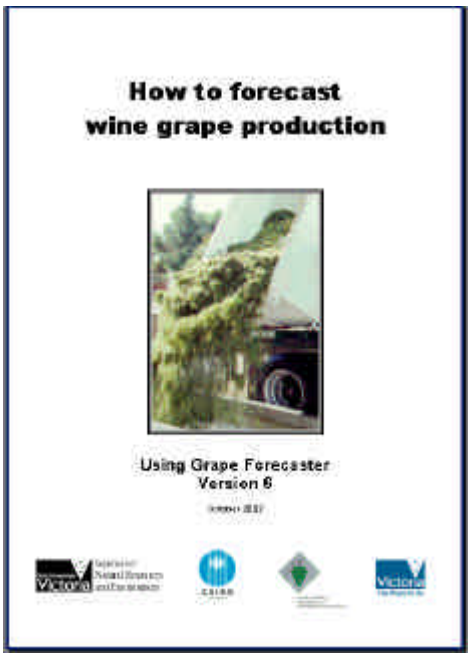
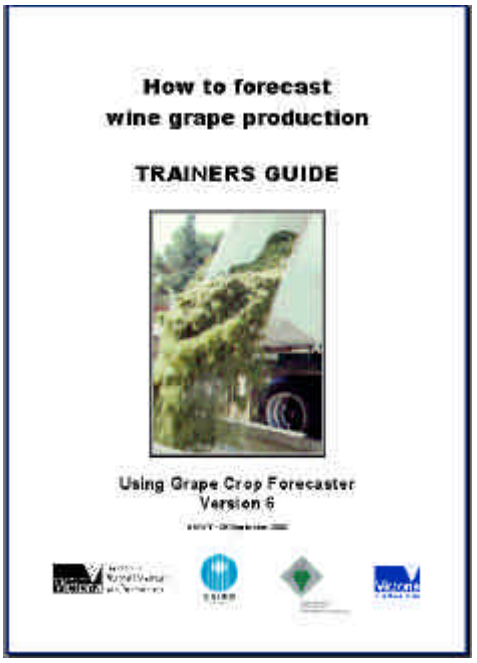
Winegrape Crop Forecasting Training Module





FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: **DNR 02/02**

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Research Organisation: **Department of Primary Industries**

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Final Report

Winegrape Crop Forecasting Training Module
DNR 02/02

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Abstract

The Winegrape Crop Forecasting Training Module comprises a training manual supported by computer software and a Trainers Guide to assist future trainers in delivering crop forecasting training. The training course advocated by the Module was evaluated and refined after delivery to five industry groups across South Eastern Australia in the 2002/2003 season. Participants were successfully trained in crop forecasting with over 90% of participants who completed the training indicating they intended to use the crop forecasting system in following seasons. The availability of the Module will be the first of its kind in the area of wine grape crop forecasting worldwide. Recommendations relating to crop forecasting training and barriers to adoption are presented and discussed.

Executive Summary

Continued advances in the accuracy of grape crop forecasting will improve the quality of planning and the profitability of businesses throughout the grape growing, wine making and marketing chain. Across the whole industry, the economic benefits of improved crop forecasting are substantial and conservatively in the order of tens of millions of dollars annually (Clingeleffer 2001). However, capturing these benefits relies on widespread industry adoption of 'best practice' crop forecasting systems. Hence, the aim of this project was to develop a Winegrape Crop Forecasting Training Module containing high quality PC software that could be delivered by accredited training providers to wine industry personnel throughout Australia. The project also tested the delivery of the training course and software before release to the Australian wine industry.

GWRDC and DPI funded this project (DNR 02/02) with considerable in-kind support from the wine industry. The project team was lead by Rebecca Dunstone, based at DPI Tatura along with project staff, Brad Montgomery (DPI Tatura) and Cynthia Mahoney (DPI Box Hill). In addition, the project was supported by strong input from Steve Martin and Dr Gregory Dunn (DPI Tatura), Dr Mark Krstic and Mark Welsh (DPI Irymple) and Peter Clingeleffer (CSIRO Merbein) from the *Crop control for consistent supply of quality winegrapes* project team. The project team reported to and was advised by an Industry Reference Group, which consisted of technical representatives from major wine companies, grower organisations and government agencies. During the life of the project, considerable in-kind support and guidance was also provided by growers and wineries that allowed training to be held at their properties.

The resulting Module comprises a training manual titled *How to forecast winegrape production* supported by *Grape Forecaster* computer software in addition to a Trainers Guide to assist future trainers in delivering crop forecasting training. The training course advocated by the Module was tested and evaluated by delivery to five industry groups across South Eastern Australia in the 2002/2003 season. Participants of the five groups were successfully trained in crop forecasting with over 90% of participants who completed the training, indicating they intended to use the crop forecasting system in following seasons.

The availability of the Module will be the first of its kind in the area of wine grape crop forecasting worldwide. Direct benefits from adoption of the crop forecasting system would increase efficiency of resource utilisation in both the vineyard and the winery with reduced waste, improved harvest scheduling, more efficient use of processing and storage capacity and greater accuracy of matching wine production volume to market demand. Social benefits to the industry would be realised if stakeholders of more accurate crop forecasting had a greater understanding of the resources required to make accurate crop forecasts and realistic expectations regarding how accurate crop forecasting can be. With a common language and an increased knowledge of the components of accurate crop forecasts, an improved relationship between grape growers and wineries should be achieved.

Background

Continued success of the Australian wine industry relies on, among other things, adequate processing capacity, continued productivity improvements and sensible risk management practices (Winemakers Federation of Australia 1996). The performance of the industry in these areas is highly sensitive to disparity between expected and actual grape intake. Continued improvement of the accuracy of grape crop forecasting would improve the quality of planning and the profitability of businesses throughout the grape growing, wine making and marketing chain. Across the whole industry, the economic benefits of improved crop forecasting are substantial and conservatively in the order of tens of millions of dollars annually (Clingeleffer 2001). However, capturing these benefits relies on widespread industry adoption of 'best-practice' crop forecasting systems. Hence, the aims of this project were to:

- Develop a Wine Grape Crop Forecasting Training Module that can be delivered by accredited training providers to wine industry personnel throughout Australia;
- Develop high quality computer software to support wine grape crop forecasting; and
- Test the delivery of the training course and software by June 2003.

The Module would incorporate important research developments, demonstrating key crop forecasting principles. Furthermore, it would be supported by a training manual and PC software, and be developed to a stage where it could be picked up and delivered by registered training providers.

Project Outputs and Performance Targets

The original project outputs and performance targets are presented in Table 1. There were several changes to outputs and performance targets *viz.*: (i) Changes in staff availability meant that the first edition of the crop forecasting PC software was not available until Jan 2003 (Output 2), (ii) After discussion with the project reference group, comprising technical representatives from wine companies, the project team with agreement from GWRDC decided to delete Output 3 – Crop forecasting web software and site, and (iii) The completion date for the final report (Output 9) was revised from 30th September 2003 until 19th December 2003 after negotiation with GWRDC.

Table 1. Outputs and performance targets for project DNR 02/02.

Outputs	Performance Targets
1. Manual: 'How to forecast grape production'	First edition of manual by Sep 2002 Revised edition of manual by Jun 2003
2. Crop forecasting PC software package	First edition of PC software by Sep 2002 Revised edition of PC software by Jun 2003
3. Crop forecasting web software and site	Interactive web site established by Jun 2003
4. Standard training exercise framework	Exercises defined for each round of workshops throughout growing season Standard training exercise framework documented by Jun 2003
5. Trainer's guide (including software)	Draft guide and software for each round of workshops throughout growing season Revised editions of guide and software by Jun 2003
6. Trained deliverers	Deliverers of module trained as per demand and budget
7. Training workshops	Course of workshops delivered to at least 6 representative groups throughout South Eastern Australia in Oct, Jan, near harvest and May 2002-03
8. Evaluations of outputs by trainers and clients	Evaluations completed after each round of workshops Results of evaluations documented by June 2003
9. Final report	Final report completed by September 2003

Method

The project team collaborated closely with members of *Crop control for consistent supply of quality winegrapes* (GWRDC Project CSP 00/2) project team during all stages of the project. Members of this group developed the original yield forecasting system that underpins the Winegrape Crop Forecasting Training Module and their involvement ensured that the Module contained up to date information on best practice crop forecasting.

The project comprised three main components.

Phase 1 (July 2002 – September 2002) Workshop development.

The project team in consultation with members of project CSP 00/2 developed a training program based on four half-day workshops held throughout the season. These workshops combined theory with field exercises and integrated best practice adult learning principles with key research and development outcomes. The first edition of training support materials consisted of a manual titled *How to forecast grape production* and crop forecasting software. A network of trainers with a high level of expertise was established from those previously involved in crop forecasting extension. Interested groups were selected for training at commercial vineyard sites in six representative regions throughout South Eastern Australia, *viz.* Coonawarra, Sunraysia, Central Victoria, the Riverina, North East Victoria and Great Western.

Phase 2 (September 2002 – May 2003) Workshop delivery and evaluation.

Originally six regions were selected for training. However, due to lower than expected interest in North East Victoria, this group was cancelled. Instead a workshop was convened to present the Module to potential training deliverers in order to raise awareness and obtain constructive feedback. For the five training groups, a series of four half-day workshops were delivered throughout and after the season. Workshops were run in October (bunch counting), January (berry counting and bunch weighing), near harvest (harvest data collection and pre-harvest forecast) and after harvest (May). During the first three workshops participants produced best practice crop forecasts for a nearby vineyard block. At the final workshop, forecasts were compared with actual production and participants shared their own forecasting experiences. An evaluation of training participants was also conducted at the final round of workshops, to collect qualitative and quantitative feedback on the utility of the crop forecasting system and the quality of the training and support materials.

The workshops combined crop forecasting theory, with practical exercises in the vineyard for generating forecasts. These forecasts acted as a catalyst for much discussion, feedback and group learning. A Microsoft® Excel workbook titled *Grape Forecaster Version 6*, a revised version of the software initially developed by the project CSP 00/2, was supplied to all participants along with a training manual.

During the first 6 months of the project Blain Howe and Bob White were contracted to develop the crop forecasting database and software, respectively.

Phase 3 (by June 2003) Support material and workshop revision.

Results of the workshop evaluations were collated and analysed to improve the training module. A standard training exercise framework and a trainer's guide (with supporting software) was developed. Although an initial aim of the project was to establish an interactive web site by June 2003, strong feedback from industry stakeholders supported by GWRDC indicated that web-based forecasting software was not currently desirable. Hence, the computer software was developed to be 'stand-alone'. It is important to note that the potential to make the system accessible via a web site still exists.

The Wine Grape Crop Forecasting Training Module is ready for use by training providers throughout Australia. Its content aligns with competencies as contained in the National Training Framework and is protected by Copyright.

Establishing close working relationship with major wine companies and opinion leaders in specific regions is facilitating rapid adoption of the technology contained in the Winegrape Crop Forecasting Training Module. The project group worked in partnership with programs such as *Grapecheque* in Victoria, and other state agencies such as the Wine Grapes Marketing Board in the NSW Riverina and industry associations.

Results/Discussion

The results of the project are discussed in order of the three project objectives. Copies of important project outputs have been submitted to GWRDC with this report.

To develop a Wine Grape Crop Forecasting Training Module that can be delivered by accredited training providers to wine industry personnel throughout Australia.

The project leader Rebecca Dunstone and team members Steve Martin and Dr Gregory Dunn had delivered crop forecasting training in previous years in conjunction with the DPI *Grapecheque* program and wine companies. This experience provided the basis for developing the Winegrape Crop Forecasting Module. The Module comprises the following components:

1. A training manual titled *How to forecast winegrape production*. The manual provides step-by-step instructions for using the crop forecasting system including software operation.
2. *Grape Forecaster* computer software in the form of either a Microsoft® Excel workbook or PC database software (Note: The development of the software component of the Module will be discussed under the next project objective).
3. A Trainers Guide containing trainer materials including;
    - An overview of the Module.
    - A suggested training framework including site requirements, timing of training interventions and venue considerations.
    - Microsoft® Powerpoint presentations and notes to support the series of four half-day workshops.
    - Adult learning considerations.

- An evaluation section including examples of evaluation tools.
- Frequently Asked Questions and recommended answers.
- Important background reading.
- A glossary of terms used in the training manual.

To develop high quality PC software and an interactive Web site to support wine grape crop forecasting.

Initially the project had access to a Microsoft® Excel workbook (*Grape Forecaster Version 5*) which had been developed by project CSP 00/2 to encourage adoption of the winegrape crop forecasting system. The Excel workbook was revised (*Version 6*) and used as a basis for developing the PC software. PC software was required to overcome significant limitations of the Excel-based system. For instance, the Excel workbook requires a separate copy of the workbook for each vineyard block or patch for each season. Apart from any problems associated with data management it is very difficult to efficiently generate historical vineyard information. A crop forecasting system based on a database overcomes this problem. Also, the Excel workbook does not allow a forecaster to sample and forecast from patches of vines that do not share the same row and vine spacing or vine structure. The PC software overcomes this problem to the extent where it can easily facilitate whole vineyard forecasts (eg. all of a vineyard's Chardonnay) or even regional forecasts (eg. all of a region's Chardonnay).

The new PC software is based on a Microsoft® Access database structure but does not require the user to be familiar with Microsoft® Access database or spreadsheet operation. It can be run on any computer with an operating system of Windows 98 Version 2 or above and does not require Microsoft® Access to be loaded onto the computer. The software has been designed so additional functionality can be incorporated over time to accommodate advances in crop forecasting methods, with sufficient flexibility to accommodate other vineyard operations such as yield regulation. It allows users to generate crop forecasts throughout the season using a variety of techniques, for any number of vineyard patches, either singularly or in groupings of 'like' vineyard patches over a number of seasons. The software also allows successive sampling events within a season and subsequently allows the user to select and specify which information is used to generate forecasts and historical yield component statistics.

To test the delivery of the training course and software by June 2003.

Attendance details for the five training groups are presented in Table 2. The number of participants attending session one ranged from 13 at Great Western to 26 at Coonawarra. For most groups there was a decline in attendance at sessions 3 and 4.

Table 2. Participant attendance for each session of the five training workshops.

Group	Session 1	Session 2	Session 3	Session 4
Coonawarra	26	20 (77%)	13 (50%)	9 (35%)
Great Western	13	9 (70%)	6 (46%)	7 (54%)
Griffith	14	11 (79%)	6 (43%)	11 (79%)
Karadoc	19	16 (84%)	10 (53%)	11 (58%)
Nagambie	15	14 (93)	7 (50%)	7 (50%)
Total	**87 (100%)**	**70 (80%)**	**42 (48%)**	**45 (52%)**

The groups also differed in composition. Emma Jamieson from the Wine Grapes Marketing Board advertised, coordinated and hosted the MIA group that was held in Griffith. This group consisted of technical staff from a number of large winery groups, NSW Agriculture staff and private vineyard operators. Southcorp coordinated and hosted the Sunraysia group (Karadoc group) at the Lindemans Karadoc winery. Vineyard managers of very large holdings in the Sunraysia that in total accounted for over 27,000 tonnes of Southcorp's grape intake dominated this group. The project team coordinated the remaining three workshop groups in Coonawarra, Great Western and Nagambie.

Participation in the Coonawarra training group was prompted by a presentation of the latest developments in crop forecasting research to local vignerons in August 2002 by Dr Gregory Dunn. Training workshops were publicised using local Coonawarra grape grower association networks. The resulting group of participants comprised vineyard managers and technical staff from various independent vineyard operations as well as technical representatives from large wine companies and viticultural consultants.

The Great Western and Nagambie training groups were initiated using the DPI *Grapecheque* network and funds from the Greater Victoria Wine Grape Industry Development Committee to advertise training workshops. Participants of the Great Western group were predominantly smaller vineyard operators from the Pyrenees and Great Western districts, with one participant from the Yarra Valley. Like the Great Western group, the Nagambie group was made up of smaller vineyard operators from the Nagambie and Colbinabbin districts, plus one participant from the Yarra Valley.

Thus, the diverse range of participants across the groups encompassed the spectrum of forecasting needs that face the Australian wine industry.

All workshop groups used a patch of nearby Chardonnay vines for practical exercises. Chardonnay was selected because it is an early variety and as such allows participants to apply techniques learned in workshops to other later maturing varieties in their own vineyards during the season. Chardonnay was also chosen to give participants the best opportunity to attend session three (near harvest) because at this time there are often other heavy time commitments. Despite the use of Chardonnay, an average of only 48% of participants attended workshop three (Table 2). Similarly, only 52% attended workshop four. Feedback from participants indicated the timing of workshop three clashed with harvesting that was already under way or imminent. It is recommended the benefits of running workshop three close to harvest, which are substantial, be weighed against the needs of training participants near harvest. Future trainers need to manage the expectations of participants to ensure that the training is tailored to suit the individual group and ensure the commitment of participants to attend all workshops in the series.

Overall, participants were very supportive of the structure of the workshops. Feedback was also particularly supportive of workshops tied to important physiological stages during the growing season. At these times, practical components of the crop forecasting system could be easily and clearly demonstrated in the field. Participants could reinforce this by implementing what they had learned upon returning to their own vineyards after the training.

The training manual impressed both participants and future potential trainers. They were confident that the manual comprehensively documented relevant theory and the practical steps required to make a best practice crop forecast. The training manual was referred to during the training and participants generally considered this to be a useful resource that they could return to as required. The provision of the Microsoft® Excel workbook was also greeted enthusiastically by participants many of whom did not have access to computer-based forecasting tools.

Rebecca Dunstone (project leader) and members of the *Crop control for consistent supply of quality winegrapes* project team, including Steve Martin, Dr Gregory Dunn and Dr Mark Krstic delivered training. Due to the project leader being absent from April to September 2003, replacement staff (Brad Montgomery and Cynthia Mahoney) helped deliver the final workshops.

Outcome/Conclusion

Evaluation of the Winegrape Crop Forecasting Training Module was an integral component of this project demonstrated by the development and implementation of an evaluation plan at the beginning of the project. A Bennett's Hierarchy (Bennett & Rockwell, 1995) for the development and dissemination of the Module provides the basis of the evaluation plan (Appendix 5). The Hierarchy is an evaluation framework, which provides a logical ordering of seven levels of inputs and outputs from extension programs that can be used in project planning and evaluation. The highest level (Level 7) addresses a broad range of social, economic and environmental (S.E.E.) outcomes of the extension program. Level 6 focuses on the practice change of end users of the extension program that would result in level 7 outcomes. The acquisition of knowledge, skills, attitudes and aspirations and the reactions to an extension program, outlined in level 4 and 5, are the result of the resources and activities of the extension program as summarised in the lower levels of the Hierarchy (Levels 1, 2 and 3).

In conjunction with the project objectives, the Bennett's Hierarchy was used to develop three Key Evaluation Questions (KEQ's) to assess outcomes of project DNR 02/02. These were:

- ***Key Evaluation Question 1. How effective is the Winegrape Crop Forecasting Training Module at training end users in best-practice crop forecasting?***
- ***Key Evaluation Question 2. What were the unexpected outcomes of the project?***
- ***Key Evaluation Question 3. Did the project deliver within budget, completing milestones to a satisfactory standard?***

Due to the relatively short 12-month duration of the project, KEQ's were developed for the lower levels of the Bennett's Hierarchy. Further evaluation over subsequent years would be required to evaluate the adoption of the crop forecasting system (Level 6 – Practice change) and higher level S.E.E. impact of the Module.

Results from evaluation conducted throughout the project will be discussed in relation to each KEQ to demonstrate how well the project performed against the planned outputs and performance targets.

Key Evaluation Question 1. How effective is the Winegrape Crop Forecasting Training Module at training end users in best-practice crop forecasting?

The objectives of this project specified the development and testing of the Winegrape Crop Forecasting Training Module. KEQ 1 attempts to evaluate the quality and utility of the finished product. Detailed qualitative evaluation results from the final session of the five training workshops forms the major source of evaluation data for KEQ 1 (an Evaluation Report is available from the Project Leader). Further evaluation data has been collated from feedback from participants at the trainer's workshop held in February 2003 and other feedback throughout the duration of the project.

KEQ 1 was divided into two main parts; the change in end users knowledge and crop forecasting practices as a result of undergoing the crop forecasting training, and the utility or suitability of the training materials and recommended training framework for delivering best-practice crop forecasting training.

Evaluation results demonstrated that the Winegrape Crop Forecasting Module successfully trained the participants from five pilot groups. All five groups had a positive training experience and most participants had a high regard for the crop forecasting system. Over 90% of participants who completed the training, when asked at the final session of the workshop series what they would do differently after attending the training, replied that they intended to use the crop forecasting system in following seasons.

Participants were positive about the structure and content of the training, which consisted of group-based workshops with incorporated practical exercises.

"I'm a hands-on person so getting out into the field was good … I couldn't understand it in the class but got it when we went out into the field."

Participants reflected that the recommended structure and timing of the workshops throughout the season meant the training was directly applicable when they returned to their own vineyard to make crop forecasts.

"Good - four sessions and tied to season (practical) was a great advantage – going out and seeing it in the field rather than looking at photos on a board."

Participants reported the manual and software to be comprehensive, user-friendly and useful.

"Things were well defined (in the folder) – took out all the guesswork."

"If you had to explain it to someone else it (the manual) made it a lot easier.'"

"It was set out well, sections were good, was easy to flick through and find the bits that you wanted – all the information was in there."

"You put the info in and it punches out the statistics for you so you don't have to have any real 'smarts' with statistics. It's a huge benefit because very few people would be able to do that themselves so gives you a lot of information in the background that you wouldn't be able to do yourself."

Participant opinions about the training materials was supported by comments from potential trainers who considered the materials to be adaptable and comprehensive, relevant to the production system and would capable of providing practical and desirable outcomes.

"… both the spreadsheet and the new software are good because there's nothing else around like this ….. it fulfils a need. There's no other program currently for this so it's good to have something."

"The whole thing is a fairly significant piece of work to get all this together in one package and the benefits of that are fairly far reaching for an integrated package."

Workshop participants were also asked to nominate barriers to adoption of this type of forecasting system and suggest improvements. The inclusion of a Glossary and a section containing Frequently Asked Questions during the project was in response to specific suggestions from potential trainers.

A major change to the training schedule was incorporated into the Trainers Guide recommending that participants should have access to a computer at the workshops, to practice and become familiar with the crop forecasting software. The previously

recommended structure of the training at the beginning of the project only suggested demonstration of the software, which participants followed with projection of the computer screen onto a large screen. The evaluation revealed that many participants would have benefited from having practical exposure to the software at the training. Consequently, the duration of the first workshop in the series of four has been extended to a whole day to accommodate the use of computers and the software by training participants. This change also has significant implications for future trainers in that suitable venues and equipment (ie. access to enough computers for a group of participants) would need to be located within close proximity to a vineyard location. This requirement is achievable in most viticultural regions with readily accessible facilities from State Departments, TAFE and University providers.

It should be noted that the Trainers Guide contained in the Module contains a recommended training framework and schedule with subsequent support materials. However it is up to individual trainers to accommodate and adjust the delivery of the training to suit their respective training groups. This may be required if participants request more time for discussion, particularly at the individual level to discuss implications of what they have learnt for their own situation or for additional instruction on the use of computers and crop forecasting software.

Key Evaluation Question 2. What were the unexpected outcomes of the project?

This question was included to identify any outcomes, associated events or issues that arose throughout the project that were not foreseen. The significant unexpected outcome of the project was the unforseen difficulty associated with the development of new database software to improve upon the previously used Microsoft® Excel

workbook. The original software engineer identified to develop the new software moved overseas before the project began. As a result, two private contractors were employed to design the database and engineer software with a simple user interface, respectively. The limited availability of the software engineer delayed delivery of the new software beyond what was anticipated by the project team.

Key Evaluation Question 3. Did the project deliver within budget, completing milestones to a satisfactory standard?

The most common and simplest form of project evaluation relates allocated resources to project delivery. The Winegrape Crop Forecasting Training Module and all of its components were completed within the allocated budget as agreed in the final project application. Due to the project leader taking maternity leave and limited availability of the engineer used to develop the software and user interface, a significant carry-forward of the allocated budget into the 2003/2004 financial year was required to complete project milestones. In addition to specified project resources, significant in-kind resources were obtained from team members from the *Crop control for consistent supply of quality winegrapes* project team who helped develop training materials and deliver training.

Although all outputs were achieved within agreed timelines (Table 1), the project team was not satisfied that the crop forecasting PC software was completed to a standard suitable for widespread release to the Australian wine industry. Based on feedback from stakeholders and key industry personnel, the project team has continued to develop the software, to improve on the product developed by June 2003 and also to include new capabilities to improve the early prediction of harvest bunch

weight. It is anticipated that the completed Module, supported by stable software will be made available to industry before July 2004.

The overwhelming response from the large majority of training participants was that the crop forecasting system, training manual and software represented a major improvement to the limited forecasting methods previously available to the Australian wine industry. Although significant barriers to adoption of the crop forecasting system were identified by the project (eg. the perceived complexity of the system and the resources required to make a forecasts), participants considered that the benefits of more accurate crop forecasts exceeded attendant costs.

The development of the Winegrape Crop Forecasting Training Module has important implications for the Australian wine industry. Widespread adoption would capture economic benefits for the production, processing and marketing sectors of the industry. Direct benefits would include increased efficiency of resource utilisation in both the vineyard and the winery with reduced waste, improved harvest scheduling, more efficient use of processing and storage capacity and improved ability to match wine production to market demand. This module is a world first in the area of wine grape crop forecasting and once gain underlines the highly regarded and long standing credentials of Australian viticultural research and development.

Additional social benefits to the industry would be realised if stakeholders were equipped with a better understanding of the resources required to make accurate crop forecasts and realistic expectations of best practice crop forecasts. With a common language and increased knowledge of the components of accurate crop forecasts, an

improved relationship between grape growers and wineries will be achieved. This relationship will assume increasing importance to the success of the Australian wine industry (GWRDC 2002).

Recommendations

These recommendations identify elements necessary to encourage widespread adoption of the methods advocated in the Winegrape Crop Forecasting Training Module. They have been generated from project evaluation results and after discussion with stakeholders.

Numerous changes were made to the training materials and workshop structure and content to improve its relevance and usefulness. However, the project identified some crucial recommendations that relate to both the crop forecasting system and crop forecasting training.

- **Innovations to simplify and improve the speed of data collection.** Currently, data collection requirements are considered to be time-consuming and continue to represent a major barrier to adoption. This is particularly the case with collecting data close to harvest. Research and development directed toward techniques or technologies to improve the ease and speed of data collection has the potential to significantly improve the adoption of the forecasting system. Advances in spatial imaging technology and the attendant data collection and analysis are proceeding at a rapid rate. This area of investment has the potential to deliver large benefits to the Australian wine industry.

- **A strategy to disseminate advances in the crop forecasting system and training to participants who have completed training.** This could be achieved with the development of a crop forecaster network comprised of training participants, crop forecasting trainers and other industry personnel. This recommendation may need to

be considered in conjunction with some kind of commercial arrangement for continued support of the Module.

- **Investigate the feasibility of incorporating the crop forecasting system into a total vineyard management software program.** Vineyard operators identified that data collection and management is a growing requirement for them in all aspects of their business including crop forecasting, quality assurance, fertiliser management, irrigation scheduling etc. It was suggested that a total vineyard management software program would be more useful than having a variety of different programs that all require different ways of entering data. Although to our knowledge there are no successful precedents for this in other horticultural industries, the world is changing rapidly and the role of information technology in measurement and management of agricultural production systems will become increasingly important.

- **Undertake cost-benefit analyses and case studies to demonstrate the benefits of adopting the system to growers.** At present there is no 'hard' published data clearly quantifying whole of industry benefits of improved crop forecasting. A major barrier to adoption is that some forecasters continue to remain sceptical that the resources required to accurately crop forecast outweigh the benefits. Cost-benefit analyses and case studies of different sized businesses would provide additional encouragement for the adoption better forecasting.

- **Continued evaluation of the Winegrape Crop Forecasting Training Module to improve decision making and enhance organisational learning in regards to future projects funded by the Australian wine industry.** This recommendation

could be addressed as part of the evaluation of the current GWRDC project *Regulating yield to improve wine quality and reduce industry costs* by modifying the project evaluation plan to consider impact of the Module on higher levels of the Bennett's Hierarchy.

- **Endorse cost-sharing arrangements between wineries and growers or incentive schemes to be provided by wineries to growers to encourage adoption of the crop forecasting system.** The primary beneficiary for more accurate forecasting is the processing sector of the wine industry (ie. the winery). However, at present there is no reward or incentive for growers to use the crop forecasting system to produce more accurate yield forecasts. The advantages and disadvantages of a number of potential models need to be assessed. These include: incentives provided to growers by wineries via a premium or an accreditation system, wineries supporting growers by managing the system set-up and the analysis of data or the use of contract specialist yield estimators to undertake crop forecasting, with costs shared between wineries and growers.

- **Develop a system of industry-wide data collection and management.** Participants and stakeholders identified that there was no coordinated approach across the industry to collect historical data. An opportunity exists to develop a system of collecting and recording regional data that can be shared by industry, not only to produce more accurate crop forecasts but also to improve industry planning during the season and in long term.

- **Expand the network of trained presenters for the Winegrape Crop Forecasting Training Module.** The Australian wine industry has invested substantial resources into research, development and extension of improved crop forecasting. The training developed in this project has been piloted successfully and is now at a crucial stage where it is ready to be promoted and delivered to groups throughout Australia to meet the increasing demand from industry. A major threat to the ultimate success of the project achieving widespread adoption is a lack of resources for the dissemination and support of the system. The project team believes that further resources are required to engage and support a network of trainers.

- **Investigate options to enable the Module to become a self-funding commercial product.** An evaluation of pilot group responses coupled with the quality of the forecasts that they made in 2002/2003 indicate that the Winegrape Crop Forecasting Training Module works and can assist growers in making more accurate forecasts. This technology is not only applicable in Australia but has potential benefits for the wine industry globally. An issue for the Australian wine industry to consider is the potential of commercialising this product for release both at home and internationally. Commercialisation has the potential of ensuring that the investment the Australian industry has made in the research and development of the Winegrape Crop Forecasting Training Module will be realised with a self-sustaining product with full end-user support for the crop forecasting methodologies and software.

Appendix 1: Communications

Project staff and collaborators have utilised funds from the Greater Victoria Wine Grape Industry Development Committee (GVWGIDC) to further extend the activities and results of the crop forecasting training project. This included a number of information sessions with grower associations across Greater Victoria and the preparation of a leaflet that was circulated in September 2002 to all GVWGIDC members. An article on the development of the training Module was published in Australian Viticulture (6(5): 64) by the Editor, titled *Adoption is a focus of forecasting effort*. Data from the training groups contributed to a paper in Australian Viticulture (7(4):37-41) by Dunn and Martin 2003, titled *Better early prediction of bunch weight*.

Appendix 2: Intellectual Property

The Winegrape Crop Forecasting Training Module is a valuable package of information and tools for the Australian wine industry. There is significant potential for the Module to be marketed either whole and/or in individual components to provide continued technical support of the Module for industry personnel who choose to implement the crop forecasting system and to potentially provide further funding for development of the product.

Appendix 3: References

Bennett, C. and Rockwell, K. (1995*) Targeting Outcomes of Programs (TOP): An Integrated Approach to Planning and Evaluation.* Draft. Washington, DC: Plant and Animal Systems, Cooperative Research, Education and Extension Service, U.S. Department of Agriculture.

Clingeleffer, P.R. (2001) *Crop Development, Crop Estimation, and Crop Control to Secure Quality and Production of Major Wine Grape Varieties: A National Approach*. CSIRO Division of Horticulture, Final Report.

GWRDC (2002) *Five year research and development plan: 2002-2007*. Grape and Wine Research and Development Corporation, Kent Town, South Australia.

Winemakers Federation of Australia, (1996). *Strategy 2025: The Australian Wine Industry*. Adelaide, South Australia.

Appendix 4: Staff

GWRDC and DPI funded this project with in-kind support from the wine industry. The project ran from July 2002 to June 2003. The project team was lead by Rebecca Dunstone, based at DPI Tatura along with project staff, Brad Montgomery (DPI Tatura) and Cynthia Mahoney (DPI Box Hill). In addition, the project was supported by strong input from Steve Martin and Dr Gregory Dunn (DPI Tatura), Dr Mark Krstic and Mark Welsh (DPI Irymple) and Peter Clingeleffer (CSIRO Merbein) from the *Crop control for consistent supply of quality winegrapes* project team. The project team reported to and was advised by an Industry Reference Group, which consisted of technical representatives from major wine companies, grower organisations and government agencies. During the life of the project, considerable in-kind support and guidance was also provided by growers and wineries that allowed training to be held at their properties.

Appendix 5: DNR 02/02 Evaluation Plan

Evaluation Plan

for the

Winegrape Crop Forecasting Training Module (DNR 02/02)

Prepared by Rebecca Dunstone

Introduction

In July 2002, the development of the Winegrape Crop Forecasting Training Module was initiated by project funded by the Grape and Wine Research and Development Corporation (GWRDC) and the Department of Primary Industries (DPI). The Winegrape Crop Forecasting Training Module will provide short course materials for training wine industry personnel in best practice, measurement-based crop forecasting systems. Development of the Module will be completed by June 2003, from which time it will be made nationally available to other training providers for delivery in subsequent years.

The stakeholders in the Winegrape Crop Forecasting Training Module include:

- Grape growers
- Wineries
- Training providers
- Project team developing the Module
- Funding providers (GWRDC and DPI)
- Wine industry
- General public
- Future manager(s) of the Module

The stakeholders listed above form the audience for evaluation information of the Winegrape Crop Forecasting Training Module although different stakeholders will be interested in different evaluation information.

The purpose of this evaluation plan is to outline the proposed collection of information to be used to improve decision making and enhance organisational learning in regards to future projects funded by the Australian wine industry.

A Bennett's Hierarchy for the development and dissemination of the Winegrape Crop Forecasting Training Module provides the basis of the evaluation plan. The Hierarchy is an evaluation framework, describing a cause and effect chain from which resources are expected to achieve an overall project outcome. In conjunction with the project objectives, the Bennett's Hierarchy has been used to develop Key Evaluation Questions (KEQ's). The KEQ's will be investigated through various data collection methods and analysis. How this information is managed and utilised is also discussed in the evaluation plan.

Bennett's Hierarchy for Development and Dissemination of the Winegrape Crop Forecasting Training Module

Bennett's Hierarchy was initially developed as a planning and evaluation framework for extension projects. The Agriculture Division of DPI has modified the Bennett's structure to accommodate planning and evaluation of projects involving reseach, dissemination and marketing. This modified structure has been used to develop a Bennett's Hierarchy for the development and dissemination of the Winegrape Crop Forecasting Training Module (see below).

The Bennett's Hierarchy encompasses development of the Winegrape Crop Forecasting Training Module, up to Level 1b (as funded by project DNR 02/02) through to expected change in Social, Economic and Environmental (SEE) conditions (Level 7) for the Australian wine industry. The framework highlights the requirement for further resource allocation if evaluation of the completed Winegrape Crop Forecasting Training Module is to be continued after June 2003, to evaluate higher levels of the Bennett's Hierarchy.

Definitions used in Bennett's Hierarchy:

- Next user – the people who will be using the research findings that result from research project activities (ie. those who will use the training module).
- End user – the people who will apply the new technology (ie. those who will use the crop forecasting system).

Level	Anticipated Outcomes
7b. SEE conditions Social, Economic and Environmental conditions expected from the use of the Winegrape Crop Forecasting Training Module.	**Economic – improved efficiency in the wine production chain.** The availability of accurate crop forecasts will enable a more streamlined intake process at the winery, minimising delays for subsequent fruit deliveries for both the winery and grape growers alike. The improved forecasts will also enable improved efficiency in resource planning and allocation at the winery, ensuring sufficient allocations for infrastructure (eg. tank space) and winemaking consumables (eg. oak, winemaking additives etc) to accommodate expected fruit delivery. **Social – improved relationships between grape suppliers and grape purchasers.** With a shared understanding of the resources required to make accurate crop forecasts and realistic expectations regarding how accurate crop forecasting can be, an improved relationship between grape growers and wineries should be achieved.
7a. Results of next users' work Adoption of Module by end users.	Through delivery of the Winegrape Crop Forecasting Training Module by training providers nationally, wine industry personnel responsible for crop forecasting will adopt a best-practice measurement-based crop forecasting system in Australian vineyards enabling more accurate yield forecasting.
6. Changes adopted by next users Use of Module by next users to improve practices and technologies.	Effective delivery of the Winegrape Crop Forecasting Training Module to wine industry personnel responsible for crop forecasting in Australian vineyards.
5**. KASA** Changes in next users' Knowledge, Attitudes, Skills and Aspirations obtained through the Module.	**Knowledge** – training providers will know: • what is involved in delivering effective crop forecasting training, • how to use the crop forecasting system contained in the Module to make crop forecasts, • that the Module is available for delivery. **Attitudes** – training providers will believe the Winegrape Crop Forecasting Training Module is a valuable tool. **Skills** – training providers will be able to use the Module and deliver the training. **Aspirations** – training providers will want to deliver the Module to wine industry personnel.

4. Reactions Immediate reactions that next users hold toward the Module.	Training providers will feel enthusiastic about the Winegrape Crop Forecasting Training Module and it's suitability for them to deliver.
3. Next users Who are the next users of the Module? What are their characteristics and requirements?	The next users of the Winegrape Crop Forecasting Training Module would be training providers across Australia and potentially internationally. This would include undergraduate training in Universities, TAFE, adult education centres, other Registered Training Organisations, service providers and consultants with existing expertise in delivery of viticultural training courses. These training providers would require training in the use of the Winegrape Crop Forecasting Training Module to ensure thorough understanding of the principles and procedures required for effective delivery of the course content.
2b. Dissemination activities Strategies, methods and scope of dissemination activities.	A communication campaign including an official launch of the Module to the wine industry would increase industry awareness of the Module and it's availability after development is completed.
1b. Research findings The output from research activities.	A comprehensive Winegrape Crop Forecasting Training Module for the extension of a best-practice measurement-based crop forecasting system, including a trainers guide, training manual and software.
2a. Research activities Strategies, methods and scope of the research design and analysis.	Outlined in the Final GWRDC Winegrape Crop Forecasting Training Module project submission.
1a. Resources Staff, time, money and volunteer time. Existing knowledge.	Refer to Final GWRDC Winegrape Crop Forecasting Training Module project submission for resources allocated for development of the Module. Additional resources would be required for continued management, dissemination and evaluation of the Module after June 2003 as discussed in the project Business Plan (see Appendix 2). Resources for continued evaluation of the Winegrape Crop Forecasting Training Module have been incorporated into a new research submission to GWRDC and DPI for the period from July 2003 to June 2006.

Key Evaluation Questions (KEQ's)

The following Key Evaluation Questions were developed to evaluate the Winegrape Crop Forecasting Training Module up to Level 3 (Next Users) in the Bennett's Hierarchy.

1. **How effective is the Winegrape Crop Forecasting Training Module at training end users in best-practice crop forecasting?**
2. **What were the unexpected outcomes of the project?**
3. **Did the project deliver within budget, completing milestones to a satisfactory standard?**

Within the scope and duration of project DNR 02/02, evaluation of the Module could only reach Level 3 on the Hierarchy discussed above because the Module will not be available to other training providers until after the project has completed. Hence, any evaluation of next user reactions, KASA and adoption and SEE conditions could not be assessed until after DNR 02/02 is completed.

Each of the KEQ's will be further discussed in relation to data required to answer each question and proposed methods to collect the evaluation data.

Management and Utilisation of Evaluation Plan

The DNR 02/02 project team utilising existing resources will conduct the evaluation outlined below. The evaluation results will be compiled and form a component of the DNR 02/02 final report which will be provided to GWRDC and DPI by December 2003.

Key Evaluation Questions and Sub Questions	Data required to Answer the Questions	Design and Methods
KEQ 1. How effective is the Winegrape Crop Forecasting Training Module at training end users in best-practice crop forecasting?		
What change in end user KASA was achieved after participation in pilots?	Change in participant KASA after pilots	• Socio-metric line at beginning of first session and at the end of session four to quantitatively compare self-assessed knowledge of crop forecasting systems and skills before and after training • Qualitative discussions with pilot participants throughout training with reference to KASA and reactions to training provided • Quantitative survey at the end of session four to determine value of the Module (KASA, reactions) to participants
What was the expected practice change of end users that participated in pilots?	Use of the crop forecasting system by pilot participants before training and number of pilot participants who expected to use the system in subsequent seasons	• Quantify number of pilot participants who have used measurement-based forecasting before training then compare with the number of participants who expect to use the system in future (survey session 4) • Quantify the number of participants who used the system during pilot duration (survey session 4)
How useful are the training materials in delivering best-practice crop forecasting methods?	Feedback from training providers and pilot participants on content and presentation of Module	• DeBono's 6 hats at the end of session 4 to gather qualitative feedback on the utility of the training materials and delivery. • Anecdotes collected from pilot participants and training providers through the duration of DNR 02/02 • Qualitative feedback from training providers who attend a workshop on the development of the Module

KEQ 2. What were the unexpected outcomes of the project?		
What were the unexpected outcomes of the project?	Unexpected outcomes resulting from the project	• Observation and documentation of unexpected outcomes of project DNR 02/02 collected by project team and collaborators
KEQ 3. Did the project deliver within budget, completing milestones to a satisfactory standard?		
Was the project completed within the allocated budget and resources?	• Budget monitoring throughout the project and reconciliation upon project completion • Documentation of collaborative support provided throughout project DNR 02/02 and compared with expected support in proposed project activities	• Budget review regularly throughout the project • Budget reconciliation upon completion of the project • Quantitative measure of collaborative support provided to project DNR 02/02 in comparison to proposed project activities • Documented negotiation of surplus resources after project completion (if required)
Were milestones met on schedule? If not, why?	Documentation of achievement of milestones	• Milestone reports supplied to GWRDC and NRE • Documented milestone negotiation (if required)