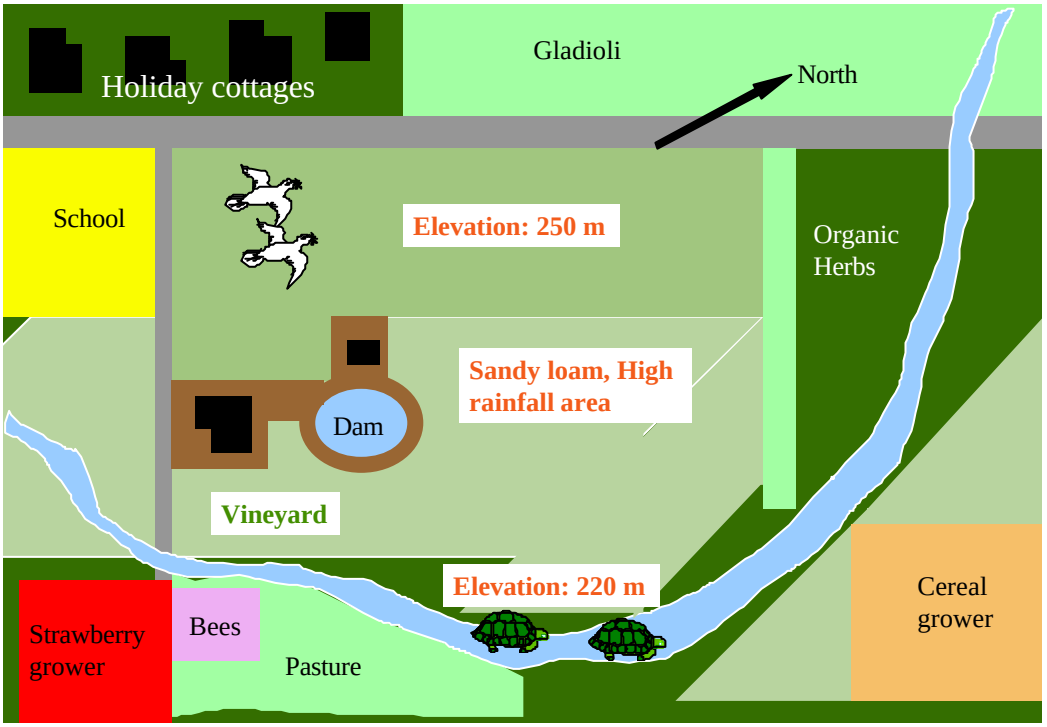
.....
.....
.....
.....

Research to Practice

Group ……

Sensitive areas OH & S	**Solutions** OH & S
Social/political	Social/political
Environmental	Environmental

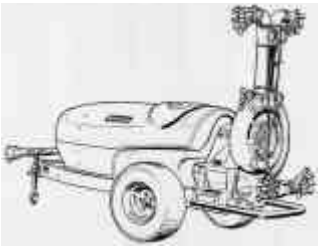


Appendix 4.3: Example of sprayer /canopy interaction group session scenario and work sheet

Group session - Disease/Canopy/Sprayer interaction

Group 2

Disease:	Botrytis
Sprayer:	Air shear sprayer
Fungicide:	Scala
Growth stage:	80% cap fall



Choose a canopy type:

……..

Description:

……

……

Application issues to consider:

- Biological / Application target requirements
- Canopy / Cultural management to improve application
- Sprayer suitability / modifications / set up
- Dilute or concentrate spraying
- Determining water volumes and chemical rates
- Improving fungicide performance
- Climatic conditions/ Drift issues

Difficulties arising from this application target / canopy type / sprayer combination

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……

……

……

……

……

How could these problems be over come?

……

……

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……

……

Appendix 5: Supplementary evaluation data

Appendix 5.1: List of promises made by less than 2% of workshop participants

Promises nominated by 1% - 2% of workshop participants

- Set up recording system - monitoring, calibration, canopy density, sprayer set up etc.
- Monitor for thorough penetration & effectiveness of spray - search for obvious chemical contact to canopy/fruit zone
- Reduce off target impacts & costs
- Determine vine wetness/point of run off for changing canopies ensuring adequate internal coverage
- Reduce number of sprays by monitoring rather than calender sprays
- Modify spray equipment/use recirculating sprayer/develop maintenance schedule
- Develop farm map & keep records and consult with neighbours to minimise off-target impacts
- Gather more information on chemicals/adjuvants/spray application/calibration
- Review alternate chemicals/modify spray program
- Get Powdery mildew/Downy mildew/Botrytis under control next season - monitor disease control
- Reduce spray volumes/Use concentrate spraying
- Improve chemical storage
- Adopt better spraying practices - better staff & operator training

Promises nominated by less than 1% of workshop participants

- Improve spray application techniques - Sprayer maintenance, examine use of nozzles, volumes and timing of applications
- Use UCR method/calculations
- Tank mix - Minimise number of chemicals in tank mix/check water quality
- Identify/implement OH&S requirements/hazards eg. Covered tractor
- Develop better set up/calibration procedures & records - build in steps to better document coverage & subsequent chemical & water rates
- Monitor spray efficiency/coverage using spray poles & WSC - adjust sprayer set up to improve coverage
- Targets, timing, treatment and technique
- Reduce herbicide spraying by 1/3 - study weed cycles & determine efficient kill rate
- Develop accountability system for herbicide application - check water quality & equipment, safe chemical use, spray records
- Reduce herbicide use - use mulching
- Reduce spray intervals
- Increase control of LBAM - spray at right time and at right rate
- Have better weed control - accurate calibrations, reduce spray time
- Clear out flower trash, preserve cuticle on berry - test air only pass, air & water, check wetters, monitor damage
- Determine rates per hectare for different row widths and canopy densities
- Investigate use of Ausvit vineyard management software
- Application per 100m of vine rather than per hectare
- To use best spray practice - monitor chemical application & rates, use manual for reference when spraying
- Send samples for testing (Botrytis)

Appendix 5.2: Spray workshop evaluation comments after the first two days

1999 Evaluation Sheets – Comments

Griffith 2-3/11/99 (Old evaluation sheet)

Positive	Workshop of great assistance Advising other farmers I shall monitor my equipment and spray application more wisely By improving sprayer operation and targeting pests better Good overall presentation of information Better understanding of how nozzles work - greater knowledge of spray application
Negative	Working out L/ha. Have air shear and difficult to compare rates with air blast Too many presenters - covered same topic twice (2)
Suggestions	
Cost	I have learnt a number of things which I can take back to the vineyard and put into practice Always good to look at a new approach or issue Because of the content New ideas on spray nozzles & latest equipment

Kurri Kurri 23-24/11/99 (Old evaluation sheet)

Positive	Content was excellent/Relates back to work Presenters were clear and easy to understand Outdoor activity was very helpful Excellent all round Good quality & informative & interesting Presenters did a good job of presenting a difficult, controversial issue Content of workshop has increased my awareness of spraying issues/ will result in greater diligence in spraying operations Best day of spray practice information ever experienced Hands on experience of measuring spray effectiveness was very good Information provided sufficient base to allow evaluation of current practice and improvement Good base of information to evaluate operation Excellent - well presented, topical and focused Very informative, factual, essential to attend
Negative	More applied examples
Suggestions	Actual vineyard examples can be given ie. if tractor speed is reduced from 10 to 5 km/h the effectiveness of your 300 km/h wind from air shear will be reduced by ??% - not precise but indicator of variation Equipment - more facts on capacity More time spent on calibration and set up in field Manufacturers to provide nozzle charts
Cost	Very helpful to my work and career Better value once definitive answers can be given in regards to label rates/dose Most relevant viticultural workshop I have ever attended Excellent to get greater understanding of what constitutes effective coverage and how we can improve air/chemical efficacy

Quotes – “Most relevant viticultural workshop I have ever attended”

Cowra 4-5/11/99 (Old evaluation sheet)

Positive	Presenters did good job explaining spray application issues in simple terms Gained a lot of info to improve coverage on the target and how this is achieved Clearer view on UCR Improved view on IPM Explanation of things I could see but did not know why or really what to do Got lot of info from group participation in the topics Kieran's very practical approach was good
Negative	Realise that off target impact and legislation are important but should be brief. People want the practicalities of spray application
Suggestions	Would like to see program before workshop More specific on adjuvants and compatibility Weed management - topic was spray application, shouldn't be included
Cost	Important part of management

Mudgee 25-26/11/99 (Old evaluation sheet)

Positive	Alison did brilliant job of explaining a difficult and often misunderstood concept of spraying using concentrated volumes Great presenters - knowledge very valuable A lot more understanding of droplet behaviour/canopy control when spraying Information was good and well presented (2) Group sessions very good Makes me more aware of setting up correctly Very comprehensive content, very knowledgeable; Presenters using effective teaching techniques Presenters seemed to have had good experience in the field and were happy to present
Negative	Outside a bit too slow and disorganised
Suggestions	Would like to have received some intro to each presenter Field demo needs to be refined
Cost	When I started I could not justify $300 for 2 days but now it is all a lot clearer and less scary We could save the cost of the workshop in one day of spraying Because of the number of presenters

Tasmania 20-21/10/99 (Old evaluation sheet)

Positive	Tank to target was very well presented Presenters very professional and friendly (2) Technical knowledge of Alison & Kieran was very interesting (2) Workshop provoked the need to experiment & guidelines for this Encouragement to determine own best practice
Negative	Similar info has been covered in IPM & chemical handling accreditation course (Day 1) Day 1 went a bit slow Too much time spent on weeds Too much time taken (Legal) Legal not valuable until there is a problem A bit too Hot climate orientated A lot of material obvious (Sprayer set up) Limited range of equipment in outdoor session Too many questions unanswered (Label rates) Not enough time for questions after each presentation Some info needed more detail
Suggestions	Specific discussion on individual chemicals would be a great assistance and wetters & adjuvants Allow enough time for spontaneous discussion on items relevant to participants More time needed on Tank to Target and Grapevine spraying More research needs to be done on the effectiveness of spray equipment More time required on chemical rates, sprayer set up in practice, wetters/oils etc. Still need clarification in the use of adjuvants
Cost	Greater knowledge of an important subject All workshops are of great value Innovative Too expensive Because principles it followed will save money in the coming months

2000 Evaluation Sheets – Comments

Angaston (Southcorp) (Old evaluation sheet)

Positive	Botrytis (good) & powdery (excellent) Excellent – good content; Very beneficial Very clear understanding and valuable Presenters and facilities made for excellent day 1 Many interesting and informative ideas (adjuvants) Any tool which can simply measure amount of chemical put out is valuable Excellent (2); Very good (2); Good (1); OK (1)
Negative	Slight confusion when discussing air blast vs air shear – more emphasis on type of machine being discussed Calibration sheets needs rehashing Outdoor session – wasted too much time/too slow Very information filled day 1 More black & white answers required Calibration just too complex Hard seats Presenters doubled up at times & occasionally difficult to understand
Suggestions	Whiteboard example before calibration exercise More pictures for legal Must be easier way to set out calibration calculations
Cost	Govt paid for it Fair % of cost already paid Good value Somewhat paid for Was good value until was told had to pay Thought Yalumba were paying but worth coming along

Nurioopta (Southcorp) (Old evaluation sheet)

Positive	Work on the calibration sheet was good Good (Botrytis) & Well done (Powdery) Botrytis & powdery were really good Chemicals – Ross' experience & anecdotes v good Good, challenged current way of doing things/encouraged lateral thinking Generally good info, well presented/interesting to take put info into practice Outdoor – stimulates ideas to improve operator set up Overall workshop quite clear and gave enough information/relevant Label rates was interesting & very relevant Presenters able to get there point across/made it interesting Day 2moved along well All very good (2)
Negative	Same old info churned over again (day 1) Been through disease part before Have been doing this for 27 years (day 1) Some detail not given or not clear Intro – too fast/ did it have too be so long (2) Chemicals – presenter spent too much time talking to each other; seemed unsure of material Labels – seemed to lack detail/assumed that some of us are up to date with this/too fast because new/some confusion Equipment – no use for someone with 20 years experience Set-up – too fast on calibration & conc. changes Off target – covering well known info Legal – not really relevant/too long & late in day/slow & boring/too much detail Outdoor session – set up not clear Repetitive in places Calibration – bit convoluted Greentech unnecessary/nothing new Vol/100m rate not valuable/avoid Long narrow room - hard to see screen
Suggestions	Course would be useful for all our grade 3-4 vineyard workers (Equipment & set up particularly) Hopefully follow up with labels examples Should have made more use of experience & knowledge of operators in group Need more photos of various machines and set ups for different canopies & modifications

Quotes – "Thanks for booklet which I am very grateful for jogging my memory and helping to explain to hubby"

Merbein South (Old evaluation sheet)

Positive	Presentation & content was very good & of great benefit to my work (Day 1) A lot taught in a limited time Good background information Excellent presenters – all very clear, good to see recognizable names from industry An excellent day (day 1) – well put together All topics covered very well – subject knowledge excellent Everything was very well presented and facilitated – generally very good Well organised and straight to the point – well presented Excellent (2); Very good (2); Well done (2)
Negative	Calibration section weak – over complicated/will not change current method A little rushed sometimes – allow time for more questions Targets – outlined aims of spraying rather than method Pace of some sections was slow but probably adequate considering backgound of attendees Many concepts r& applications repeated over and over again
Suggestions	Chemicals – need more detail on modes of action, perhaps chart listing successful rotations etc. Equipment should be region specific Have a section where bring in spray diaries to check if using too much chemical etc.
Cost	Good presenters & info Good information for the price

Quotes – "Excellent. Great presenters with exceptional knowledge on topics. A must for all growers."

McLaren Vale (New evaluation sheet)

Positive	Very useful info on importance of air Very good course overall – interesting & presenters easy to follow Presenters & facilitator spoke in easy to understand language Very good (3); Well done (1)
Negative	Chemicals – a bit vague Spent too much time on calibration Lecturer wasn't energetic or enthusiastic (chemicals)
Cost	Good value for money because it gave us a lot of information

Quotes - "All sessions were worthwhile – just grand!! (Day 2)"
- "It really was good. I honestly don't have a best/worst! (Day 1)"

McLaren Vale (Southcorp) (New evaluation sheet)

Positive	Powdery & botrytis were excellent Good presentations on all subjects Good to recap on equipment available Very informative & effective (outdoor) Very well presented Interaction between group & presenters was very good Barbara was very good at answering questions Outdoor session – excellent demonstration of what was presented Group session (Day 1) was essential to make some people take in what is taught All showed good knowledge and delivery Nothing, all sessions (Day 2) were excellent Very good (3); Good (3);
Negative	Chemicals – presenter not very good. An interesting topic made average unfortunately Chemicals – quite a simple presentation & content/rather basic/ session needs to be improved Chemicals – very poor delivery & incorrect statements/confused Calibration – too many options, focus on session outcome Discussion tended to get buried in detail & prolonged at times Seats hard (4)
Suggestions	Chemicals – Could have been more specific/detailed and used case study examples and solutions Lot of group interaction throughout sessions/no real necessity for group session (Day 1) Watch the time/Focus on subject Expert delivery much more valuable than group session
Cost	Yes, good value for money (knowledge gained on sprayer set up) Concise, effective and well presented Value for money especially for growers for farmbis Will help improve efficiency

Quotes - "One of the best workshops I have ever attended"
- "Excellent, one of the best teams I have had the opportunity to listen to"
- "A worthwhile 2 days – I can feed information back to operators & technical staff"

Griffith (New evaluation sheet)

Positive	Powdery & botrytis were excellent All subjects covered thoroughly Excellent presenters, very well run Kept to time and practical part worked well Good interaction between people Presenters were excellent – clear & concise Everything appeared to be presented and coordinated quite well Enjoyed all sessions, very interesting, informative Excellent (3); Very good (3)
Negative	Sometimes too much info in a short time (Day 1) Didn't understand the chemicals used, but discussion after was good Having covered (Powdery & Botrytis) in IPM found these a bit repetitive (although comprehensive). Was looking for more info about setting of ducted air blast Should have presented info on NSW EPA legislation Sessions on botrytis & PM didn't really fit. Calibration units were sometimes hard to digest
Suggestions	Feel that (Powdery & Botrytis) should be related more to spray issues eg. Correct dose and water at phenological stages More info on spray techniques would have been beneficial Label rates – should include labels of some common chemicals used in vineyards Keep to time
Cost	Will hopefully reduce the losses caused by powdery last season I was looking for more practical skills to help with setting up my sprayer Two full days for $75 cheap!! Using latest technology and up to date info with well organised and informed speakers

Quotes - "Very good booklet to go with good presentations"
- "Two full days for $75 cheap!!"
- "There is always something to pick up at each session we attend as we hear different presenters experiences"

Orange (New evaluation sheet)

Positive	Helpful comments from presenters (group session) Very informative All speakers did an exceptional job. Very thought provoking. Useful suggestions made on using equipment outside design parameters Excellent (2);
Negative	Here this information all the time (Powdery & Botrytis) Very detailed - keep it simple Chemical info not so good Too full on for my knowledge of viticulture (Targets) Powdery & Botrytis too in-depth Too much to take in over two days
Suggestions	More time on labels and examples More time needed on calibration and different types of sprayers Should be set up to enable people to get the information that is relevant to them Shorter sessions with exercises involving some thought about practical situations would be more beneficial
Cost	Good value any time you learn something new The company paid for it and will reap the benefits Very inexpensive

Quotes - "The company paid for it and will reap the benefits"

Student suggestions from workshop

Generally interesting but covered a lot of this in Uni
Some info presented was a bit too technical & too much detail for the average grower attending
More practical exercises are needed. Most people participating want to relate to hands-on practices
Some people got lost and disinterested at times due to too much time inside and not knowing where the technical info was leading
Good to work through calculations & spend time in the field doing set up

Coonawarra (Southcorp) (New evaluation sheet)

Positive	Each session has an integral part to play in end result and its not often we get the chance to discuss them all together Very informative and relevant Excellent presentations – I learned a lot about general spray application All very interesting and relevant to out line of work Excellent (3); Very Good (3)
Negative	Some repetition Legal issues – not enough detail to be practically applicable Legal issues – been covered in detail in other workshops Seats a little uncomfortable Technical information not relevant to me personally (vineyard hand) Some repetitive information/concepts Warm in room (3)
Suggestions	Group sessions good way to swap ideas/experiences An air shear sprayer would have been good for comparison (regional issue) Would like brief detail on various canopy types and more detail of canopy structure
Cost	Clarify and optimise spray effectiveness Any workshop that gives you info to improve is always worthwhile All new information to me Very good value for money

Quotes – "Kieren does enjoy the white board – not that this is a bad thing"
"Beers were lovely"
"Excellent presenters, knew their topic, enjoyed their topic, were very diplomatic and persuasive with getting people to change their management –well done"

Rutherglen (New evaluation sheet)

Positive	All sessions were relevant to each other (Day 1) – liked all Well presented & organised Very clear and informative (Day 1) – better than expected Outdoor session – could see what had been discussed Excellent (1); Very Good (2)
Negative	A lot of information to take in Day 2 probably more helpful than Day 1 Label rates – too confusing Calibration – too confusing Sometimes got a bit technical Perhaps too much info too quickly
Suggestions	Maybe more group discussions & outdoor sessions Practical activities makes info clearer Would like to have more sessions on labels, equipment and set up
Cost	It was value for money with rebate Delivered by experts Good value as covers a broad range of issues Very worth while Save money, better spray coverage Yes, as it gives you a good idea of how to make your spray applications more effective I will save $50 in chemicals in around half-a-day (of spraying) Time away & cost will be quickly recouped

Quotes – **Regarding value for money of workshop "I will save $50 in chemicals in around half-a-day (of spraying)"**

Tumbarumba (New evaluation sheet)

Positive	All excellent – very impressive (Day 1) The book is very handy Well done – continue to good work All presenters did a great job Very pleased with the information Label rates – a difficult subject carefully handled Excellent (2); Good (4)
Negative	Chairs gave one a numb bumb (3) Information was good but could be presented better (more interesting) Only one group session (Day 1) and only partly useful Legal – could have been better, it sucked! Outdoor session could have been a lot better (ran out of time) Powdery & Botrytis: Replaying IPM we have done before (2) Some of the topics were repetitive A lot of time spent on air blast (understandably) but in Tumbarumba the norm is air shear
Suggestions	Presenters need more practical skill and with time they will have enough knowledge to relate back to our level at all times & presenters will improve
Cost	Value due to Farmbis subsidy, quality of info and practical info Yes, very Great transfer of information

Quotes – Regarding the whole workshop "This was a very thorough discussion on all aspects of sprayer calibration and set up"

Participant comments
Involve people more in discussion, don't just stand there and give information for long periods
When asked a question please say I don't know instead of making up answers
Do not make recommendations on sprays that are not completely founded eg. Mancozeb. You only suggest it, explain why and ask for class input

Langhorne Creek (New evaluation sheet)

Positive	Kieran exhibited great knowledge and experience and made the workshop successful! Good, informative day (Day 10 – well presented Informative and good information for us to take home (2) A lot more things to consider than I thought/ a lot of things overlooked when people are spraying Most useful especially the set up segment Very Good (1)
Negative	Some sessions too basic (Droplets, Labels, Set-up) Had previous good speakers on Powdery & Botrytis Equipment – Different sprayers to what I use but some day may help in choosing a sprayer Calculations were not clear Fairly intense 1st day Some details were probably too in depth/detail
Suggestions	Consider more group work to break up talks Have tech notes to look at – show growers just how much is on the label More detailed field session with one other machine would have been beneficial
Cost	Very good value for money If farmbis had not subsidised half of cost may be getting little expensive

Quotes – Regarding Off-target session "I liked it for its entertainment value"
"This (workshop) will make a big difference to the way I use my sprayer and chemicals"
"A very informative workshop with plenty of relevant information"
"All in all I think it was very helpful and I will pass on what I have learnt to my fellow employees"
Regarding value for money "You always need to learn more and become more efficient! It may also save us money in spraying time and wasted over-spray"

2001 Evaluation Sheets – Comments

McLaren Vale

Positive	Good choice of specialist speakers Great food – well presented All sessions of value and great interest Excellent venue, food, presenters and information (2) Found all sessions very good, enjoyable and informative Very good notes, well set out Very enjoyable and informative Outdoor session very useful, especially WSC exercise
Negative	Targets – Less general information A lot of topics not explained very well – hard to follow (Day1) Poorly organised outdoor session – no operator with machine knowledge Chemicals – presenter information didn't follow manual
Suggestions	Presenters need to follow manual more closely
Cost	Expensive but worthwhile attending

Quotes – "Make more informed decisions, have better understanding of calibration, droplets and labels"

Swan Hill

Positive	All topics covered from all angles Very good All very informative and presenters had expert knowledge in their field (2) Presenters concise, knowledgable & approachable
Negative	Labels confusing Outdoor session dragged on a bit
Suggestions	More information on boom sprayers and multihead
Cost	

Quotes – "Better understanding of pest & disease spraying"

Coonawarra (Southcorp)

Positive	Very good information (3) Great presentations – well thought out and presented I found presentation easy to understand (2) Calibration – working out the equations was very useful Unaware of methods being used Presenters displayed a great deal of knowledge (2) Course created a lot of questions
Negative	Don't get machinery reps to talk about equipment and calibration Don't underestimate knowledge of your group Calibration run through too quickly (2) Many people unclear about sprayer set up info which need further clarification Outdoor session too short
Suggestions	Powerpoint could be more closely matched to manual content
Cost	

Quotes - "I went in with an open mind and came out with some good information"
- "Learnt more than I thought I would"
- 'I was unaware that changing little things could effect the end result so dramatically"

Robe (Southcorp)

Positive	Most sessions explained well Very useful 2 day workshop Very clear delivery KM was excellent presenter Outdoor session – demonstrated very clearly where chemical is landing on vine (2) Presentations excellent from all speakers
Negative	Seemed to run out of time meaning some sessions were rushed Hardi salesman was a poor presenter Kieran spoke for too long as was too technical (2) Very repetitive (3) Questions directed more between presenters than group A lot of revision & some repetition – chemcert course (3) Chemicals – felt we were getting an ad for someones products
Suggestions	Some terminology requires definition for new growers (2) Need to determine lowest level of prior learning to avoid much revision (2)
Cost	

Quotes - “It was great learning a lot and look forward to getting it out in the field to put it into practice"

Adelaide Hills

Positive	Very well presented (4) All sessions interesting Very good Good focus on regional issues Very impressed with DM’s attention to detail and practical s olutions (2) Presenters all easy to listen too and showed good knowledge Calibration – excellent job of explaining in clear language
Negative	Outdoor session – too drawn out, really wanted to see results of spraying Labels – frustrating due to no right answers Mostly useful – a lot covered old ground
Suggestions	Would like objective assessment of sprayers to assist with purchase More time required in outdoor session to set up & calibrate sprayers
Cost	

Milawa

Positive	Presenters very informative (2) Day was well put together Well presented (2) Excellent – above my expectations (2) All sessions of value Day 1 – there wasn’t one session I didn’t like All presentations were well researched & presented
Negative	Chemicals – a bit hard to follow (2)
Suggestions	

Quotes - “I participated in this exact course 2 years ago and found this time around it was run a lot more professionally and organised"

Echuca

Positive	Filled in a lot of gaps wasn’t sure of Nice to have some one who is involved rather than reading from books Presenters were very well spoken and know subjects well (3) Excellent (3)
Negative	Not enough group discussion
Suggestions	More info required – labels and chemicals More outside sessions Maybe timing could be improved

Quotes - “Most informative spray seminar I’ve been to"

Appendix 6: Bennett's Hierarchy methodology

Extract from "Evaluation – Extension Bulletin. Ohio State University. 1997."