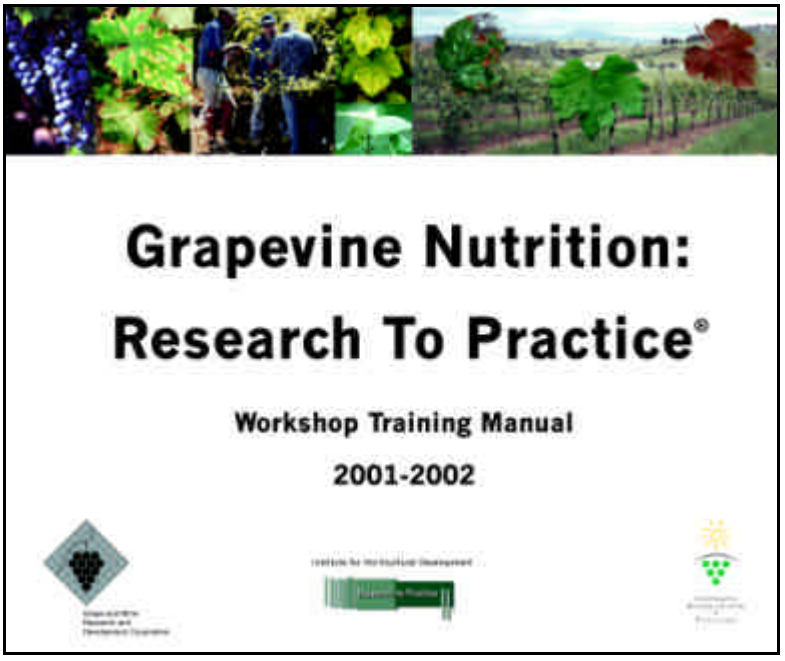
Grapevine Nutrition: Research to Practice®



FINAL REPORT to
GRAPE AND WINE RESEARCH & DEVELOPMENT

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

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Research Organisation: **CRC for Viticulture**

Date: **30 June 2002**

Abstract

The change from routine use of fertilisers to a more strategic or integrated approach to nutrition management in the vineyard impacts on the need to provide grower training and education to ensure ideas of best nutritional practice are adopted. Grapevine nutrition managers need a framework for developing an improved capacity for identifying and implementing strategic decisions. This includes not only the technological competence, but also developing a positive perspective with the confidence and commitment to implement the changes. Managers need a clear understanding of the options available and the dynamics of their agricultural system with up-to-date information, user-friendly identification and diagnostic tools. Scientific research needs to be translated into information and methodology that works 'on the ground'.

The aim of the current project is to develop and maintain a flexible model that brings these various aspects of Grapevine Nutrition together, while making them accessible to growers and resulting in effective incorporation of research results into nutritional management practices in Australia. The model has been tested over three seasons with more than 500 participants involving growers, vineyard managers, company grower liaison officers/technical officers, researchers, fertiliser company representatives, extension workers and educators. Evaluation of results to date suggest that there have been a number of direct benefits from this program, including important changes in monitoring and testing grapevine health, associated fertiliser practices and improved understanding of industry research priorities. A number of indirect benefits have also resulted from the information being passed on by company grower liaison officers / technical officers and educators to growers who haven't personally attended a workshop.

Executive summary

Grapevine Nutrition: Research to Practice® was based on the format of the successful IPM Viticulture: Research to Practice® workshop. This involves a three-day workshop, two days initially early in the season, then a third follow up day after harvest. Research to Practice® workshops are developed using adult learning principles and groups dynamics. They aim to create an 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. This is done in the form of a promise written at the end of the workshop, implemented over the current season then reported on at the follow up third day.

A total of 26 workshops were delivered in 20 regions of Australia to 527 participants. There were 37 presenters involved in the development and delivery of the workshop from a number of different agencies and companies Australia wide. The workshop format and content was continually developed during the project. Feedback from the participants and presenters contributed to the development of the workshop. The aim of the changes were to make the content more relevant to growers and provide information in a format that was easy to understand, while still providing enough information to make growers confident enough to implement changes.

Overall the response to the workshop was extremely positive and participants were very happy with the content and format of the workshop. 73% of participants indicated they changed their nutrition management practices after the first two days of the workshop. 70% of participants indicated they based management decisions on monitoring results. The workshop manual proved to be a valuable resource with 68% of participants indicating they used the manual during the season. The most significant impact the workshop had was to indicate the importance of tissue testing as part of a management strategy. This was reinforced by the high number (22.5%) of participants who indicated the commencement or ongoing use of tissue testing as their promise. Overall testing inclusive of tissue (petiole, sap and blade), soil and water testing resulted in 27.7% of participants making this their promise. The next popular promise of changing the current fertiliser strategy (17.6%). This was followed closely by improvements in record keeping (13.1%), monitoring (10.9%), management practices (9.5%), attention to quality (7.4%), a general updating of knowledge (6.5%), extension roles in sharing information (3.5%), organics (2.7%), and setting up specific trials (1.1%).

Feedback from the first two days in 2001 indicated that 93% felt that the information was useful, the information was presented clearly (93%) the group sessions were useful (77%). Many felt their nutrition management improved by carrying out tissue and/or soil testing, this allowed for a more informed approach to fertiliser strategies. 76% of participants enjoyed the opportunity to discuss their issues in an open forum with 89% picking up useful tips. Many also indicated that the workshop was part of a process of gathering information about various aspects they wanted to change, but generally not the only source. Many also indicated that often the workshop gave them the confidence they needed to implement a change they had been thinking about.

Attendance at the workshops by significant numbers of wine company grower liaison officers / technical officers and also educators ensured that there was a considerable amount of information passed on to growers who had not personally attended a workshop. As a consequence, the penetration of the information throughout the industry was considerably greater than that reflected by simply adding up the number of people who attended workshops.

Overall the objectives of the project were achieved and in some cases exceeded. The continued support of the industry to the Research to Practice® program indicates how highly valued it is. Planned improvements and continued development will ensure the Grapevine Nutrition: Research to Practice® workshop continues to meet the needs of industry, ensuring best practice grapevine nutrition management is maintained in the Viticulture industry.

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Background

The Grapevine Nutrition: Research to Practice® workshop is a successful continuation of Research to Practice® (Viticulture) which currently includes workshops on; Integrated Pest Management (IPM), Water Management for Grape Production, Spray Application in Viticulture and Winegrape Quality Management. Grapevine Nutrition is the third workshop developed in this series.

The Research to Practice® (Viticulture) concept was developed specifically to facilitate the incorporation of research outcomes into practical and economically feasible strategies and practices for vineyard management and grape production in each viticulture region of Australia. The concept was developed at the Institute of Horticultural Development (IHD), Knoxfield (Agriculture Victoria) with the support of a team of research staff from a number of participating agencies of the Cooperative Research Centre for Viticulture. The Grapevine Nutrition workshop is modeled on the successful IPM and Water Management for Grape Production: Research to Practice® workshops. The training program is a 2 day structured interactive workshop with a 3rd day held after vintage for groups of up to 25 in each region.

The initial IPM workshop focused on current knowledge and then challenged each participant to commit to adopting a new technique based on greater confidence in scouting and monitoring and the strategic approach, as opposed to the traditional calendar approach to pest and disease management. During the development of the IPM workshop (CRV 94/4) considerable time was spent on embedding adult learning principles into the workshop structure. Considerable thought was given to the best format for adult learning and also the form in which information was delivered. The response from this program provided the industry and researchers with sufficient confidence in the model to adapt it to training for subsequent workshop topics.

The principles of Research to Practice® are detailed in the manual 'Demonstrating Best Practice in Vocational Education and Training', developed by the Department of Natural Resources and Environment, and Education. This manual is part of the final report for the IPM Viticulture: Research to Practice® project and can be accessed at the Grape and Wine Research and Development Corporation.

Advances in the areas of irrigation management, optimising soil resources and modeling vine physiology all have the potential to significantly improve the performance of grapevine nutrition management and end product quality. There is an ongoing requirement for these technologies to be delivered to industry in a useable and enjoyable form, to improve practitioner confidence to change practices by adopting the best available methods of production and management.

At the beginning of this project soil and water resource management information was available to industry in the Water Management for Grape Production: Research to Practice® workshop, however a need was identified to develop information specifically to meet the needs of nutritional managers. The Grapevine Nutrition workshop was formulated in an effort to standardise the content and principles in nutritional management and provide participants with direct access to researchers from around Australia. Issues specific to various regions could be accommodated through a flexible system of delivery. A follow-up session after harvest provides participants with the opportunity to re-enforce the practices and principles discussed on the first two days. The third day also provides valuable feedback to the course designers and speakers. This report details the development of Grapevine Nutrition: Research to Practice® from 1999 to 2002.

Project Aims and Performance Targets

The objectives of the project are as follows.

1) To provide Australian winegrape growers with a training framework to enable greater uptake of best practice in nutrition management for the production of winegrapes to specification and to minimise negative environmental impacts.

2) Establish an avenue for improved and broader access to the outcomes of viticultural soil and plant nutrition R&D in a consolidated, practical training format within a network of quality, commercially supported trainers.

3) Enhance the management capacity and confidence of winegrape growers in improved nutrition management practices.

4) Review and update workshop manual, incorporating new material as identified during workshops this season.

5) Standardise presentations and training support material

Method

The workshop program

Grapevine Nutrition: Research to Practice® is a three-day workshop designed to promote the uptake of new grapevine nutrition management strategies. The concept was developed by the education team at the Institute for Horticultural Development, Knoxfield, Agriculture Victoria with support from the Cooperative Research Centre for Viticulture. The three-day workshop is broken into two days initially then a third (follow-up) day after harvest. Central to the success of the workshop is the commitment of each participant to a promise (or learning contract) at the end of the first two days. This encourages growers to implement something new they gained from the workshop, with the opportunity to discuss the results and any problems at the follow-up day. 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 the Research to Practice® team has developed a set of protocols which need to be followed by potential workshop hosts.

The workshops were delivered across 20 viticultural regions of Australia, with grape grower organisations, wine companies and others taking the responsibility for hosting the workshops. This involved coordinating the participants, booking the venue, catering and liaising with the workshop facilitator. The workshop facilitator was responsible for organising presenters, workshop equipment, travel and accommodation, plus other details as they emerged. The project coordinator developed the presentations in consultation with speakers, discussed the presentations with speakers highlighting possible questions and issues and kept the manual up to date. In this program the workshop facilitator and project coordinator were generally the same person, making the delivery of the workshops easier, but the load on one person has traditionally been quite heavy.

While providing a large number of benefits to the program, this structure also has the major flaw of relying heavily on one person.

If problems arose with the availability of the project coordinator/facilitator there were subsequent problems with program delivery. This issue was partially dealt with by increasing the number of facilitators familiar with the workshop. In addition, a range of protocols have been developed to streamline the facilitation process and this is currently coordinated from a central person located at Knoxfield.

As part of the on-going development of the project, further efforts will be made to train more facilitators. Accessing facilitators from non-traditional areas (ie outside the viticulture industry) will

also be investigated. Options include sublicensing workshop materials to registered training providers and TAFE's for delivery, this will be discussed further in the report.

The workshop structure

The workshop structure is based on the IPM and Water Management for Grape Production: Research to Practice® workshops. When developing the workshop, adult group learning dynamics were considered. Foremost was the fact that most participants are generally very active people during the working day. The program for the workshop needed to take into account they are not used to sitting for long periods and to provide timely breaks and adequate activities for them to interact with others in the group. The program for the workshops, **see Table 1** was developed starting with the introduction of the properties of nutrients in soil and vine, then moving into the sessions on specific management issues.

Table 1: The program for the first two days of the Grapevine Nutrition workshop

DAY 1		**DAY 2**	
8:30	**Introduction**	9:00	**Other nutrients**
9:00	**Role of nutrition in grape and wine production**	10:15	***Tea break***
9:15	**Nutrients, soil and vines**	10:30	**Fertilisers** Different types/forms Application methods
10:15	***Tea break***	11:15	***Group exercise:*** Cost calculations
10:30	**Group session:** sampling case study	11:45	**Fertiliser Discussion**
11:15	**Soil Testing and analysis**	12:30	***Lunch***
11:45	**Plant Testing and analysis**	1:15	***Group session (Case Studies)***
12:30	***Lunch***	2:15	***Tea break***
1:30	**Nitrogen**	2:30	**The role of nutrients in wine quality**
2:15	**Phosphorus**	3:15	***On my vineyard I promise ……***
3:00	***Tea break***	4:00	
3:15	**Potassium**		
3:45	**Group Session:** NPK current practices		***Finish***
4:45	**Close for the day – Drinks**		

The first two days

The first two days of the workshop are highly structured and very busy. Participants are required to concentrate for extended periods of time and it is obvious by the end of the two days that they are tired and the level of concentration diminishes. In response, increased focus was placed on group sessions which changes the focal point and pace of the 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. 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 1.1.**

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 which gives the 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 structure 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 development

The Research to Practice® process is dynamic and workshop programs change rapidly as feedback and participant's needs are analysed. Presentations change from one workshop to the next not only to take into account regional variations, but also in response to evaluation by the participants and speakers. The program for the Grapevine Nutrition workshop has evolved continuously, **Table 1** shows the program in its current format.

Changes to the program included the removal of the field session which was held at the end of the first day mainly due to the fact that it was hard to find vineyards with nutritional deficiencies and the fact that it is hard to characterise 'typical' symptoms, this session was replaced with more group sessions and the new section looking at' the role of nutrition in grape quality.

Results and Discussion

Overview of presentations from the first two days

Overall, the workshop feedback is extremely positive with the 12 of the 15 presentations liked by over 75% of participants in 2000 and 2001, **see Figures 1 - 4**.

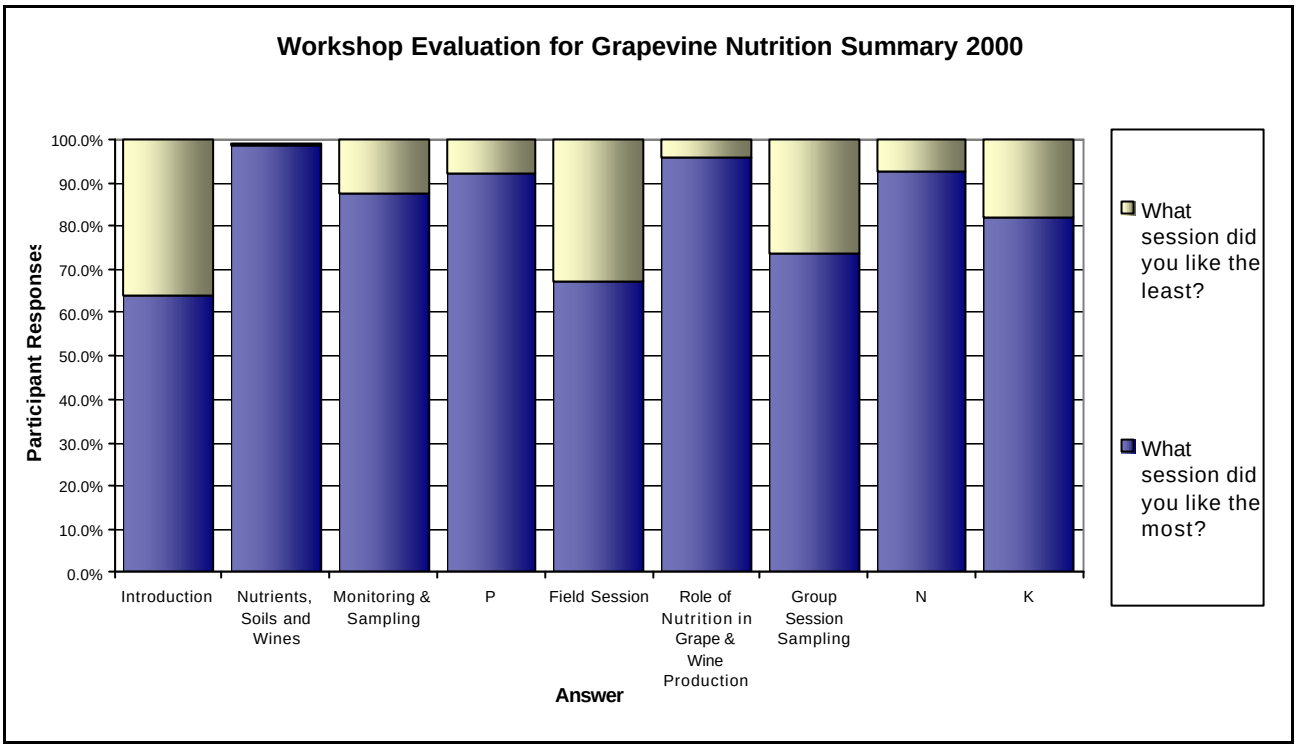


Figure 1: Grapevine Nutrition Workshop evaluation 2000 – Day 1 summary

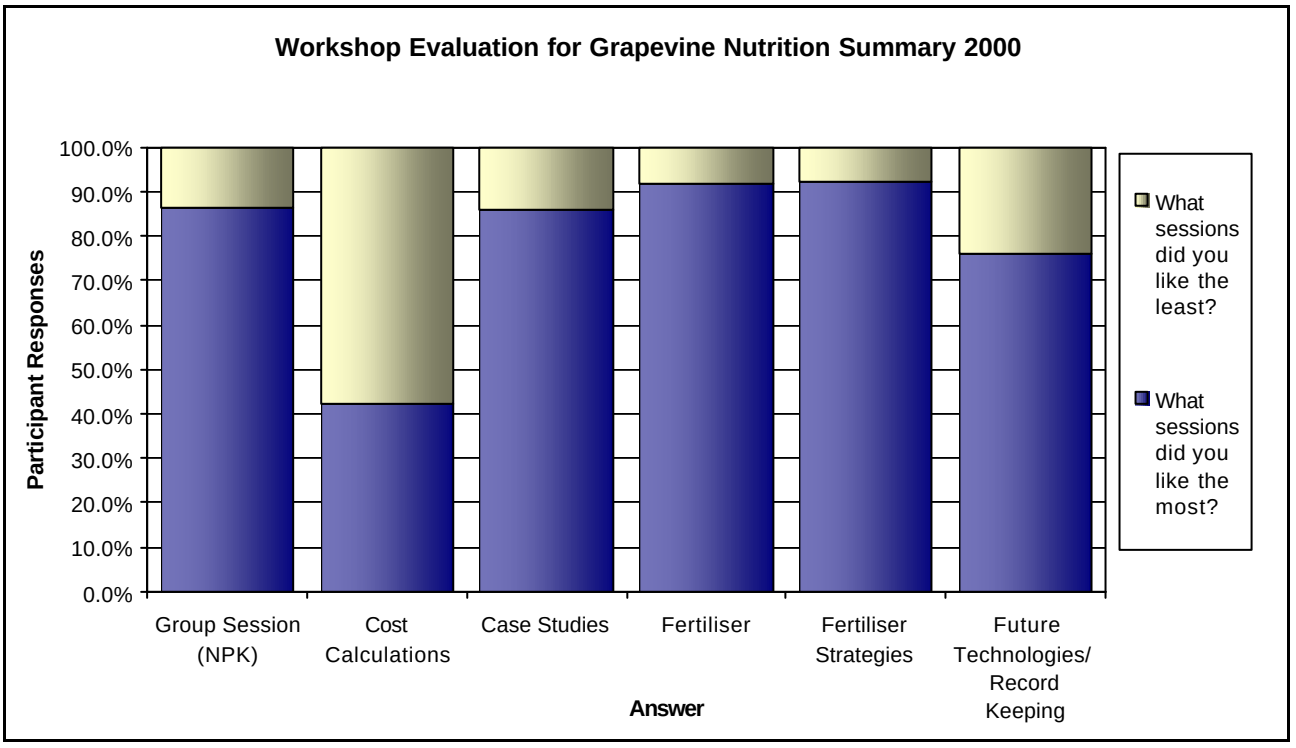


Figure 2: Grapevine Nutrition Workshop evaluation 2000 – Day 2 summary

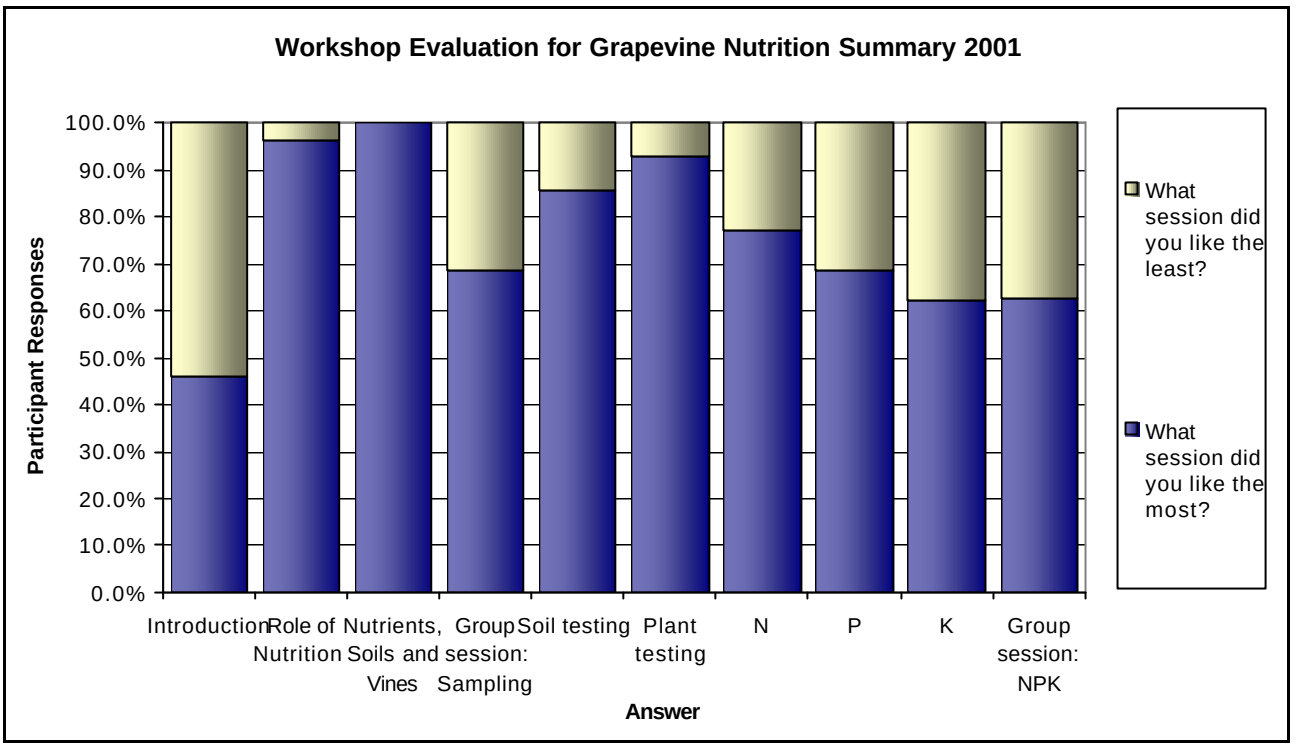


Figure 3: Grapevine Nutrition Workshop evaluation 2001 – Day 1 summary

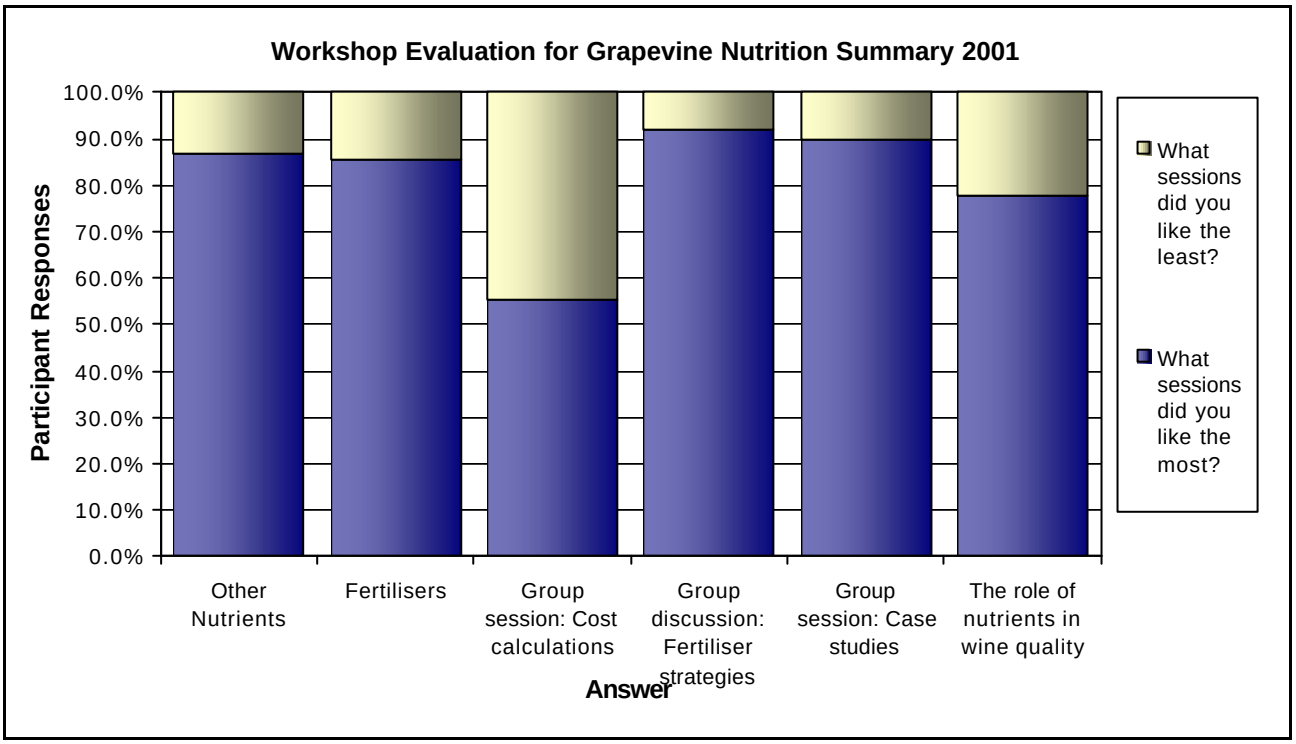


Figure 4: Grapevine Nutrition Workshop evaluation 2001 – Day 2 summary

The introduction was not regarded with high importance this may have been due to many of the participants had already attended one or more of the Research to Practice® workshops and were already familiar with the structure. The cost calculations section initially started with a complicated calculations sheet and improvement in the worksheet resulted in more people enjoying this section in 2001. It was quite common for workshop participants to indicate that they liked all of the presentations delivered.

It is important to note that the two highest rating presentations are the 'role of nutrition' and ' nutrients, soils and vines' topics covered in the first morning and involved setting the scene and looking at the relationships between nutrients, soils and vines. Many participants underestimate the importance of these interactions and find these sessions a good introduction to the topic. This is followed by the sessions on sampling (tissue and soil) and macronutrients, **see Figures 5 – 6**.

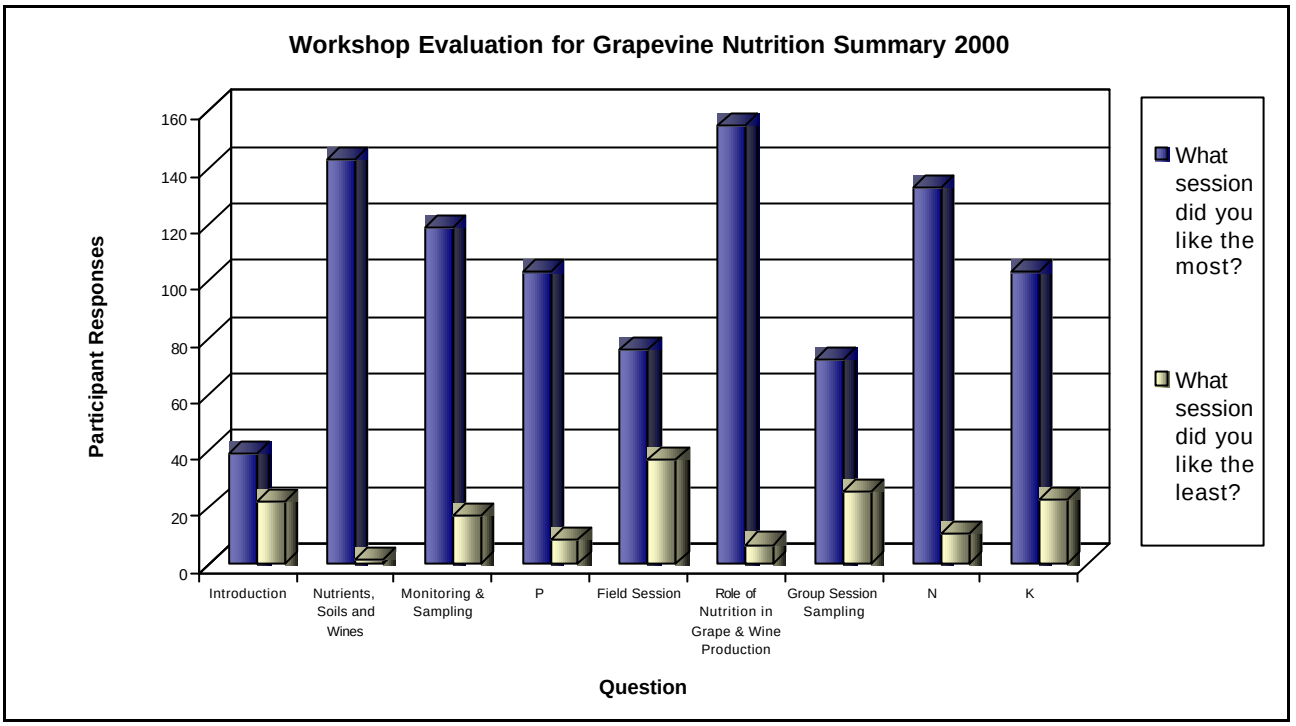


Figure 5: Most and least liked Grapevine Nutrition Workshop sessions 2000 – Day 1

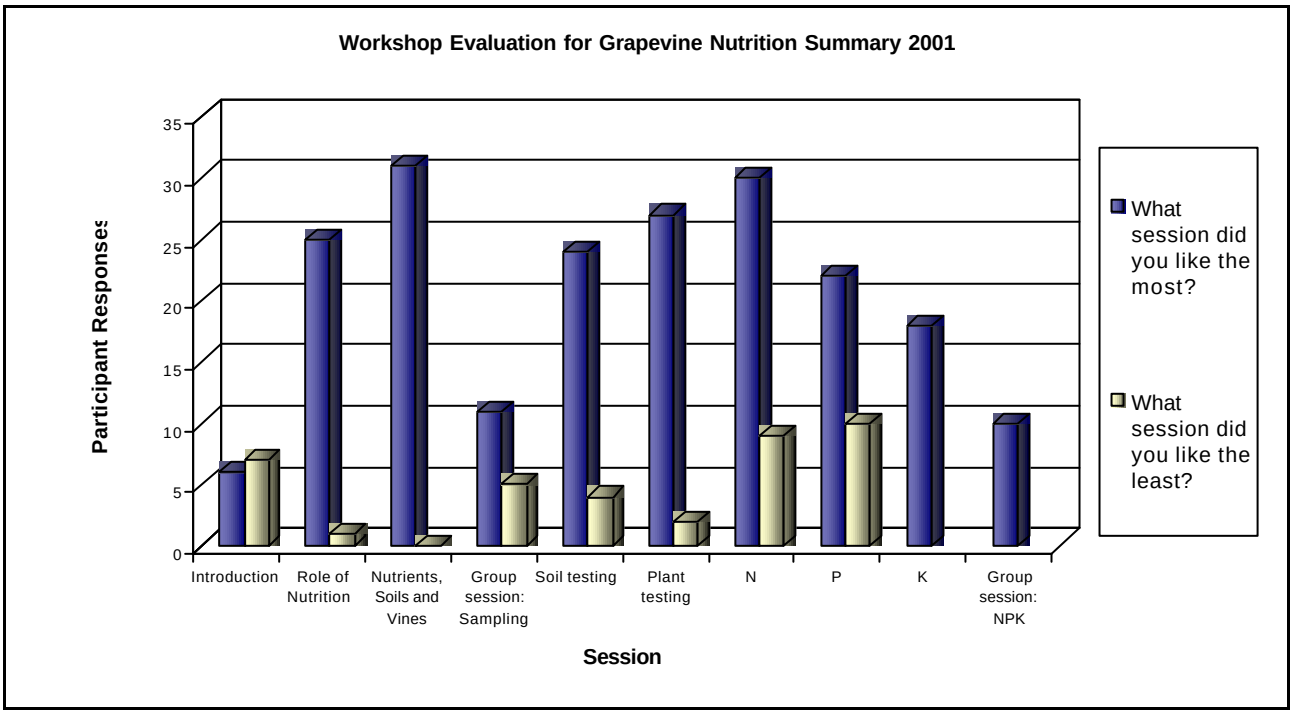


Figure 6: Most and least liked Grapevine Nutrition Workshop sessions 2000 – Day 2

On the second day sessions on fertilisers and fertiliser strategies rated highly. Participants are especially interested in a more strategic use of nutrients to save labour, reduce the cost of purchasing fertilisers and avoiding an over vigorous canopy.

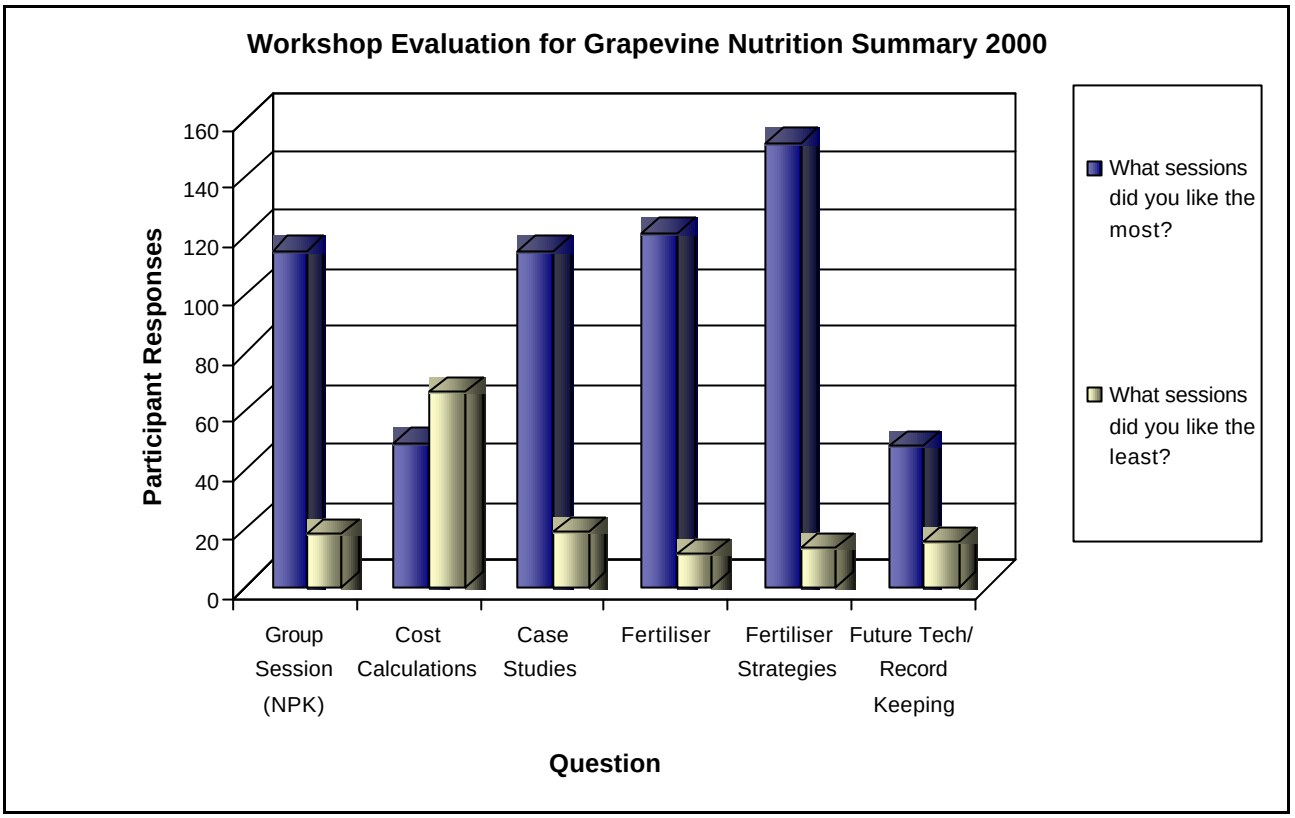


Figure 7: Most and least liked Grapevine Nutrition Workshop sessions 2001 – Day 1

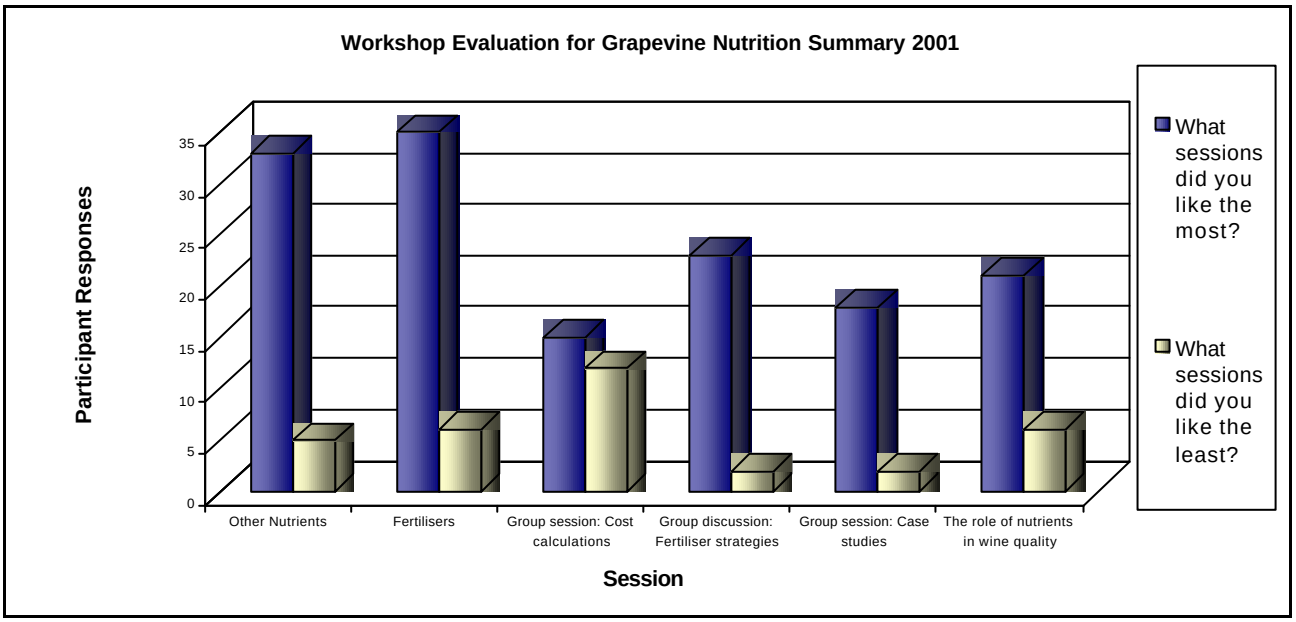


Figure 8: Most and least liked Grapevine Nutrition Workshop sessions 2001 – Day 2

In response to participant requests the role of nutrients in wine quality was piloted in the 2001 season and received favourably. This session allowed the participants to focus on the end product and how their management affects quality.

The group sessions

There are four group sessions during the workshop, which provide opportunity for participants to look at issues in more detail than is possible during the presentations. Two group sessions occur

on the first day, just after morning tea (Sampling Case study, 10.30 am) and mid afternoon (NPK current practices, 3:45pm), and two group sessions on the second day the first mid morning (cost calculations, 11:15am) and then just after lunch (case studies, 1:15pm), **see Table 1.** The group sessions involve breaking the participants into 4 groups of 4-6 depending on the total number of participants. The value of the group sessions is in the opportunity it provides for the participants to get to know each other in smaller groups and find out their interests and ideas. The larger group during the workshop can be intimidating to some participants and they will not ask questions. However during the group sessions they can target people of interest and interact without the pressure of the whole group watching.

The group sessions changed as the workshop progressed to more accurately reflect the needs of growers. Originally the group sessions were very similar to those used by the IPM and Water Management workshops. 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 feedback about the group sessions was very positive with 87.1% (2000) and 76.8 (2001) of participants finding them useful, only 1.1% (2000) and 1.4% (2001) did not find them useful at all, **see Figures 9 - 10.** Both sessions on day one were developed as opportunities to run through the current techniques used by participants, ie sampling and formulating nutrition management decisions and current NPK practices. Feedback from the evaluation sheets indicated that nearly 70% enjoyed the group session on sampling, over 60% enjoyed the sessions on NPK, 55% enjoyed the session on cost calculations, **see Figure 3 – 4.**

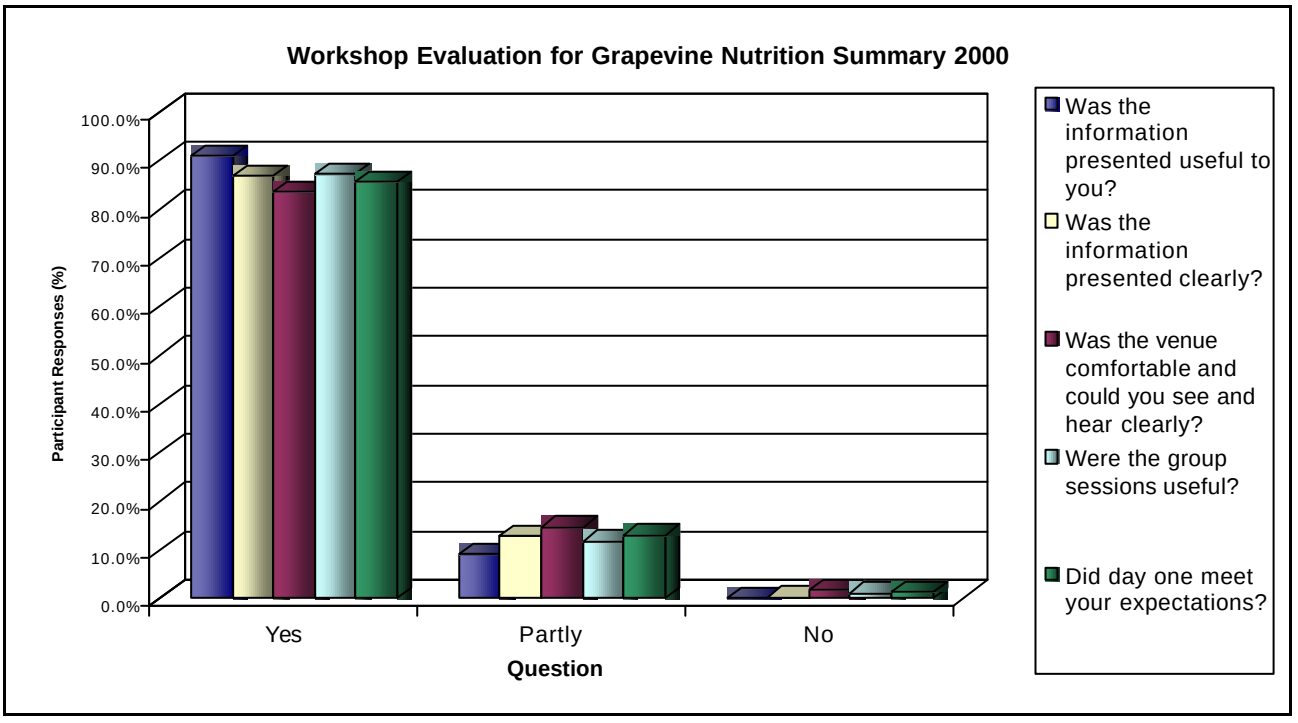


Figure 9: Grapevine Nutrition Workshop evaluation 2000 - Usefulness of group sessions

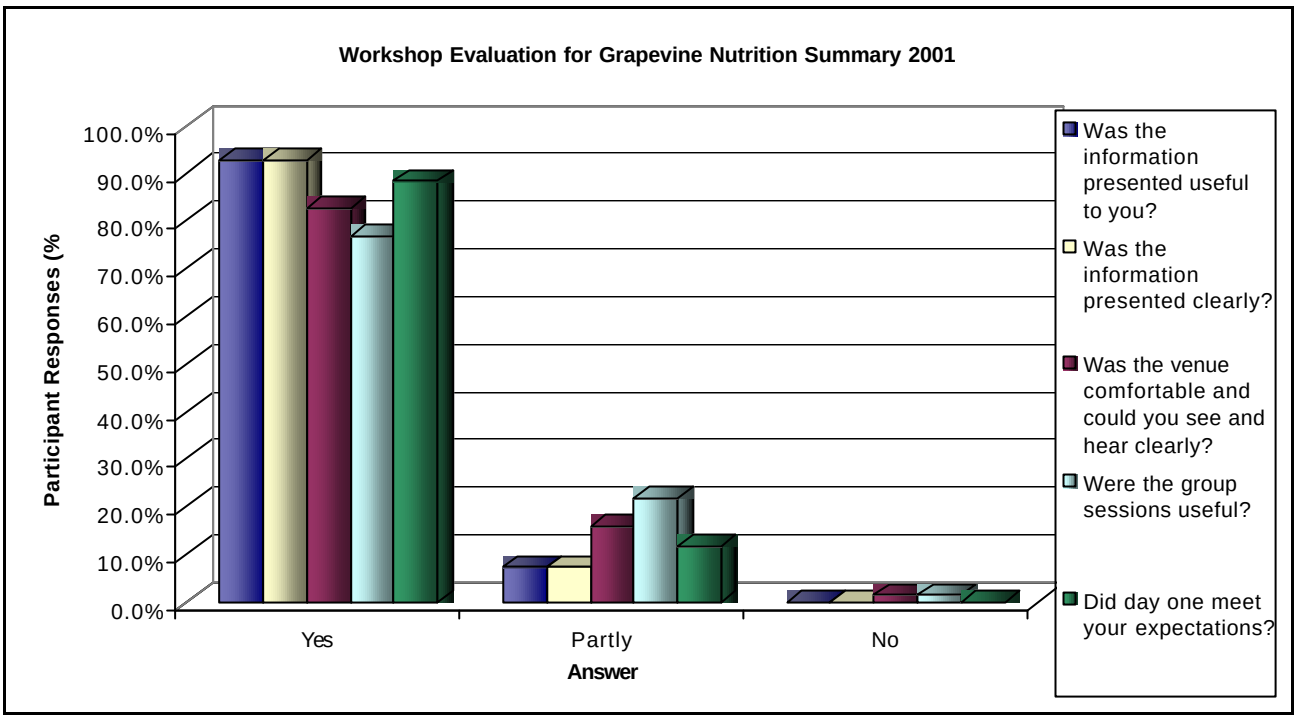


Figure 10: Grapevine Nutrition Workshop evaluation 2001 - Usefulness of group sessions

Sessions on day two dealt with calculating fertilizer prices on a per unit basis. Feedback on third cost calculations session indicates that it has the lowest approval rating of all the sessions (55%), and general comments on this session indicate higher ambivalence towards this session than the other group session. However there are also some extremely positive comments about this session and the value of it. One reason for the negative comments is due to some participants struggling with the calculations required to work out per unit cost.

Comments about the group sessions indicated that the interaction and opportunity to meet people was most beneficial. The change in the group after the first group session is obvious as they have more confidence about asking questions of speakers and discussing issues among themselves. Where there were negative responses to the group sessions the comments indicated that mainly the problems were with personalities within the group. Participants disliked overbearing members of the small groups as they limited interaction between the group.

Case studies

On the second day a session looked at case studies of real life situations the participants might have to deal with, **see Appendix 1.2**: or where possible real data was provided (anonymously) by participants to be discussed.

Feedback from the evaluation sheets indicated that over 90% enjoyed the session on case studies with people finding this forum helpful in giving them ideas they could try in their own situations, **see Figure 4**. The comments/feedback that each group was given by the expert in attendance was also highly regarded.

The promise

An integral part of the Research to Practice® model is the promise filled out by participants at the end of the first two days. The promise provides them with an opportunity to plan and implement a new practice 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.

The promises from all workshops have been collated and grouped into broad categories **see Figures 11 – 17.**

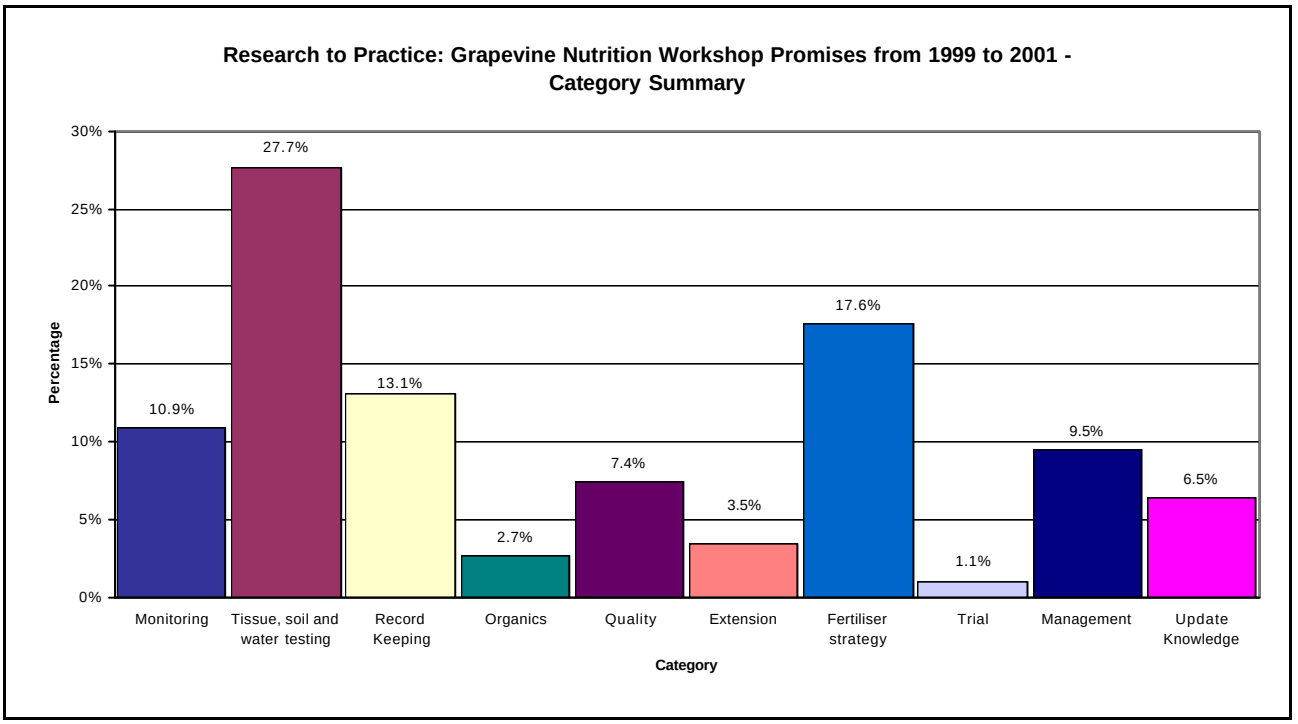


Figure 11: Summary of the promises made by participants – category summary

More than 1.5 times as many participants promised to modify their tissue, soil and water testing techniques than the next popular promise of changing the current fertiliser strategy (17.6%). This was followed closely by improvements in record keeping (13.1%), monitoring (10.9%), management practices (9.5%), attention to quality (7.4%), a general updating of knowledge (6.5%), extension roles in sharing information (3.5%), organics (2.7%), and setting up specific trials (1.1%), **see Figure 11**.

The most significant impact the workshop had was to indicate the importance of tissue testing as part of a management strategy. This was reinforced by the high number (22.5%) of participants who indicated the commencement or ongoing use of tissue testing as their promise. Overall testing inclusive of tissue (petiole, sap and blade), soil and water testing resulted in 27.7% of participants making this their promise.

8% of participants indicated they promised to carry out tissue testing while 5.7% felt they were able to monitor the vines for visual symptoms, follow this up with tissue testing, own interpretation of results and then act on this information to modify management practices. 2.3% of participants indicated they would feel more confident about interpreting their own data. 4.7% of growers indicated they would carry out soil testing and 5.9% of growers indicated they would carry out soil testing in combination with tissue testing to aid in the interpretation of the results, **see Figure 12.**

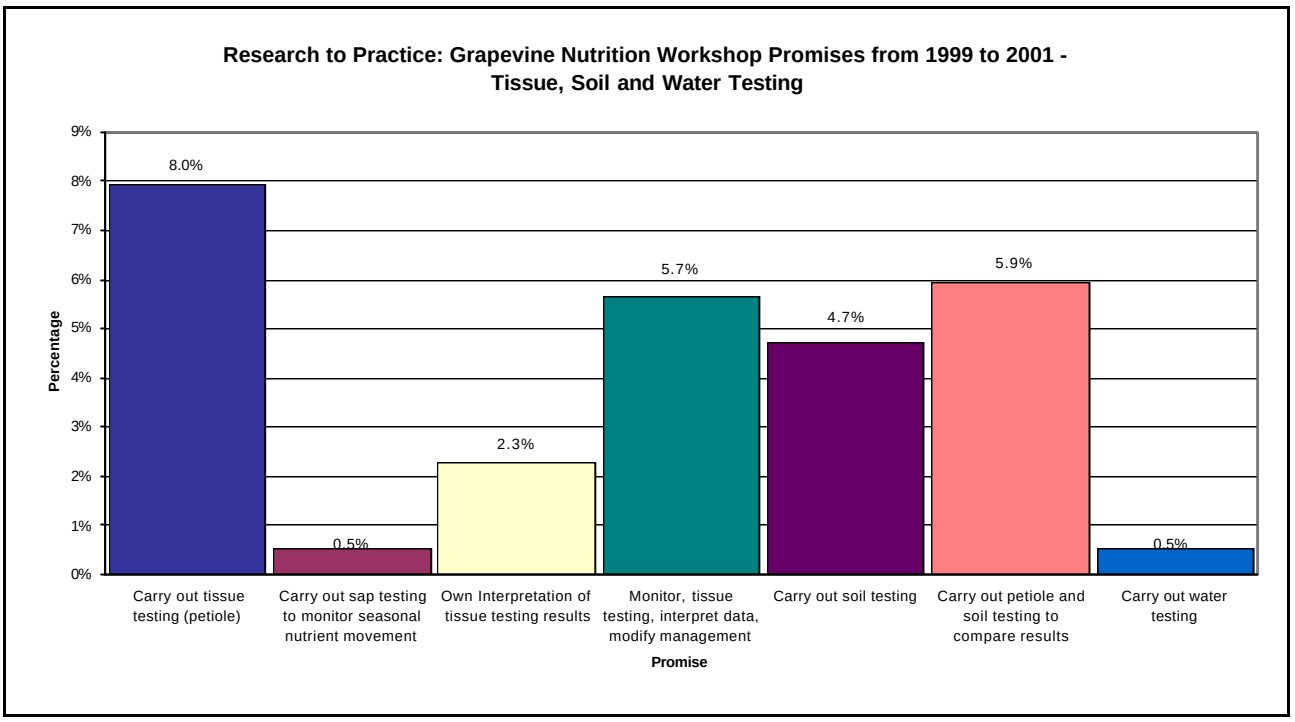


Figure 12: Summary of the promises made by participants – Tissue, soil and water testing category.

9.4% of participants indicated they would like to develop a more strategic use of fertilisers, 3.8% had a specific interest in modifying their use of nitrogen and 1.3% to modify their use of micronutrients, this was in response to information on the plants effectiveness of using different nutrients and most appropriate application methods, **see Figure 13.**

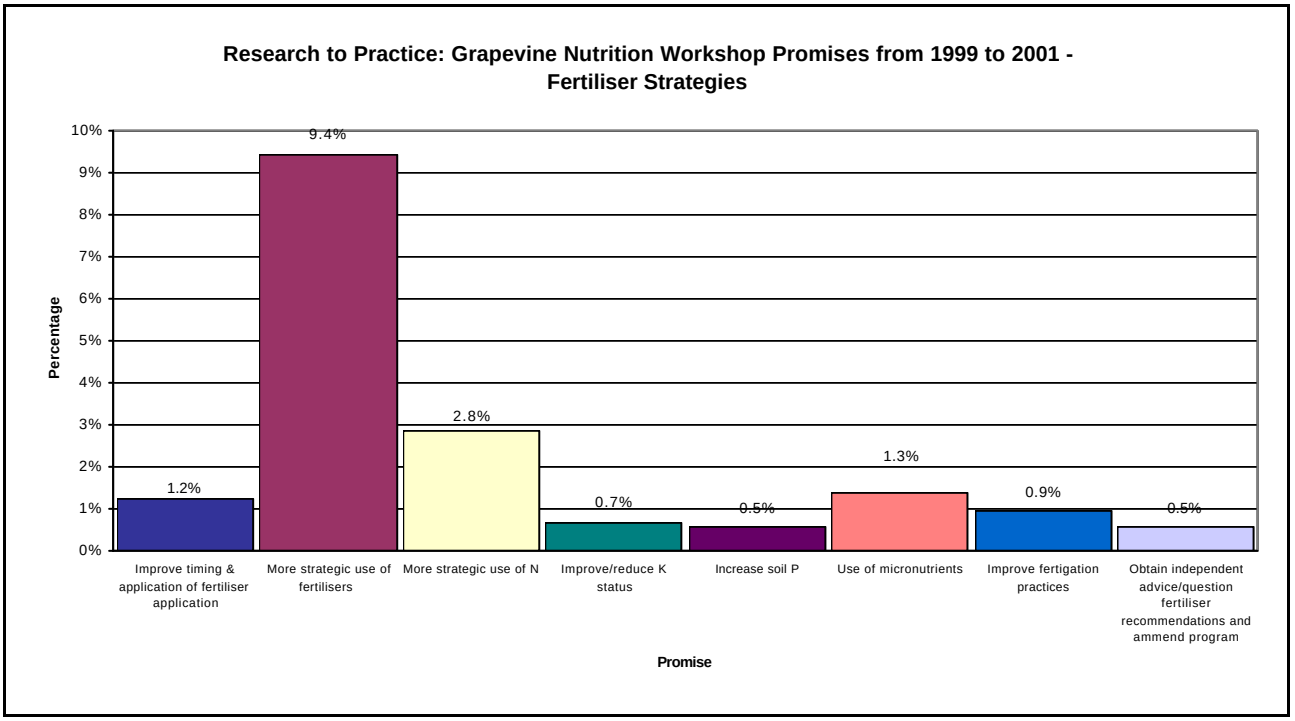


Figure 13: Summary of the promises made by participants – Fertiliser strategies category.

Record keeping was of particular importance for growers (9.6%) this was largely in response to the fact they were collecting data but had not collated it in a manner which made it easy to analyse. 3.2% of growers were interested in developing a historical perspective to aid in more informed decisions in the following growing season(s), **see Figure 14.**

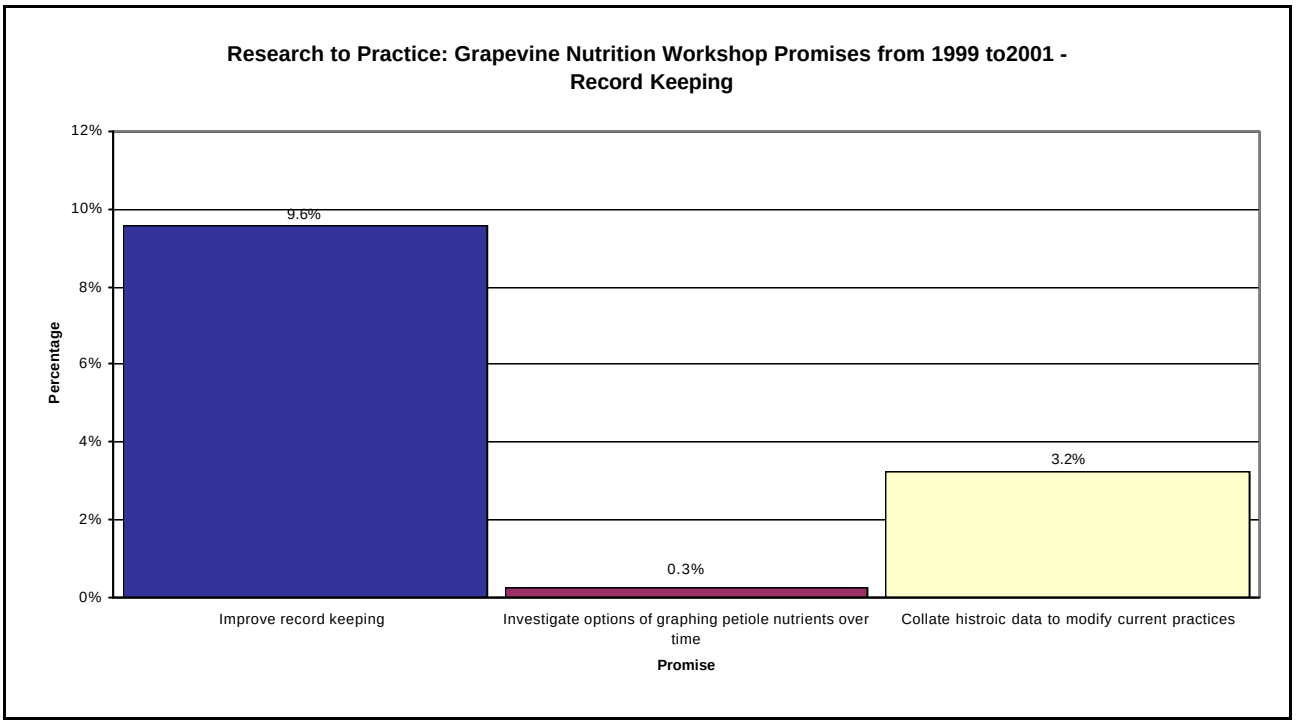


Figure 14: Summary of the promises made by participants – Record keeping category.

Alternate management practices looked at improving overall management and nutrition strategy 4%, to looking at overall vine balance 2.6% and other related issues, **see Figure 15.**

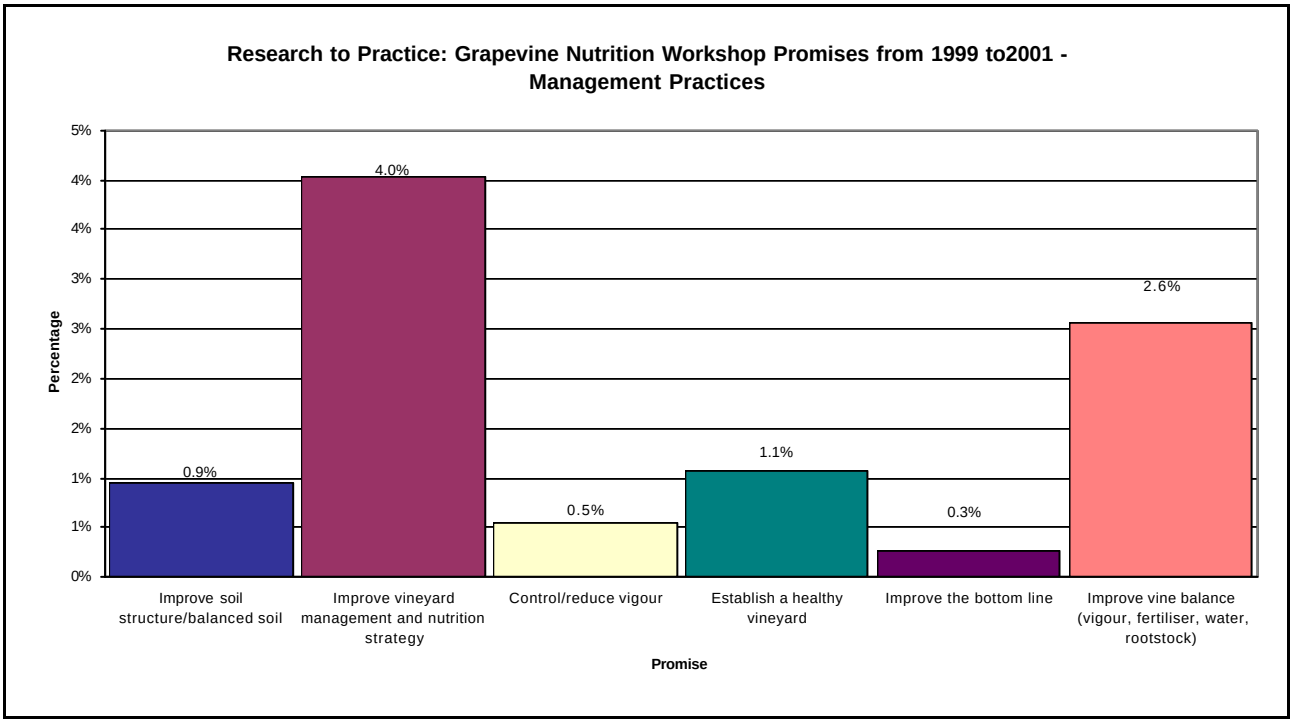


Table 15: Summary of the promises made by participants – Management practices category.

Quality was a large driver for change and this is further encouraged by the larger wineries monitoring spray diaries and linking payment with fruit quality. 5.8% wanted to improve the quality of their fruit with other promises being a variation on this theme, **see Figure 16**.

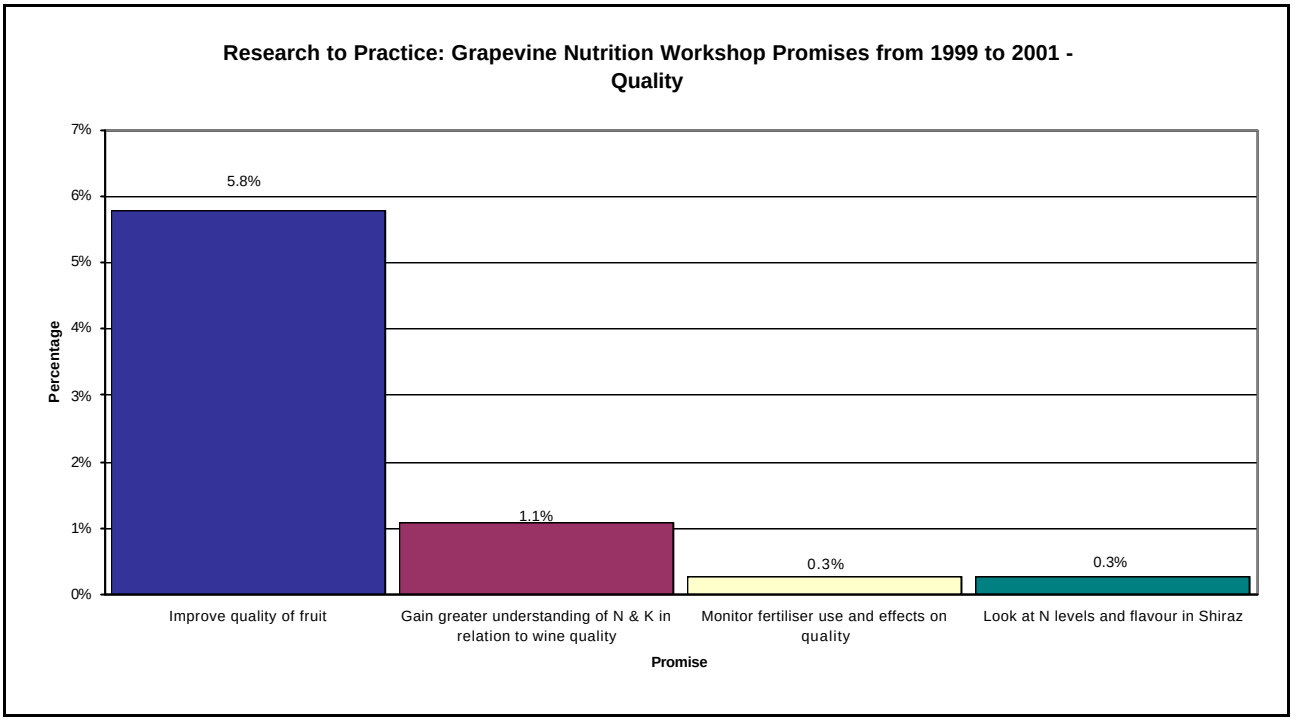


Table 16: Summary of the promises made by participants – quality improvement category.

This information shows the variety of promises made by participants, which indicates that all aspects of the workshop were valued. As a summary the top 6 individual promises are presented in **Figure 17.**

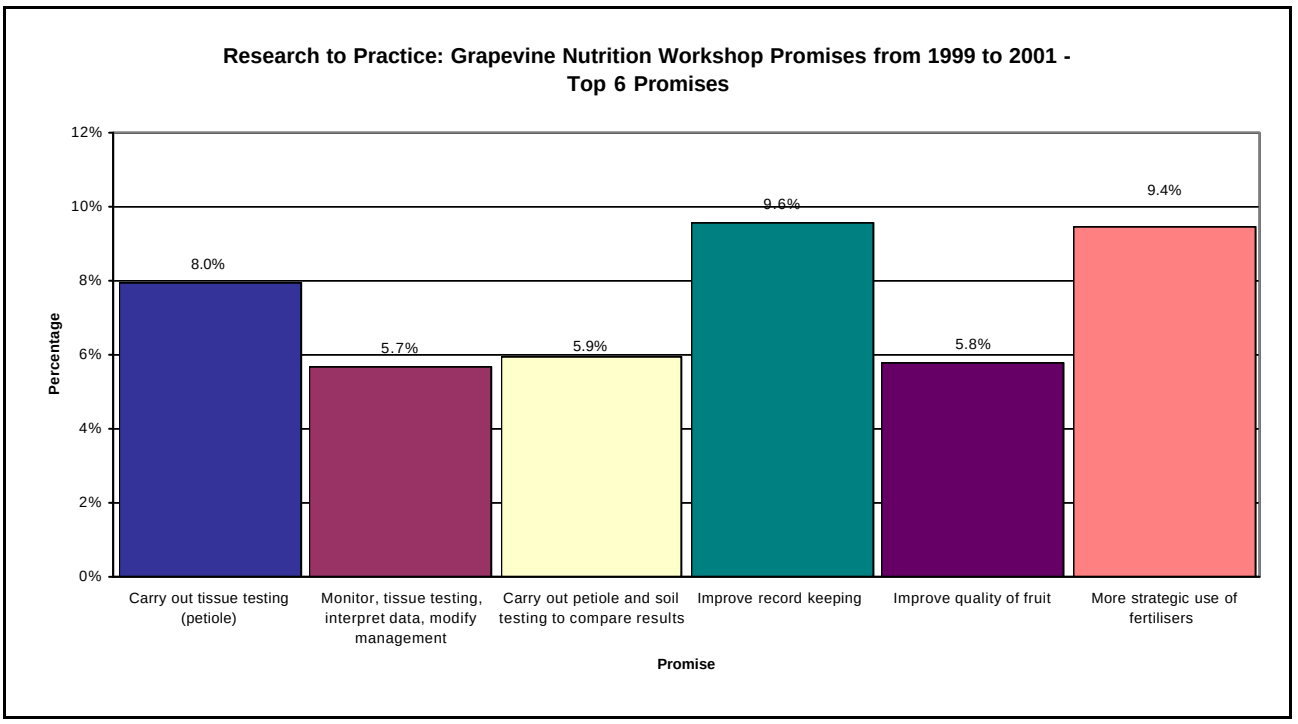


Table 17: Summary of the promises made by participants – top six individual promises

The third day

Integral to the success of promoting changes in practices and the uptake of new research is the third 'report back' day. This day is held following the harvest after the first two days. The timing of

this day allows participants to complete their promise and report back on how well the changed practice integrated into their vineyard management. One problem we have with the third day is the number of original participants who attend. On average about 54% return for the third day. This is an issue for the Research to Practice® team and is currently being addressed. We are investigating better advertising of the benefits of returning for the third day and emphasising the importance of it at the first two days and when the information letters are sent to participants notifying them about the third day. Another option is to cancel the use of the third day and provide an alternative feedback mechanism such as a bulletin board, or e-mail these and other options are currently being assessed.

The participants who attend on the third day fill in an evaluation sheet, which indicates what changes they have made during the season. This information is discussed later in the report. General comments about the third day indicate the relaxed atmosphere and ability to interact and participate more is valued very highly. Some people commented that the third day was 'necessary', probably due to the consolidatory nature of the day. Many enjoyed the opportunity to share experiences.

Participants were generally very happy with the content and format of the workshop Feedback at the third day indicated that (73%) of participants changed their management practices after the first 2 days workshop. 46% monitored soil or vine nutrition more often after the initial 2 days (however many were already doing this and this isn't reflected in this percentage). 70% based management decisions on monitoring results with 59% of participants carrying out soil or tissue testing after the initial workshop. 63% consulted their manual during the course of the following growing season, **see Figure 18.**

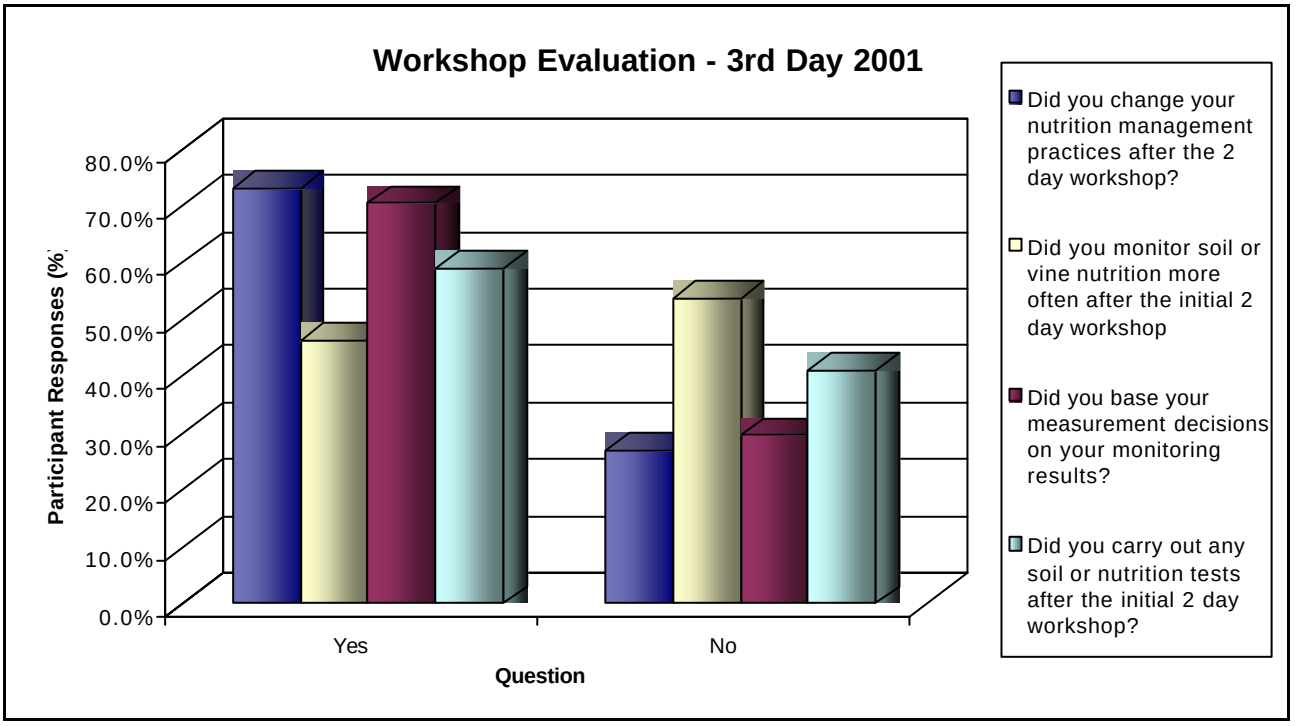


Figure 18: Evaluation of 3rd day – changes in practices.

Many felt their nutrition management improved by carrying out tissue and/or soil testing, this allowed for a more informed approach to fertiliser strategies. 76% of participants enjoyed the opportunity to discuss their issues in an open forum with 89% picking up useful tips, **see Figure 19**. Many also indicated that the workshop was part of a process of gathering information about various aspects they wanted to change, but generally not the only source. Many also indicated that often the workshop gave them the confidence they needed to implement a change they had been thinking about.

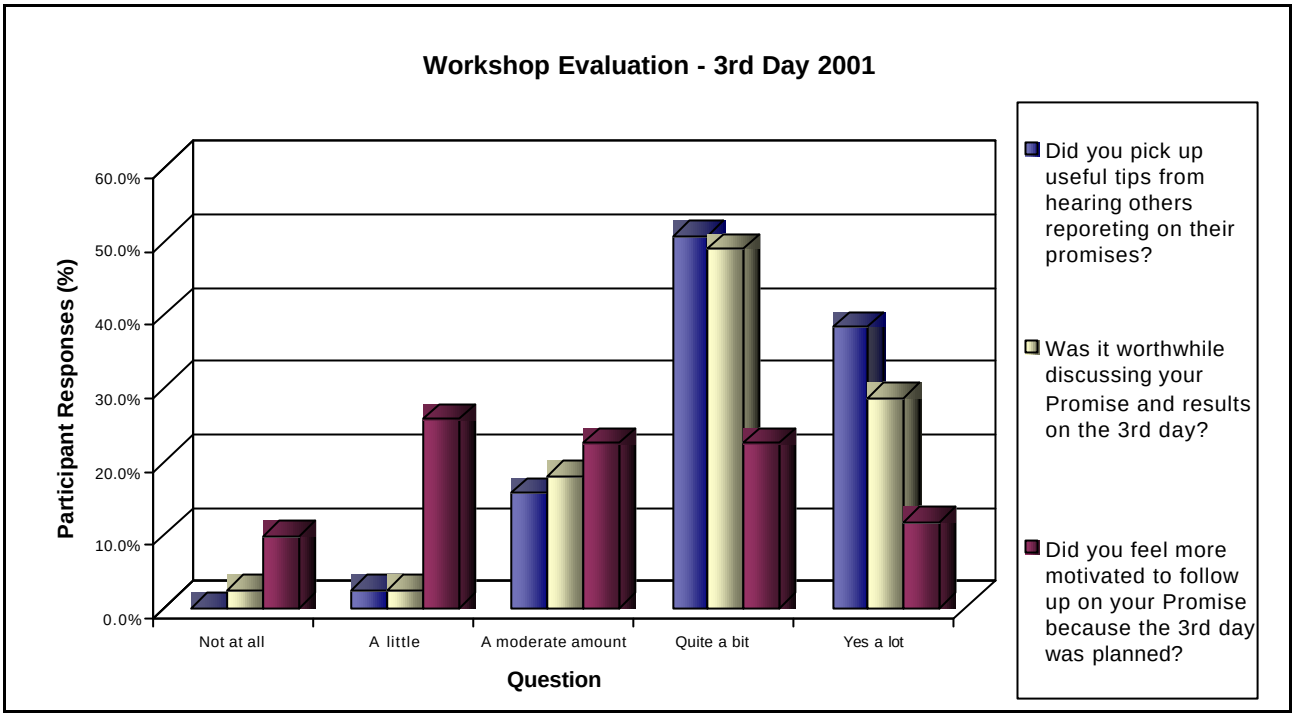


Figure 19: Evaluation of 3rd day – relevance of material presented.

The motivation for participants to follow up on their promise was fairly evenly spread across all categories with 10% feeling that this didn't contribute at all, 26% a little, 22% a moderate amount, 22% quite a bit and 12% yes a lot, **see Figure 19**. This is interesting as it indicates that the report back process is not the major reason for people making changes in management. This attitude may contribute to the high percentage of participants who expanded on or implemented new practices since the completion of the workshop.

It seems that it could also be assumed that participants (about 50 % from the third day evaluation, are gaining enough information in a relevant format at the workshop that they do not need a prompt, like the third day, to make them change a practice or implement a new practice. The processes and format of the Research to Practice® workshop seem to be successful in providing a certain type of participants with enough information to implement change without needing a follow up day to motivate them. Of this group some of them may not even need the prompt of writing a promise, however the advantage of this activity is that participants leave the workshop with an action plan to achieve over the next season.

Surprise was often expressed after the workshop at the amount of detail on individual nutrients included in the presentation and manual, but the value of this information was appreciated for future reference. A new section 'A natural approach' is currently being trialed at the 3rd days and will be incorporated in the manual when it is updated prior to the 2002 workshop season.

Workshop locations

In the first year of the project eight pilot workshops were delivered, 14 and 4 workshops were delivered in years 2 and 3, respectively. There were a total number of 26 workshops run over the three year life of the project, **see Table 2 and Appendix 5.1** . The total number of participants who filled out enrolment forms was 527. There were also a number of participants who attended as part of their training to become presenters as well as people from State Ag departments.

Table 2: Breakdown of number of workshops (and participant numbers) in each state

State	Number of workshops	Number of participants
South Australia	10	218
Victoria	6	99
New South Wales	5	101
Tasmania	1	23
Western Australia	3	63
Queensland	1	23
Total	**26**	**527**

From **Table 2** it is obvious that the majority of workshops were held in South Australia. When these numbers are further broken down into regions, **see Table 3.** It is obvious that McLaren Vale was a region which participated in the most workshops. A factor contributing to the large response from this region was the support of one of the major wineries in the region. The company viticulturist organised and hosted a number of the workshops as well as contributing to the presentation and general discussion. This input was valuable to the group, as they were able to find out more about the requirements of the company they were selling grapes to.

Table 3: 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	3	60
	South East	1	25
	Adelaide Hills	2	40
	Barossa Valley	1	24
	Riverland	1	26
	Langhorne Creek	1	23
	Clare Valley	1	20
Victoria	Sunraysia	1	17
	Geelong	1	18
	Melbourne	1	10
	Central Victoria	2	38
	Great Western	1	16
New South Wales	Riverina	2	36
	Cowra	1	14
	Hunter Valley	1	24
	Mudgee	1	27
Tasmania	Hobart	1	23
Western Australia	Margaret River	2	44
	Albany	1	19
Queensland	Granite Belt	1	23

Workshop Participants

A broad break down of the industry sectors from which participants came from is presented in **Figure 20**. It is difficult to divide the first category into growers and employees of smaller companies, as this information is not available. Knowing this information would provide some indication of how well we are accessing a sector of the market that has relatively limited access to scientists and technical experts. This information would more importantly indicate what percentage of the owner/growers we are not accessing and help with the development of programs to target these people. Of significance also is the large attendance by employees of the large corporate wine companies these include Southcorp, Orlando Wyndham, BRL Hardy, Beringer Blass (formally Mildara Blass) and Simeon. Rosemount in McLaren Vale was the only wine company to host workshops.

Many of the attendees from the large corporate wine companies were their grower liaison officers (GLOs), also called technical officers (TOs) whose role it is to liaise with growers who grow on contract for the wine company. Each GLO/TO deals with approximately 100 growers and is expected to keep them informed of latest company recommendations and relevant best practice coming out of recent R&D projects. The GLOs/TOs attending workshops and follow up 3rd days have often reported that they obtain excellent value from the Research to Practice® workshops as they are able to take the information and pass it on to growers who have not personally attended a workshop. The same applies to the various educators (from TAFE and other providers) who have attended and as a consequence, the penetration of the information throughout the industry is considerably greater than that reflected by simply adding up the number of people who attended workshops.17% of the 527 workshop attendees were from the large corporate wine companies and approximately half of these were GLOs/ TOs totalling approximately 45 attending across the 3 seasons of Nutrition workshops. If each GLO/ TO passed on critical parts of the workshop information to most of their growers then this information will have been dispersed to approximately a further 4,500 people in the grape and wine industry as well as to the 527 who attended.

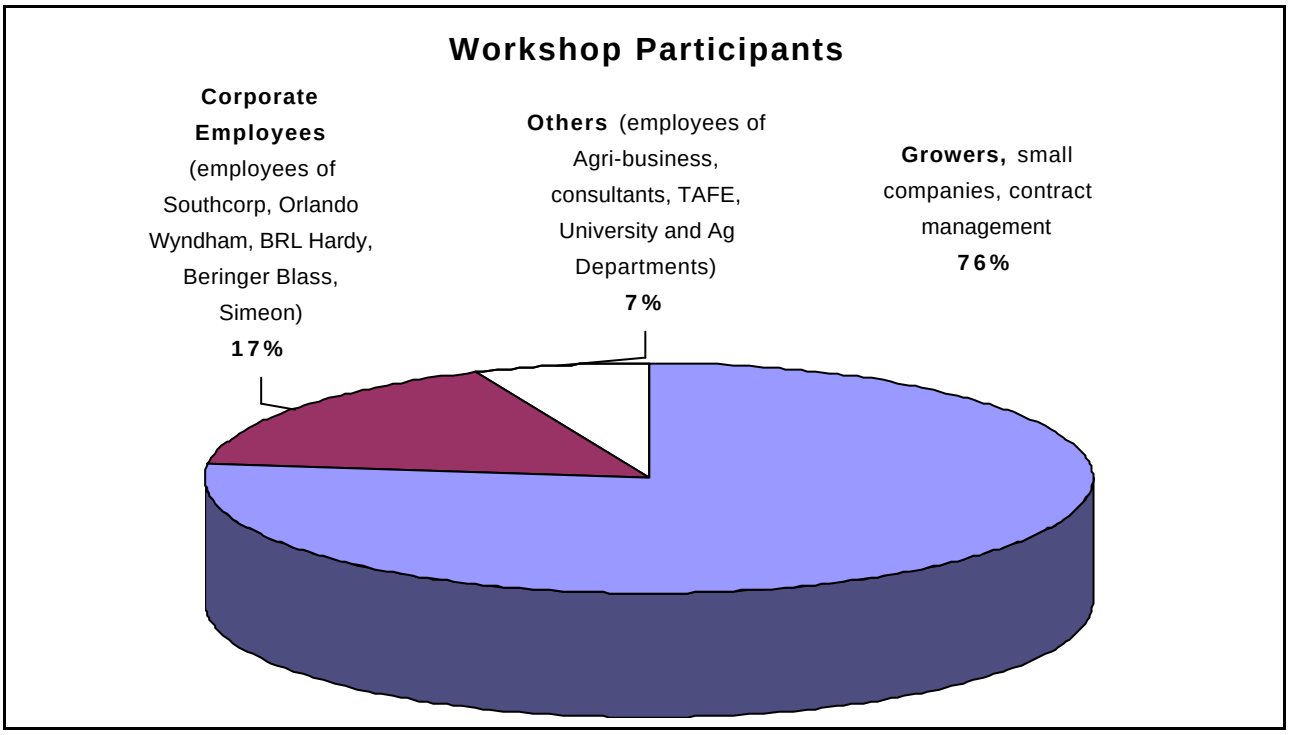


Figure 20: Breakdown of origins of participants to the workshop, sourced from their enrolment details**.**

Evaluation of impact measured against the objectives

As stated previously, Research to Practice® workshops are dynamic and change in response to feedback received from participants and speakers. Feedback was sought from participants in the form of evaluation sheets they filled in at the end of the first two days as well as the third day.

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 about their promises.

Objective 1

To provide Australian winegrape growers with a training framework to enable greater uptake of best practice in nutrition management for the production of winegrapes to specification and to minimise negative environmental impacts.

The development of the Grapevine Nutrition: Research to Practice® training workshop was designed to meet objective one. The most significant aspect of the workshop that induced participants to make change and implement best practice grapevine nutrition management was the process of making, completing and reporting back on a promise. The feedback obtained from the third day participants indicates an overwhelmingly positive response to this process, **see Figure 21**.

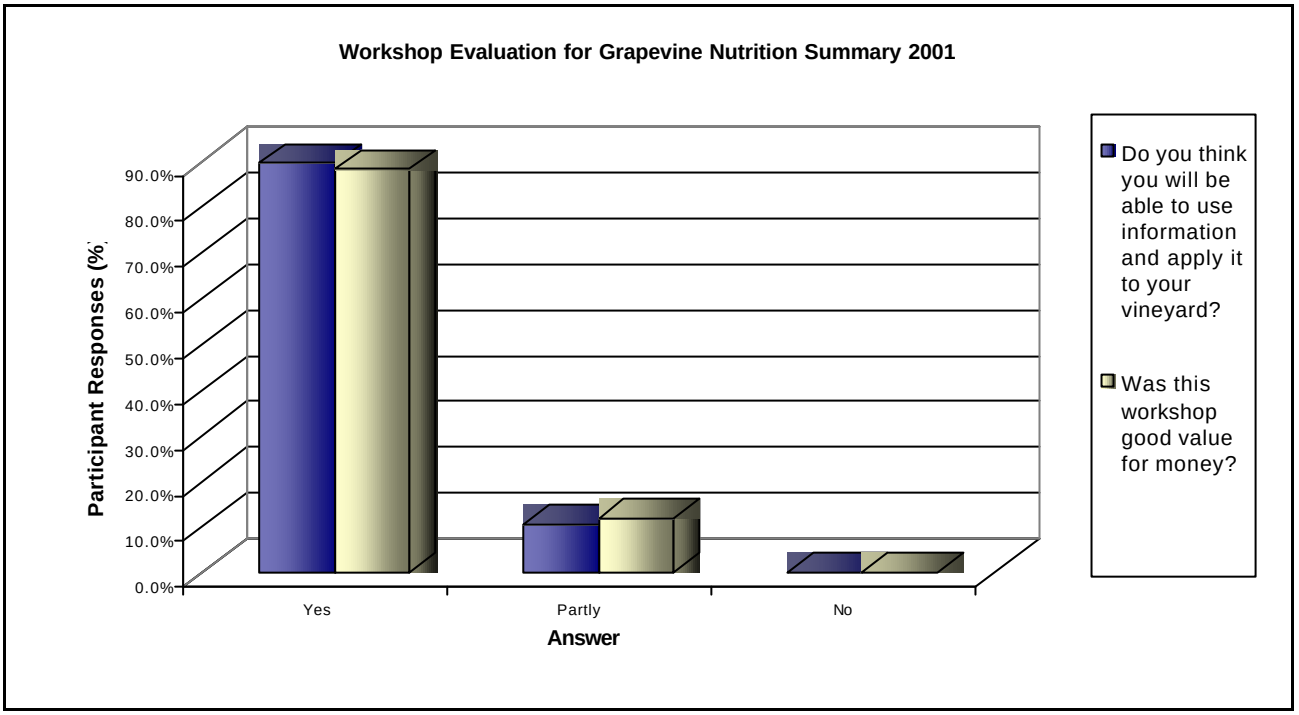


Figure 21: Overall successfulness of grapevine nutrition workshop

Of the participants, 73% indicated that they had changed a nutrition management practice after the first two days. 60% of the participants who changed a practice carried out soil or tissue tests after the initial two day workshop.

Corresponding to this outcome was the percentage (70%) of participants who based their management decisions on the monitoring results. This value is higher than the percentage that made a change, possibly due to some of the participants who ticked 'no' for the first question already carried out some testing on either a current or ad hock basis but increased the frequency of testing and monitoring and felt more comfortable with using the information.

Of interest also is that of those who changed a practice as a result of attending the workshop, 63 % indicated that the changed practice was part of the promise they made at the workshop. Since the main focus of this objective was to provide a framework to enable uptake of best practice, and the information discussed in the workshop was best practice, it is reasonable to assume that the process of filling out a promise impacts on vineyard managers and their inclination to make change. However, information from the evaluation of the third day of the workshop showed that the fact they made a promise was not the only factor that motivated them to make the change. Participants were asked to assess their motivation in keeping their promise with the knowledge that it would be discussed on the third day, **see Figure 19**

In addition there was a strongly positive reaction to discussing promises and results and growers picking up useful tips during the reporting process in a relaxed atmosphere with access to industry experts.

Objective 2

Establish an avenue for improved and broader access to the outcomes of viticultural soil and plant nutrition R&D in a consolidated, practical training format within a network of quality, commercially supported trainers.

The Grapevine Nutrition: Research to Practice® workshop was developed by a small group of core researchers. While comment on the content was sought on a wider scale, relatively few people undertook the bulk of the development. It was important that as part of the program, efforts were made to develop and train as many speakers as possible in each state. The demand for the workshop during the three years of funding was very high initially (8 workshops in 1999 and 14 workshops in 2001) with demand dropping off in the third year (4 workshops). This was due to a number of grower associations pulling out at the last minute. In some cases this has been due to financial issues and increased paperwork for the associations linked to recent changes in the administration of FarmBis funding arrangements. Despite this, virtually all major wine regions have had representation during the preceding seasons.

It was impractical and imprudent to rely on a small group of presenters. **Appendix 4** highlights the people involved in workshop presentation. One source of technical speakers was the major wine companies. Quite often these speakers had detailed knowledge of implementing the 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 the session. The other sources of speakers were the state agricultural departments, CSIRO and Universities as well as private consultants.

One of the strengths of the Research to Practice® to practice program has been the quality of speakers at the workshops. While not every person who has presented at workshops has been successful, overall most speakers have been well received and have prepared well for their session. Presenters are supplied with the presentations and the facilitator of each workshop spends 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, as well as anecdotes from previous workshops. Presenters are also encouraged to contact the scientist associated with that topic for further clarification and information.

For the 2001 season comprehensive speaker's notes were developed for each sessions PowerPoint slide set. This provided speakers with not only specific information about each slide but appropriate references, and examples of questions to ask participants and some of their answers, **see Appendix 1.3**.

Objective 3

Enhance the management capacity and confidence of winegrape growers in improved nutrition management practices.

Initial indications by participants in the workshop from the evaluation sheets show that many identified information in the workshop that would improve their vineyard operations. The most popular comments centred on the processes of soil and tissue testing, monitoring of testing results and the vines, improvement of record keeping and more efficient use of fertilisers. All the comments from the evaluations of the workshop regarding the information indicate that the majority of participants learnt something valuable about grapevine nutrition management and that as part of a

continual process of information gathering many vineyard managers continue to fine tune and improve their practices.

One of the major influences on improved nutrition practices is the carrying out of soil and tissue testing. From the summary of the promises made by participants is it clear that the importance of this practice was identified**, see Figure 17**. This was translated to the responses from participants who returned to the third day. They were asked whether they based management decisions on their monitoring results, 70 % indicated yes.

The biggest impact of monitoring grapevine nutrition was on timing and frequency of fertilizer additions. Changes in more strategic use of fertilisers can have a significant impact on the quality of fruit, resource availability and vineyard sustainability.

Objective 4

Review and update workshop manual, incorporating new material as identified during workshops this season.

Evaluations by participants of the 2000/01 workshop series were collated and reviewed. This information was used in the further development of the workshop and accompanying training manual.

New sections which were piloted at 3rd day workshops in the areas of organic viticulture, cover cropping, mulching/composting and grape quality parameters, and FAQ (frequently asked questions) section will be incorporated in the manual as a continuing progression of revision. An initial reworking of the manual to refine and improve presentation materials was completed prior to the start of the 2001 season. New additions to the manual include:

- a glossary,
- pictures of grapevine nutrition toxicities and deficiencies,
- a comprehensive reference list
- new section 'The role of nutrients in wine quality'.

Updates will continue in the future.

In addition, protocols were developed for participants seeking to use their attendance at a Research to Practice® workshop to contribute to formal training qualifications, **see Appendix 1.4** and Journal articles were written for inclusion in industry publications, **see Appendix 1.5.**

Objective 5

Standardise presentations and training support material

The Grapevine Nutrition manual was completely revised prior to the start of the 2001 season. This included the reformatting of the manual, content and diagrams.

By re-assessing the way in which the manual was presented allowed for formatting changes which made the information more easily absorbed this was achieved by 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. Each page was numbered and this was cross referenced to the appropriate PowerPoint presentation slide so participants could monitor their progress and link information presented to the specific section in their manuals.

Overall the objectives of the project were achieved and in some cases exceeded. The continued support of the industry to the Research to Practice® program indicates how highly valued it is.

Outcome/Conclusion

The Research to Practice® program

The development of the Grapevine Nutrition: Research to Practice® training workshop provided a platform to deliver the latest research information to the wine grape industry. The workshop design was based on the successful IPM Viticulture and Water Management for Grape Production: Research to Practice® workshops and delivered in 20 regions around Australia. The objectives of the project focused on integrating nutrition management with soil and irrigation management practices and enhancing the confidence of growers and managers in implementing best practice in these areas.

The workshop program focused on providing an opportunity for participants to interact with the speakers and with each other, participate in problem solving and field sessions and identify a new or changed practice that were interested in implementing during the season after their workshop. The follow up (third day) of the workshop provided participants with the opportunity to discuss what changes they had made to vineyard management, how these changes had affected their management in the rest of the vineyard and work through any problems they had with implementing the changes.

The response to this format was extremely positive with many participants implementing changes in nutrition and associated soil and irrigation practices. This resulted in greater monitoring and improved fertiliser strategies being the most common outcome.

The impact of the Research to Practice® workshop

Overall the response to the information presented in the workshops and promotion of a promise to implement change was extremely high. The format developed appeared highly successful with a high proportion of participants implementing changes in practices in the years following their attendance at a workshop. The types of changes that occurred were many and varied indicating that all information in the workshop was valued. Many participants were motivated to make the changes they did for reasons other than the fact that a follow up day was planned where their promises were to be discussed.

The quality of speakers is also an issue that cannot be underestimated when considering the training framework. Participants were unreserved in their praise for speakers who interacted with them, presented credible information and were realistic with their management options. The flip side of this is the speakers who do not perform in a satisfactory manner, and every effort is made to determine speaker suitability before the workshops. Overall a large number of people were involved in the workshop delivery in the three years of the project, and a significant majority had a positive influence on participants.

Most states of Australia containing wine regions have enough trained presenters to deliver the workshop using in-house people. Critical to the success of the program is the continued support of wine companies in providing a source of technical speakers and in promoting and hosting the workshops. Many of the grower liaison officers / technical officers, whose role it is to liaise with growers who grow on contract for the wine company, are the ideal personnel to use as speakers or facilitators in workshops sublicensed to the wine companies. They have the ideal mix of technical expertise and interpersonal skills for this role. They were also exceptionally valuable in terms of their inputs into the Nutrition workshops.

The value to participants of being able to discuss issues with other participants and speakers present was also rated highly in the other evaluation data collected at the workshop. 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 improvements in their vineyard nutrition management as a result of attending the workshop and comments from the follow up day indicated this occurred. A large number of participants started or increased their frequency of soil and tissue testing with following changes in monitoring observed as a result.

Many ultimately saved time and money on streamlining their vineyards nutritional needs by not putting out unrequired fertiliser products and as a result saw improvements in vine health and fruit quality. All these findings indicate that the program was successful at providing a framework for the uptake of new nutritional management strategies. Many appeared more confident about implementing change at the third day as a result of the framework that was provided to give them support.

"the workshop provided a wealth of information on nutritional management in vines that will enable all participants to develop and fine tune fertiliser programs to maximise the production of quality winegrapes"

Shane Smith (Geelong Grapegrowers Association)

All presentations and manual

The workshop manual and presentations will be reviewed and updated this year, as the results of recent studies become available. Further information on grapevine quality will be added and the current content revised, the section looking at natural amendments will be incorporated in the 2002 manual update.

The third day

A new presentation building on concepts from the first day and expanding into the natural alternatives which are available has been developed. This will help introduce the topic again to participants and focus them on some of the issues that may have arisen during the season. It will also provide participants who have not completed their promise with ideas about other changes they may have made as a result of the workshop.

New topics and research

There is a great deal of interest within the grape growing community in the aspects of organic viticulture and using composts and mulches as part of the vineyard system. As well as water conservation benefits there are implications for nutrition management and environmental systems. There is also considerable interest the biological activity of soil and the impacts this can have on vines for nutrient cycling and release. Specifically participants mentioned earthworms and the soil food web. While there is some information on soil biology and the use of mulches and composts, there is relatively little that relates specifically to vines and the impacts of management changes on vines.

Some of the information is being gathered with respect to the nutrition management of these issues, however there needs to be more work on these topics in vineyards to clarify some of the issues, including the quantification of the release of nutrients from mulch/compost formulations and leguminous cover crops in a range of environmental conditions.

There is considerable work occurring on wine and grape quality and there is a Quality Research to Practice® workshop currently in its first season. Further critical analysis of what it means to vineyard managers would be useful. How much of what we know can be manipulated in the vineyard and what affects will that have on the vine are unknowns at this stage.

There is some sound knowledge available about the affects of potassium on wine quality, and there is an awareness of the relationship between nitrogen and quality but more work needs to be done on looking at nitrogen in relation to phenols and flavours.
Not much work has been done on phosphorus looking at quality or vine physiology parameters

Growers were interested in the possibility of linking nitrogen and potassium must values to viticultural practices, and timing of sampling earlier in the season to anticipate values however there are currently no standards available to carry this out. In addition, information on the relationship of nutrient uptake by different rootstocks is currently in progress.

Future changes to program

Many changes are planned for the Grapevine Nutrition: Research to Practice® program in the future to ensure it remains at the forefront of the research currently being conducted. Improvements to the delivery of information and the processes involved in that delivery are also planned. The following is a list of issues, changes and new products planned for consideration to maintain the reputation of Research to Practice® as major source of research information for the Australian wine industry.

- increasing the number of trained facilitators
- Addressing budgeting issues as part of the Research to Practice™ (Viticulture) business plan.
- Commercialising the delivery of Research to Practice® (Viticulture) workshops
- Evaluating the current format of day 2 in response to participant feedback
- Improving return rate of participants to third day of workshop
- Review presentations and workshop manual
- Determine possibility of running more train the trainer workshops
- Develop some tools for participants to use to determine profitability of changes made, incorporating some form of environmental accounting
- Develop Research to Practice® update days to showcase latest research information that past participants would not have viewed

Appendix 1: Communication

Appendix 1.1: Research to Practice® Grapevine Nutrition Workshop Evaluation

EVALUATION

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)

		Yes	Partly	No
1.	**Was the information presented 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.	**Were the group sessions useful?**	☐	☐	☐
	Comments.....			
5.	**Did the workshop meet your expectations?**	☐	☐	☐
	Comments.....			

DAY 1

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

Introduction	Plant Testing and analysis
Role of nutrition in grape and wine production	Nitrogen
Nutrients, soils and vines	Phosphorous
***Group session**:* sampling case study	Potassium
Soil Testing and analysis	***Group session**:* NPK current practices

7. **What sessions did you like the least? (circle)**

Introduction	Plant Testing and analysis
Role of nutrition in grape and wine production	Nitrogen
Nutrients, soils and vines	Phosphorous
***Group session**:* sampling case study	Potassium
Soil Testing and analysis	***Group session**:* NPK current practices

DAY 2

8. What sessions did you like the most? (circle)

Other Nutrients	***Group discussion:*** Fertiliser strategies
Fertilisers	***Group session:*** Case studies
Group session*:* Cost calculations	The role of nutrients in wine quality

9. What sessions did you like the least? (circle)

Other Nutrients	***Group discussion:*** Fertiliser strategies
Fertilisers	***Group session:*** Case studies
Group session*:* Cost calculations	The role of nutrients in wine quality

Any **general comments** about the workshop content, the presenters, the facilitators, or other aspects?

10. **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?.....

.....

11. **Was this workshop good value for money?** (tick a box)

Yes ☐ Partly ☐ No ☐

Why / why not?.....

.....

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

Appendix 1.2: Petiole analysis test results #1

Vineyard: Shiraz vines on own roots

Problem:
It's February and your vine leaves appear to be slightly paler than usual and some leaves have patches of leaf burn on the edges of the leaves. Your record keeping has been a little lax lately, but you think a similar thing happened last year. After a summer thunderstorm last year the vines seemed to recover slightly and went on to produce slightly lower tonnes than the year before. The winery also had some concerns about the quality of your fruit.

This year you decide to do a petiole test at flowering and the results have just come back and are below.

Test	Result	Test	Result
Total N %	1.15	Sodium %	0.46
Nitrate N mg/kg	400	Chloride %	1.2
Sulfur %	0.09	Copper mg/kg	4
Phosphorus %	0.18	Zinc mg/kg	42
Potassium %	2.38	Manganese mg/kg	72
Calcium %	1.32	Iron mg/kg	25
Magnesium %	0.52	Boron mg/kg	38
		Aluminium mg/kg	25

Identify any nutrient deficiencies or toxicities that appear in the petiole test.

_____
_____
_____
_____-
_____

What nutrients need to be applied and what application strategy and rates should be used?

_____
_____
_____
_____

Identify what other information is required to put the petiole results in perspective

_____
_____
_____
_____

Soil analysis test results #1

Texture	Clay
Free Carbonate	Effervescent
Electrical conductivity (dS/m)	0.14
Organic carbon %	0.7
pH ($CaCl_2$)	8.0
pH (water)	8.3
Exchangeable calcium (meq/100g)	12.5
Exchangeable magnesium (meq/100g)	3.41
Exchangeable sodium (meq/100g)	0.35
Exchangeable potassium (meq/100g)	1.89
Exchangeable sodium percentage (ESP)	2
Extractable phosphorus (mg/kg)	4.7
Extractable potassium (mg/kg)	15

Identify the problems associated with this soil

_____
_____
_____
_____

What nutrient problems may develop in this soil?

_____
_____
_____
_____

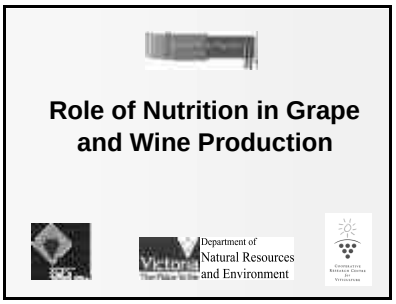
What may your nutrient strategy be on this soil?

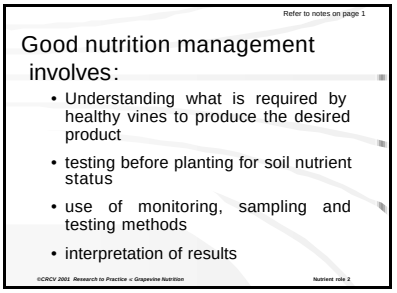
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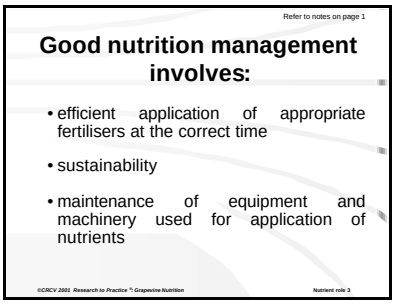
What other information is required to develop your nutrient management strategy?

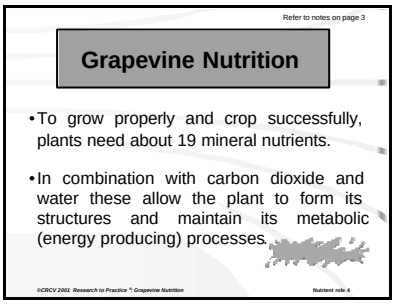
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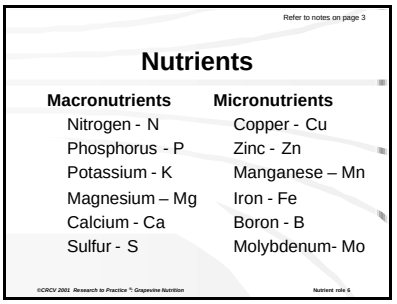
Appendix 1.3: Presentation used to introduce grapevine nutrition concepts at the workshop.

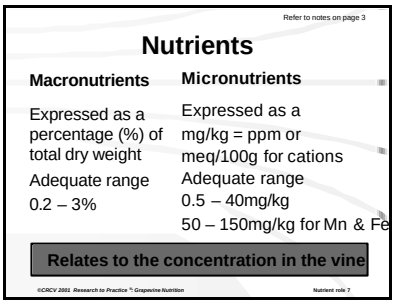


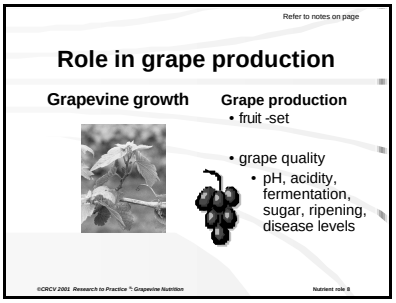


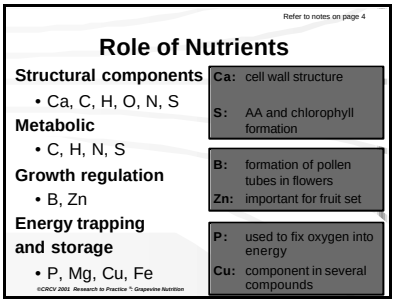


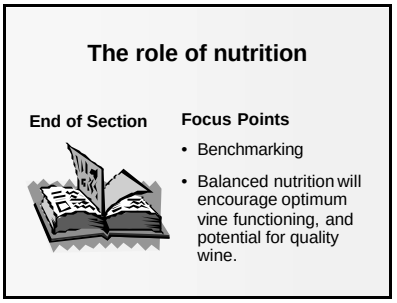












Appendix 1.4: Links with Units of Competency

Research to Practice®



Grapevine Nutrition

Links with Units of Competency

Components of Research to Practice® workshops can be used towards elements of competency for the following units.

NB: Attendance at a Research to Practice® workshop (with accompanying short report) will not independently fulfill elements of competency for the unit(s) listed below.

Participants are encouraged to contact their local Registered Training Organisation (RTO) to organise a skills assessment to fully document competency against the performance criteria for a specific unit.

Research to Practice: Grapevine Nutrition

LEVEL 3
RUH98 Certificate III in Horticulture (Production) - Viticulture
RUH HRT359 A Implement a plant nutrition program

Certificate in Food Processing (Wine)
FDF WGGVDD A Monitor and control vine disorders and damage
FDF WGGCBA A Apply chemicals and biological agents
FDF WGGISI A Implement an irrigation schedule
FDF WGGSMP A Implement a soil management program

LEVEL 4
RUH98 Certificate IV in Horticulture (Production) - Viticulture
RUH HRT438 A Develop a plant nutrition program

LEVEL 5
Diploma in Viticulture Management – MNA (TAFESA)
FTLK Vine Nutrition

Braybrook, D., Robinson, B., Treeby, M., Grieger, G., Retallack, M. (2001) **Nitrogen management for improved quality and sustainability.** *Australian Grapegrower and Winemaker, Annual Technical Issue.* (449a) 95 - 96.

Appendix 1.5: Improving nitrogen management for improved quality and sustainability

David Braybrook[1], Ben Robinson[2], Michael Treeby[1,3], Gayle Grieger[1] and Mary Retallack[1]

1 Cooperative Research Centre for Viticulture
2 Scholefield Robinson Horticultural Services
3 CSIRO Plant Industry

The latest Research to Practice® workshop series on Grapevine Nutrition has highlighted a number of issues relating to the management of nitrogen (N) in vineyards. A commonly-asked question is, "How much nitrogen do I need to apply to maintain current grape production and quality?" The answer, no one wants to hear, is "it depends". In some vineyards no nitrogen may be required while in others 50 kg/ha/yr is needed. As with all aspects of vineyard management, viticultural practices need to be adapted to meet site characteristics, varietal differences and production targets.

Is nitrogen required? If so, why, when and how much?

Role of nitrogen

Nitrogen is an essential nutrient for both vine growth and for growth of yeast in wine production. However, there are mixed messages about the need to have an adequate supply of nitrogen in the grapes for fermentation. Di-ammonium phosphate (DAP) is commonly added as a nitrogen source in the winery during fermentation. But there is still debate about the relative merits, in terms of wine bouquet, of nitrogen present in the berries at harvest versus nitrogen added later as DAP. Australian researchers have found that both high and low levels f nitrogen in the vine and berries can have a detrimental impact on wine quality, both through impact on grape quality and the influence on fermentation characteristics (Treeby *et al.,* 1997).

In the vineyard, the detrimental impact of excessive nitrogen is often considered more important than the need for adequate levels of nitrogen in the grapes. Excess nitrogen may impact on grape production by increasing vigour, resulting in a delay in fruit maturity and/or loss of production. The shading of basal buds in vigorous vines can reduce yield potential through a reduction in bud fertility and fruit set. High nitrogen levels may be associated with increased Botrytis levels due to an affect on berry skin thickness and reduced vine canopy ventilation. If excess nitrogen is applied there is also environmental concerns associated with the potential for nitrogen to be leached through the soil profile into groundwater, or streams.

Assessing nitrogen requirements

Soil tests are not particularly reliable indicators of grapevine nitrogen requirements due to the variability during the year in the amount of nitrogen actually available to the vine. For example, there could be up to 10 tonnes of elemental nitrogen per hectare in the top metre of soil, but only a very small proportion of this may be available for vine uptake at any given time.

While leaf petiole tests provide a better indication of vine nitrogen status than soil tests, the data can be difficult to interpret. For example, petiole levels may be low if vines are under water stress and therefore not taking up nitrogen, or levels may by high if a nitrate-based fertiliser has been applied

just prior to plant tissue sampling. The standards set for interpretation of nutrient levels relate to a maximum yield or likelihood of a yield response, which many grape growers are trying to limit using pruning and various canopy management techniques. In these cases, standards for the interpretation of nitrogen levels may not be relevant.

Test results should, therefore, always be assessed in relation to vine vigour and yield, targets. Petiole testing over a number of years will enable vine nitrogen status to be linked with observations of vine performance.

Measurements of canopy characteristics, harvest assessments and feedback from packers will help growers refine nitrogen application strategies to sustain vineyard productivity and meet yield and quality targets.

Determining rates of N application

Nitrogen management should be fine-tuned over a number of seasons. One way to do this is to trial applications of varying amounts of nitrogen across a block over a number of years. This way, the "best" approach for a particular site can be chosen.

Some other ways to get a general indication of requirements include:

- Basing application on the average amount used by other vineyards in the region. However, this assumes that all sites and varieties have the same requirements for nitrogen, which can be misleading.
- Using an estimate of nitrogen removed with the crop of about 1.2 to 2.4 kg nitrogen per tonne of grapes harvested. For example, for a crop of 12 t/ha, expect to replace about 20-30klg nitrogen/ha.

A complicating factor when using this "balance sheet" approach is the potential for other gains and losses of nitrogen in the vineyard. For example, nitrogen can be added through:

- **Cover crops:** There is a potential for nitrogen input from legume cover crops, due to their ability to fix atmospheric nitrogen. This nitrogen can become available to the vines when the plant material is broken down in the soil, particularly if the soil is cultivated. For example, trials with Paraggio medic in Sunraysia indicated potential inputs into the vineyard of up to 80 kg N/ha over a year (Sanderson, 1999). Despite this result, the trials also indicated that the Paraggio medic could not meet the nitrogen requirements of the vines in this vineyard.
- **Other inputs:** Inputs of nitrogen from the atmosphere (eg from air pollution, lightening etc) may be significant in some regions, with estimates of annual inputs ranging between five and 30 kilograms of nitrogen per hectare (White, 1979). In some regions there may be sufficient nitrogen in the irrigation water to contribute a significant amount of nitrogen to the vineyard system.

Losses of nitrogen can result from:

- Leaching and erosion from poor fertiliser timing, excessive application or poor application strategies
- Removal of grapes and prunings
- Loss as gas from volatile forms of fertiliser (eg ammonium-based products applied to an alkaline surface soil).

Timing of application

Nitrogen application should be timed to coincide with the peak periods of vine root growth and vine demand. Early season applications can be difficult to plan because active root growth, which is strongly retarded by soil temperatures below 10oC, is needed for N uptake. Vines also rely heavily on stored reserves of nitrogen until the 5th or 6th leaves have unfolded. In irrigated vineyards, application is generally focused 3-4 weeks pre-flowering through to veraison. In cooler areas,

nitrogen is often applied by fertigation, either with a special short irrigation, or regularly between the beginning of the irrigation season to about Christmas time. Application should be avoided during the flowering period.

The other peak period for nitrogen uptake can be the post-harvest flush of root growth. However in some regions where leaf fall occurs soon after harvest, or if harvest is late and soils have cooled down there is less opportunity for uptake by the vine. If, in this circumstance, nitrogen is applied, there may be a risk of leaching the nutrient through the soil profile during the winter dormancy period, before the vines can take it up.

The form of nitrogen applied will influence timing. For example, if nitrogen is being applied as a nitrate-based product it will be immediately available for vine uptake, whereas nitrogen applied as urea, ammonium or organic amendments may not be. Timing can also be more difficult to manage on non-irrigated vineyards because rainfall is required to move nitrogen into the root zone.

Summary

As with many aspects of grape production, site and climatic characteristics, production goals and varietal characteristics will influence nitrogen management practices. While nitrogen is a key nutrient required for grape production, the requirement for a particular vineyard should be fine tuned over a number of seasons through monitoring and testing.
Further information about fine-tuning nitrogen management is addressed in the Grapevine Nutrition: Research to Practice® workshop, which is conducted nationally each year. Contact Francha Horlock at the Institute for Horticultural Development on phone 03 9210 9222 for workshop details.

References:

Sanderson, G. and Fitzgerald, D. (1999) **Cover crop nitrogen - vineyard trials with sultana vines.** *Australian Grapegrower and Winemaker.* (422), 13 - 15.

Treeby, M.T., Holzapfel, B.P., and Walker, R.R. (1996) **Optimising nitrogen supply to grafted shiraz.** Stockley, C.S., Sas, A.N., Johnstone, R.S. and Lee, T.H. Ed(s) *Proceedings of the Ninth Australian Wine Industry Technical Conference. Adelaide, South Australia.* Winetitles, Adelaide. 132 - 137.

White, R. (1987) **Introduction to the principles and practices of soil science.** 2nd Edition, Blackwell Scientific Publications.

Braybrook, D., Robinson, B., Treeby, M., Grieger, G., Retallack, M. (2001) **Nitrogen management on dried fruit vineyards.** *Dried Fruit News.*

Improving nitrogen management on dried vine fruit vineyards

David Braybrook[1], Ben Robinson[2], Michael Treeby[1,3], Gayle Grieger[1] and Mary Retallack[1]

1 Cooperative Research Centre for Viticulture
2 Scholefield Robinson Horticultural Services
3 CSIRO Plant Industry

The latest Research to Practice® workshop series on Grapevine Nutrition and Drying for Profit Short Courses have highlighted a number of issues relating to the management of nitrogen(N) in vineyards. Queries centre around a common theme: "How much nitrogen do I need to apply to ensure high productivity and to produce high quality dried fruit". The answer, no one wants to hear, is "it depends". In some vineyards no nitrogen may be required while in others 50 kg/ha/yr is needed. As with all aspects of vineyard management, viticultural practices need to be adapted to meet site characteristics, production targets and product specifications.

Is nitrogen required? If so, why, when and how much?

Role of nitrogen

Nitrogen is an essential nutrient for both vine growth and productivity. However, there are dried vine fruit (dvf) quality issues associated with high levels of nitrogen in the grapes when harvested that have become more obvious in recent years. Australian researchers have found that both high levels of nitrogen in the berries is associated with browning of the fruit during storage (Frank and Millikan, unpublished data).

In the vineyard, the detrimental impact of excessive nitrogen is often considered more important than the need for adequate levels of nitrogen in the grapes. Excess nitrogen may impact on grape production by increasing vigour, resulting in a delay in fruit maturity and/or loss of production. The shading of basal buds in vigorous vines can reduce yield potential through a reduction in bud fertility and fruit set. High nitrogen levels may be associated with increased disease pressure due to an affect on berry skin thickness and reduced vine canopy ventilation. There are also environmental concerns associated with the potential for nitrogen to be leached through the soil profile into groundwater, drainage basins and the river.

Assessing nitrogen requirements

Soil tests are not particularly reliable indicators of grapevine nitrogen requirements due to the variability during the year in the amount of nitrogen actually available to the vine. For example, there could be up to 10 tonnes of elemental nitrogen per hectare in the top metre of soil, but only a very small proportion of this may be available for vine uptake at any given time.

While leaf petiole tests provide a better indication of vine nitrogen status than soil tests, the data can be difficult to interpret. For example, petiole levels may be low if vines are under water stress and therefore not taking up nitrogen, or levels may by high if a nitrate-based fertiliser has been applied just prior to plant tissue sampling. The standards set for interpretation of nutrient levels relate to a maximum yield or likelihood of a yield response, which many grape growers limit using pruning.

Test results should, therefore, always be assessed in relation to vine vigour and yield, the latter particularly in relation to other producers with comparable trellis and rootstocks. Petiole testing over a number of years will enable vine nitrogen status to be linked with observations of vine performance.

Measurements of canopy characteristics, harvest assessments and feedback from packers will help growers refine nitrogen application strategies to sustain vineyard productivity and meet yield and quality targets.

Determining rates of N application

Nitrogen management should be fine-tuned over a number of seasons. One way to do this is to trial applications of varying amounts of nitrogen across a block over a number of years. This way, the "best" approach for a particular site can be chosen.
Some other ways to get a general indication of requirements include:

- Basing application on the average amount used by other vineyards in the region. However, this assumes that all sites and varieties have the same requirements for nitrogen, which can be misleading.
- Using an estimate of nitrogen removed with the crop of about 3.6 to 7.2 kg nitrogen per tonne of dried vine fruit(dvf) harvested. For example, for a dvf crop of 8 t/ha, 29 - 58 kg nitrogen would be removed per ha. The important issue here is whether we want that much nitrogen to be removed given the linkage between nitrogen in the berries and the darkening of dried vine fruit later during storage.

A complicating factor when using this "balance sheet" approach is the potential for other gains and losses of nitrogen in the vineyard. For example, nitrogen can be added through:

- **Cover crops**: There is a potential for nitrogen input from legume cover crops, due to their ability to fix atmospheric nitrogen. This nitrogen can become available to the vines when the plant material is broken down in the soil, particularly if the soil is cultivated. For example, trials with Paraggio medic in Sunraysia indicated potential inputs into the vineyard of up to 80 kg N/ha over a year (Sanderson, 1999). Despite this result, the trials also indicated that the Paraggio medic could not meet the nitrogen requirements of the vines in this vineyard.
- **Nitrogen sprays**: Some growers routinely add 5kg of low biuret urea for every 1000L of spray mix. Assuming that about 2000L per hectare is needed for adequate coverage during the middle of the season, then this could potentially supply approximately 5 kg nitrogen per hectare with each spraying event. Obviously, this amount will vary according to the volume of water needed to achieve adequate coverage, which will vary according to the time of the year, trellis type and rootstock. It is also unclear just how much of this nitrogen supplied in foliage sprays is actually used by the vine.

Significant losses of nitrogen can result from leaching due to heavy rainfall or excessive irrigation. Movement of nitrogen can also occur when irrigation water carries soil and dissolved nitrogen to the lower end of an irrigation run. Losses as gas can occur when volatile forms of fertiliser (*e.g.* ammonium-based products) are applied to the surface of moist alkaline soil and permitted to remain there. Gaseous losses of nitrogen also occur when soils remain waterlogged for significant periods of time.

One should also distinguish between a program needed to get young vines up to the wire and cordons established and a "steady state" program. Obviously, greater inputs are required to get vines established when root systems are so much smaller.

Timing of application

Nitrogen application should be timed to coincide with the peak periods of vine root growth and vine demand. Early season applications can be difficult to plan because active root growth, which is strongly retarded by soil temperatures below 10oC, is needed for N uptake. Vines also rely heavily on stored reserves of nitrogen until the 5th or 6th leaves have unfolded. In irrigated vineyards, application is generally focused 3-4 weeks pre-flowering through to veraison. Application should be avoided during the flowering period.

The other peak period for nitrogen uptake can be the post-harvest flush of root growth.

The form of nitrogen applied will influence timing. For example, if nitrogen is being applied as a nitrate-based product it will be immediately available for vine uptake, whereas nitrogen applied as urea, ammonium or organic amendments may not be available for uptake for periods of time ranging from days to weeks on some sites. Thus, nitrogen applications during the post harvest period would be more likely to be effective if nitrate-based products are used.

Summary

As with many aspects of dried vine fruit production, site and management characteristics and production goals will influence nitrogen management practices. While nitrogen is a key nutrient required for grape production, the requirement for a particular vineyard should be fine tuned over a number of seasons through monitoring and testing.
Further information about fine-tuning nitrogen management is addressed in the Grapevine Nutrition: Research to Practice® workshop, which is conducted nationally each year. Contact Mary Retallack at the Cooperative Research Centre for Viticulture (Phone:08 8271 9586; Fax: 08 8373 7091; Mobile: 0411 513 621) for workshop details.

References:

Sanderson G and Fitzgerald D. (1999) **Cover crop nitrogen - vineyard trials with sultana vines**. *Australian Grapegrower and Winemaker*. February 1999.

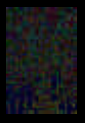
Appendix 2: Intellectual Property

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Use: General
Location: Manual
Section: Folder Cover
Nutrients and grapevine growth p12



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 1

Name: Mg Deficiency? on leaf
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Front Cover
Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)





Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 1

Name: Boron Toxicity
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Front Cover
Micronutrients p4
Deficiencies and toxicities symptoms colour plates
Other Nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 3

Name: Field Diagnosis
Owner: Anon
Use: General
Location: Manual
Section: Front Cover



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide #4

Name: Fe deficiency on leaves
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Front cover
Micronutrients p14
Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 5

Name: B Deficiency – Stunted shoot growth
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Folder Cover
Micronutrients p3
Deficiencies and toxicities symptoms colour plates
Role of nutrition in grape and wine production (PP)
Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 6

Name: Vineyard view
Owner: Anon
Use: General
Location: Manual
Section: Front cover



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 7

Name: K Deficiency – Shiny leaf
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentaiton
Section: Front cover
Deficiencies and toxicities symptoms colour plates
Potassium (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 8

Name: N Deficiency – deficient and healthy leaf
Owner: Barry Goldspink
Use: General
Location: Manual/PowerPoint Presetation
Section: Front Cover
Deficiencies and toxicities symptoms colour plates
Nitrogen (PP)



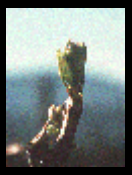
Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 9

Name: N Deficiency – chlorophyll unmasked
Owner: Ben Robinson
Use: General
Location: Manual/ PoweerPoint Presentation
Section: Front Cover
Deficiencies and toxicities symptoms colour plates
Nitrogen (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 10

Name: First leaves unfolding
Owner: Anon
Use: General
Location: Manual
Section: Nutrients and grapevine growth p6



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 11

Name: 4-5 leaves unfolding
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Use: General
Location: Manual
Section: Nutrients and grapevine growth p6



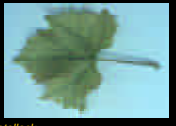
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Section: Nitrogen



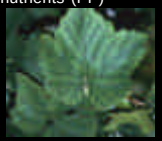
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Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



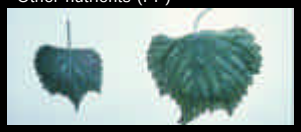
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©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 14

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Location: Manual/PowerPoint Presentation
Section: Micronutrients p19
Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 15

Name: Zn deficiency – stunted petiole sinus
Owner: John Whiting
Use: General
Location: Manual/PowerPoint Presentation
Section: Micronutrients p28
Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 16

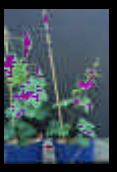
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Owner: Ben Robinson
Use: General
Location: Manual
Section: Deficiencies and toxicities symptoms colour plates
Nitrogen (PP)





Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 17

Name: N deficiencies – potted vines
Owner: Ben Robinson
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Nitrogen (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 18

Name: Effects of phylloxera
Owner: John Whiting
Use: General
Location: Manual
Section: Deficiencies and toxicities symptoms colour plates



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 19

Name: N toxicity – marginal necrosis
Owner: Ben Robinson
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Nitrogen (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 20

Name: N toxicity – salt and AA exudes
Owner: Ben Robinson
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Nitrogen (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 21

Name: P deficiency – basal leaves senesce
Owner: Anon
Use: General
Location: Manual
Section: Deficiencies and toxicities symptoms colour plates



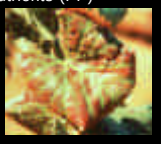
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©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 22

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Section: Deficiencies and toxicities symptoms colour plates
Phosphorus (PP)



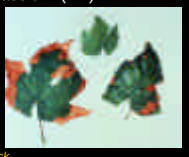
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©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 23

Name: Leaf roll virus
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Location: Manual/ Powerpoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Phosphorus (PP)
Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 24

Name: K Toxicity
Owner: Ben Robinson
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Potassium (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 25

Name: K deficiency leaf
Owner: Barry Goldspink
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Potassium (PP)



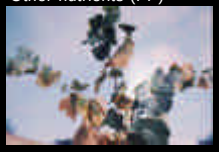
Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 26

Name: Rust mite damage
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Potassium (PP)



Holder: Mary Retallack
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Name: S Toxicity
Owner: Anon
Use: General
Location: Manual/ Powerpoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 28

Name: Mg Deficiency
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Other Nutrients (PP)



Holder: Mary Retallack
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Name: Mg severe deficiency
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



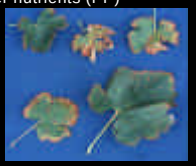
Holder: Mary Retallack
©CRCV 2002 Research to Practice® : Grapevine Nutrition Slide # 30

Name: Boron deficiency on bunches
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



Holder: Mary Retallack
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Name: B deficiency x 5 leaves marginal necrosis
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Deficiencies and toxicities symptoms colour plates
Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 32

Name: Fe chlorosis
Owner: Anon
Use: General
Location: Manual
Section: Deficiencies and toxicities symptoms colour plates



Holder: Mary Retallack
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Name: Stunted young vine growth
Owner: Anon
Use: General
Location: Manual
Section: Deficiencies and toxicities symptoms colour plates



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 34

Name: Zn deficient shoot
Owner: Anon
Use: General
Location: Manual
Section: Deficiencies and toxicities symptoms colour plates



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 35

Name: Soil profile
Owner: Anon
Use: General
Location: Manual
Section: Monitoring and sampling for nutritional requirements



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 36

Name: Results of irrigating with saline water
Owner: Ben Robinson
Use: General
Location: Manual/PowerPoint Presentation
Section: Water quality
Nitrogen (PP)



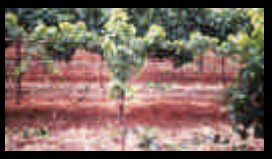
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 37

Name: Excess N causing petiole collapse
Owner: John Whiting
Use: General
Location: PowerPoint Presentation
Section: Nitrogen



Holder: Mary Retallack
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Name: Stunted vine growth due to root rot
Owner: John Whiting
Use: General
Location: PowerPoint Presentation
Section: Nitrogen (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 39

Name: Stunted vine growth due to root rot
Owner: John Whiting
Use: General
Location: PowerPoint Presentation
Section: Nitrogen (PP)



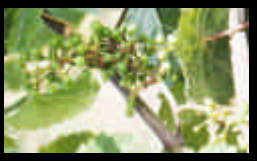
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©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 40

Name: K deficiency in older leaf
Owner: Anon
Use: General
Location: PowerPoint Presentation
Section: Potassium (PP)



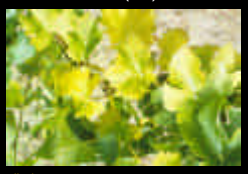
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 41

Name: Poor Set
Owner: John Whiting
Use: General
Location: PowerPoint presentation
Section: Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 42

Name: Chlorotic leaves
Owner: Barry Goldspink
Use: General
Location: Manual
Section: Other Nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 43

Name: Fe chlorosis on Swartzman & Dog Ridge
Owner: John Whiting
Use: General
Location: Manual
Section: Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 44

Name: Fe chlorosis
Owner: Ben Robinson
Use: General
Location: PowerPoint Presentation
Section: Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 45

Name: Fe Chlorosis
Owner: Anon
Use: General
Location: PowerPoint Presentation
Section: Other nutrients (PP)



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 46

Name: Zn deficiency
Owner: Ben Robinson
Use: General
Location: PowerPoint Presnetation
Section: Other nutrients (PP)



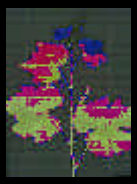
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 47

Name: Zn Deficiency
Owner: Ben Robinson
Use: General
Location: PowerPoint Presentation
Section: Other nutrients



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 48

Name: Zn Deficiency
Owner: Ben Robinson
Use: General
Location: PowerPoint Presentation
Section: Other nutrients



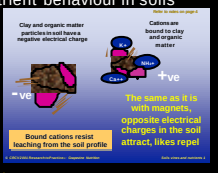
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 49

Name: Spreading lime/gypsum
Owner: Anon
Use: General
Location: PowerPoint Presentation
Section: Fertilisers (PP)



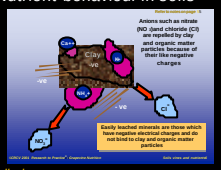
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 50

Name: Figure 1: Cations are attracted by –ve charges
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrient behaviour in soils



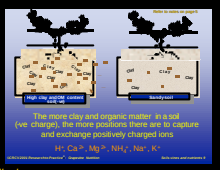
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition Slide # 51

Name: Figure 2: Anions are repelled by like charges
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrient behaviour in soils



Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 52

Name: Figure 3: CEC
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrient behaviour in soils



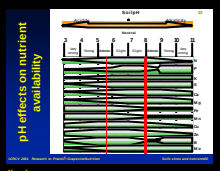
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 53

Name: Texture grades
Owner: IHD Knoxfield
Use: General
Location: PowerPoint Presentation
Section: Nutrient behaviour in soils



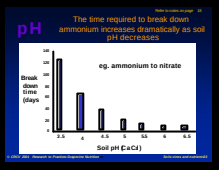
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 54

Name: pH scale
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrient behaviour in soils



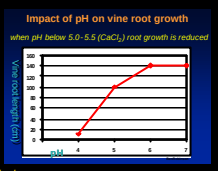
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 55

Name: Effect of pH on ammonium to nitrate
Owner: Mike Treeby?
Use: General
Location: PowerPoint Presentation
Section: Nutrient behaviour in soils



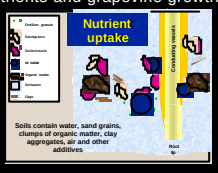
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 56

Name: Effect of pH on root growth
Owner: Ben Robinson
Use: General
Location: PowerPoint Presentation
Section: Nutrient behaviour in soils



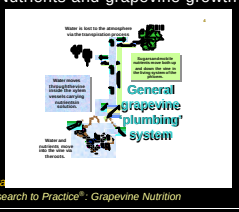
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 57

Name: Figure 1: Uptake of nutrients
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrients and grapevine growth



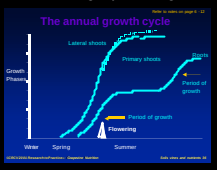
Holder: Mary Retallack
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Slide # 58

Name: Figure 2: Xylem and phloem system
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrients and grapevine growth



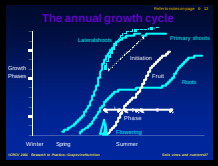
Holder: Mary Retallack
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Slide # 59

Name: Figure 5: The annual cycle of a grapevine
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrients and grapevine growth



Holder: Mary Retallack
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Slide # 60

Name: Figure 6: Summary of grapevine growth
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Nutrients and grapevine growth



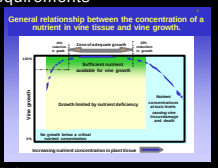
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 61

Name: Figure 1: Distribution of extractable P
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Sampling for grapevine nutritional requirements



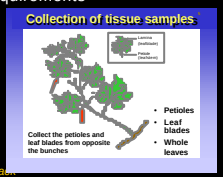
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 62

Name: Figure 1: Nutrient curve
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Sampling for grapevine nutritional requirements



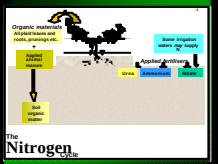
Holder: Mary Retallack
©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 63

Name: Figure 2: Tissue sampling
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Sampling for grapevine nutritional requirements



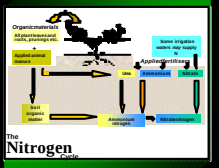
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©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 64

Name: Nitrogen Cycle
Owner: IHD Knoxfield
Use: General
Location: PowerPoint
Section: Nitrogen



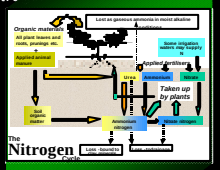
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©CRCV 2002 Research
Slide # 65

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Owner: IHD Knoxfield
Use: General
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Section: Nitr



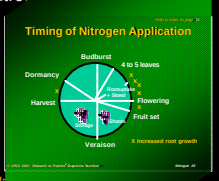
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©CRCV 2002 Res
Slide # 66

Name: Nitrogen Cycle
Owner: IHD Knoxfield
Use: General
Location: Manual/P ion
Section: Nitro



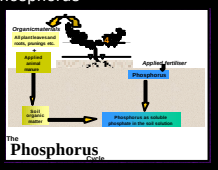
Holder: Mary Retalla
©CRCV 2002 Resear
Slide # 67

Name: Nitrogen Cycle
Owner: IHD Knoxfield
Use: General
Location: Manual/P tion
Section: Nitro



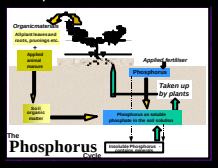
Holder: Mary Retalla
©CRCV 2002 Resea
Slide # 68

Name: Phosphorus Cycle
Owner: IHD Knoxfield
Use: General
Location: PowerPoint Presentation
Section: Phosphorus



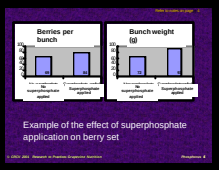
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©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 69

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Use: General
Location: Manual/PowerPoint Presentation
Section: Phosphorus



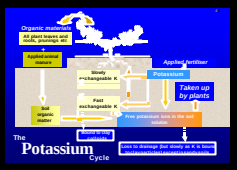
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©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 70

Name: Effect of P on yield
Owner: Anon
Use: General
Location: Manual/PowerPoint Presentation
Section: Phosphorus



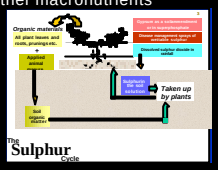
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©CRCV 2002 Research to Practice®: Grapevine Nutrition
Slide # 71

Name: Potassium Cycle
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Potassium



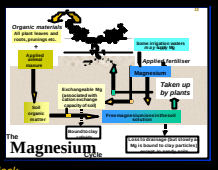
Holder: Mary Retallack
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Slide # 72

Name: Sulfur Cycle
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Other macronutrients



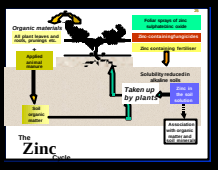
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Slide # 73

Name: Magnesium Cycle
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Other macronutrients



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Slide # 74

Name: Zinc Cycle
Owner: IHD Knoxfield
Use: General
Location: Manual/PowerPoint Presentation
Section: Other macronutrients



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Slide # 75

Appendix 4: Staff

Presenters with expertise in different aspects of nutrition in viticulture have been included in the development of the workshop content and structure, presentations, manual and support materials.

Thirty-two presenters have presented modules in the workshops in different regions. Presenters with local knowledge have been included when possible. This has helped with collection of new information and provision of a regional perspective, as well as to provide training. Due to the specialised knowledge required for parts of the program and the lack of data in others, further in-house workshops will need to be conducted to clarify the presentations and sections of the manual.

Presenters involved included:

00/01 season		01/02 season	
Alex Banks Sally Bell Derek Cameron Jacinta Corrie Harry Creecy Claire Davies Duncan Farquhar Gayle Grieger Barry Goldspink Shayne Hackett Megan Hill Bruno Holzafel	Neil Lantzke David Morrow Shane Phillips Ross Polglase Mary Retallack Ben Robinson Amanda Schapel Bruce Scott David Shearer Michael Treeby Chris Williams	Sally Bell Steve Brooks Jacinta Corrie Richard Emery Gayle Grieger Matt Harrip Andrew McLoughney	Ken Orr Chester Osborne Mary Retallack Amanda Schapel Bruce Scott Trevor Spurr John Whiting

People involved in the formulation of the manual include:

Donna Aitken (DNRE)	Ross Polglase (consultant)
Hugh Armstrong (GWRDC/CRCV)	Peter Rand (Serve-Ag)
Sally Bell (AWRI)	Mary Retallack (CRCV)
David Braybrook (CRCV)	Ben Robinson (SRHS)
Derek Cameron (IAMA)	Graham Sanderson (NSW Ag)
Nick Fazekas (IAMA)	Alex Sas (AWRI)
Barry Goldspink (AgWA)	Bruce Scott (EE Muirs)
Gayle Grieger (CRCV)	Jan Strawhorn (IAMA)
Shayne Hackett (NSWAg)	Rob Sward (DNRE)
Jim Hardie (CRCV)	Michael Treeby (CSIRO)
Bruno Holzapfel (NSWAg)	Robyn van Heeswijck (Adelaide University)
Mike McCarthy (SARDI)	Stephen West (PIRSA)
Stuart McNab (Southcorp)	Don Wheatley (CSIRO)
Sellappah Nagarajah (DNRE)	Ashley Wheaton (DNRE)
David Oag (DPIQld)	Chris Williams (SARDI)
Ken Orr (Pivot)	John Whiting (DNRE)

Appendix 5: Any other material

Appendix 5.1: Location of workshops and number of participants

Year	Location	No. Participants
99	Wangaratta	18
99	Mildura	17
99	Margaret River	24
99	Albany	19
99	Cowra	14
99	Adelaide Hills	16
99	Knox	10
99	Griffith	14
TOTAL	**8 Workshops**	**132 participants**
00	Adelaide Hills	24
00	Barossa	24
00	McLaren Vale #1	17
00	Mudgee	27
00	Denman	24
00	Robe	25
00	Margaret River	20
00	Stanthorpe	23
00	Riverland	26
00	McLaren Vale #2	23
00	Robinvale	22
00	Nagambie	20
00	Langhorne Creek	23
01	Hobart	23
TOTAL	**14 Workshops**	**321 participants**
01	Clare	20
01	McLaren Vale	20
01	Geelong	18
01	Ararat	16
TOTAL	4 Workshops	74 participants
Over 3 year funding period	**26**	**527**

Appendix 5.2: Season 2000/2001 summary of first 2 days

Qn	Region		Adelaide Hills	Barossa	Hobart	Hunter Valley	Langhorne Creek	Margaret River	McLaren Vale #1	McLaren Vale #2	Mudgee	Nagambie	Queensland	Riverland	Robe	Robinvale	TOTAL	%
1	Was the information presented useful to you?	Yes	21	16	15	19	19	15	16	12	22	14	19	22	23	20	**253**	**91.0%**
		Partly	0	2	5	0	3	2	2	3	3	3	1	0	0	1	**25**	**9.0%**
		No	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	**0.0%**
2	Was the information presented clearly?	Yes	20	16	11	19	19	13	16	12	22	15	19	20	23	16	**241**	**86.7%**
		Partly	1	2	8	0	3	3	2	3	3	2	1	2	0	6	**36**	**12.9%**
		No	0	0	1	0	0	0	0	0	0	0	0	0	0	0	**1**	**0.4%**
3	Was the venue comfortable and could you see and hear clearly?	Yes	20	5	14	17	21	16	14	13	22	14	18	20	23	16	**233**	**83.5%**
		Partly	1	12	5	2	1	1	2	0	4	3	2	2	0	6	**41**	**14.7%**
		No	0	1	0	0	0	0	2	2	0	0	0	0	0	0	**5**	**1.8%**
4	Were the group sessions useful?	Yes	20	18	17	16	20	13	15	12	23	14	19	19	19	18	**243**	**87.1%**
		Partly	1	0	3	3	2	4	3	2	2	2	0	3	4	4	**33**	**11.8%**
		No	0	0	0	0	0	0	0	1	1	0	1	0	0	0	**3**	**1.1%**
5	Did day one meet your expectations?	Yes	20	16	13	17	18	13	16	13	22	16	17	20	22	14	**237**	**85.6%**
		Partly	1	2	5	2	4	3	0	2	4	0	3	2	1	7	**36**	**13.0%**
		No	0	0	2	0	0	1	0	0	0	1	0	0	0	0	**4**	**1.4%**
6	What session did you like the most?	Introduction	5	3	4	1	4	0	2	2	0	2	2	4	7	3	**39**	
		Nutrients, Soils and Wines	14	11	13	10	10	5	9	7	9	7	14	10	16	8	**143**	
		Monitoring & Sampling	8	12	9	9	6	6	7	4	5	7	11	8	19	8	**119**	
		P	10	7	8	6	8	2	5	6	8	5	6	10	14	8	**103**	
		Field Session	8	6	4	2	4	5	3	2	5	5	8	5	10	9	**76**	
		Role of Nutrition in grape & Wine Production	15	11	10	9	10	9	5	6	12	7	17	15	16	13	**155**	
		Group Session Sampling	8	7	7	2	3	4	6	2	3	4	8	4	10	4	**72**	
		N	15	7	9	12	11	6	8	7	7	5	7	14	14	11	**133**	
		K	11	6	11	6	5	3	6	6	8	3	6	11	15	6	**103**	
7	What session did you like the least?	Introduction	5	2	2	1	2	2	1	2	1	1	2	0	0	1	**22**	
		Nutrients, Soils and Wines	0	0	0	0	0	1	1	0	0	0	0	0	0	0	**2**	
		Monitoring & Sampling	0	0	1	0	0	2	1	2	0	0	0	1	0	10	**17**	
		P	0	2	0	1	1	0	0	0	0	0	3	1	0	1	**9**	
		Field Session	6	7	1	3	1	1	3	1	1	0	2	5	6	0	**37**	
		Role of Nutrition in grape & Wine Production	0	1	1	1	0	0	0	0	2	1	0	0	0	1	**7**	
		Group Session Sampling	2	0	4	3	1	2	1	3	5	1	0	1	1	2	**26**	
		N	0	2	1	1	2	1	0	0	1	1	2	0	0	0	**11**	
		K	3	3	0	2	5	0	0	0	5	1	2	1	0	1	**23**	
8	What sessions did you like the most?	Group Session (NPK)	11	10	10	3	11	4	6	3	7	6	11	12	15	6	**115**	
		Cost Calculations	5	2	4	2	4	3	2	2	3	1	5	5	10	1	**49**	
		Case Studies	12	8	6	6	8	7	7	3	8	6	15	9	11	9	**115**	
		Fertiliser	12	7	10	4	10	4	8	5	11	5	8	12	14	11	**121**	
		Fertiliser Strategies	12	11	12	11	10	7	7	6	13	7	15	14	16	11	**152**	
		Future Technologies/ Record Keeping	7	5	5	1	4	0	1	3	0	2	4	3	11	2	**48**	
9	What sessions did you like the least?	Group Session (NPK)	1	0	1	3	1	3	0	0	3	1	2	0	1	2	**18**	
		Cost Calculations	3	6	0	0	1	2	9	3	8	6	7	9	7	6	**67**	
		Case Studies	0	2	0	2	0	3	1	1	4	1	0	1	2	2	**19**	
		Fertiliser	0	2	1	1	1	1	0	0	2	3	0	0	0	0	**11**	
		Fertiliser Strategies	0	3	1	1	0	1	0	1	2	1	0	1	0	2	**13**	
		Future Technologies/ Record Keeping	3	0	2	1	3	0	1	0	0	0	1	2	0	2	**15**	
10	Do you think you will be able to use information and apply it to your vineyard?	Yes	19	15	17	18	19	11	14	12	22	13	17	21	21	20	**239**	**88.5%**
		Partly	1	3	2	1	1	3	4	2	3	4	3	1	1	1	**30**	**11.1%**
		No	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	**0.4%**
11	Was this workshop good value for money?	Yes	20	17	14	17	19	9	16	13	22	16	19	20	21	18	**241**	**90.3%**
		Partly	1	1	5	2	1	6	2	1	2	0	0	0	0	3	**24**	**9.0%**
		No	0	0	0	0	0	0	0	0	1	1	0	0	0	0	**2**	**0.7%**
Total number of participants for workshop			24	24	23	24	23	20	17	23	27	20	23	26	25	22	**321**	

No of participants who returned for 3rd day workshop	8	17	18	17	13	0	24	13	7	14	13	17	12	**173**	**53.9%**
% of participants who returned for 3rd day workshop	33.3	71	78	71	57	0	60	48	35	61	50	68	55		

Appendix 5.3: Season 2000/2001 summary of 3rd Day

Qn	Region		Riverland	Barossa	Hunter	McLaren Vale	Mudgee	Robinvale	Nagambie	Queensland	Tasmania	TOTAL	%
1	Did you change your nutrition management practices after the 2 day workshop?	Yes	8	10	12	10	8	7	5	NA	NA	60	73.2%
		No	3	6	2	7	1	2	1			22	26.8%
2	Did you monitor soil or vine nutrition more often after the initial 2 day workshop	Yes	7	4	3	7	5	7	5			38	46.3%
		No	4	11	12	10	4	2	1			44	53.7%
3	Did you base your measurement decisions on your monitoring results?	Yes	7	8	12	10	4	5	4			50	70.4%
		No	2	6	0	6	3	4	0			21	29.6%
4	Did you carry out any soil or nutrition tests after the initial 2 day workshop?	Yes	5	5	9	10	8	5	4			46	59.0%
		No	4	10	5	7	1	3	2			32	41.0%
5	Have you used you manual during the season?	Yes	8	8	11	8	7	6	6			54	62.8%
		No	2	7	4	8	2	3	0			26	32.5%
6	Your suggestions for other topics in the future.	Organic Growing	0	0	0	1	1	0	0			2	7.4%
		Economics	0	0	0	0	1	0	0			1	3.7%
		Application rates	0	0	1	0	0	0	0			1	3.7%
		Role of Ca	0	0	1	0	0	0	0			1	3.7%
		Animal manures	0	0	0	1	0	0	0			1	3.7%
		Raising OM	0	0	0	1	0	0	0			1	3.7%
		Pre-harvest Nutrition	0	1	0	0	0	0	0			1	3.7%
		Record Keeping	0	4	0	0	0	0	0			4	14.8%
		Hydrology	0	0	0	0	0	0	1			1	3.7%
		Canopy Mgt/pruning	0	1	0	0	0	1	0			2	7.4%
		Enjoyed open forum	0	1	4	2	5	0	0			12	44.4%
7	Did you feel more motivated to follow up on your Promise because the 3rd day was planned?	Not at all	0	0	4	1	2	1	0			8	9.8%
		A little	2	4	5	5	3	1	1			21	25.6%
		A moderate amount	3	4	2	5	1	4	2			21	22.3%
		Quite a bit	2	6	4	4	1	2	2			21	22.3%
		Yes a lot	4	2	0	2	2	0	1			11	11.7%
8	Was it worthwhile discussing your Promise and results on the 3rd day?	Not at all	0	0	1	1	0	0	0			2	2.4%
		A little	0	0	1	0	0	1	0			2	2.4%
		A moderate amount	3	2	3	4	1	2	0			15	17.9%
		Quite a bit	5	10	7	7	4	5	3			41	48.8%
		Yes a lot	3	4	3	6	4	1	3			24	28.6%
9	Did you pick up useful tips from hearing others reporting on their promises?	Not at all	0	0	0	0	0	0	0			0	0.0%
		A little	1	0	0	1	0	0	0			2	2.4%
		A moderate amount	0	4	3	1	1	4	0			13	15.7%
		Quite a bit	7	6	9	8	3	5	4			42	50.6%
		Yes a lot	3	6	3	7	5	0	2			26	38.2%
10	Did you have enough time to discuss you promise and results?	Not at all	0	0	0	0	0	0	0			0	0.0%
		A little	0	0	0	0	0	0	0			0	0.0%
		A moderate amount	0	0	0	2	0	0	0			2	2.4%
		Quite a bit	5	9	8	6	2	2	1			33	40.2%
		Yes a lot	6	7	6	9	7	7	5			47	58.8%
11	Did you feel comfortable discussing your findings wit the group in this way?	Not at all	0	0	0	0	0	0	0			0	0.0%
		A little	0	2	1	1	0	1	0			5	6.1%
		A moderate amount	2	4	1	7	1	0	0			15	18.3%
		Quite a bit	5	3	8	4	0	2	3			25	30.5%
		Yes a lot	4	7	4	5	8	6	3			37	59.7%
12	Was the presentation valuable?	Not at all	0	0	0	0	0	0	0			0	0.0%
		A little	1	0	0	0	0	0	0			1	1.3%
		A moderate amount	1	1	1	2	0	1	0			6	7.9%

		Quite a bit	5	7	9	8	3	4	2			38	50.0%
		Yes a lot	4	5	4	6	5	3	4			31	40.8%

Appendix 5.4: Season 20001/2002 summary of first 2 days

Qn	Region		Clare	McLaren Vale	Geelong	Ararat	TOTAL	%
1	Was the information presented useful to you?	Yes	17	19	15	13	**64**	**92.8%**
		Partly	2	0	1	2	**5**	**7.2%**
		No	0	0	0	0	**0**	**0.0%**
2	Was the information presented clearly?	Yes	19	16	15	14	**64**	**92.8%**
		Partly	0	3	1	1	**5**	**7.2%**
		No	0	0	0	0	**0**	**0.0%**
3	Was the venue comfortable and could you see and hear clearly?	Yes	18	11	14	14	**57**	**82.6%**
		Partly	1	8	2	0	**11**	**15.9%**
		No	0	0	0	1	**1**	**1.4%**
4	Were the group sessions useful?	Yes	14	16	12	11	**53**	**76.8%**
		Partly	5	3	3	4	**15**	**21.7%**
		No	0	0	1	0	**1**	**1.4%**
5	Did day one meet your expectations?	Yes	17	17	16	10	**60**	**88.2%**
		Partly	2	2	0	4	**8**	**11.8%**
		No	0	0	0	0	**0**	**0.0%**
6	What session did you like the most?	Introduction	2	0	3	1	**6**	
		Role of Nutrition	9	1	9	6	**25**	
		Nutrients, Soils and Vines	12	0	9	10	**31**	
		Group session: *Sampling*	3	2	4	2	**11**	
		Soil testing	8	4	5	7	**24**	
		Plant testing	10	0	11	6	**27**	
		N	10	6	7	7	**30**	
		P	8	5	4	5	**22**	
		K	6	3	5	4	**18**	
		Group session: NPK	4		4	2	**10**	
7	What session did you like the least?	Introduction	4	0	3	0	**7**	
		Role of Nutrition	0	1	0	0	**1**	
		Nutrients, Soils and Vines	0	0	0	0	**0**	
		Group session: *Sampling*	1	2	1	1	**5**	
		Soil testing	0	4	0	0	**4**	
		Tissue testing	0	0	1	1	**2**	
		N	0	6	2	1	**9**	
		P	0	5	2	3	**10**	
		K	3	3	3	2		
		Group session: NPK	3		2	1		
8	What sessions did you like the most?	Other Nutrients	9	9	7	8	**33**	
		Fertilisers	11	8	9	7	**35**	
		Group session: Cost calculations	4	1	6	4	**15**	
		Group discussion: Fertiliser strategies	3	4	6	10	**23**	
		Group session: Case studies	3	2	7	6	**18**	
		The role of nutrients in wine quality	7	6	4	4	**21**	
9	What sessions did you like the least?	Other Nutrients	2	1	2	0	**5**	
		Fertilisers	2	2	1	1	**6**	
		Group session: Cost calculations	6	5	1	0	**12**	
		Group discussion: Fertiliser strategies	1	0	1	0	**2**	
		Group session: Case studies	1	0	1	0	**2**	
		The role of nutrients in wine quality	2	2	0	2	**6**	
10	Do you think you will be able to use information and apply it to your vineyard?	Yes	15	17	15	13	**60**	**89.6%**
		Partly	4	0	1	2	**7**	**10.4%**
		No	0	0	0	0	**0**	**0.0%**
11	Was this workshop good value for money?	Yes	17	13	16	14	**60**	**88.2%**
		Partly	2	5	0	1	**8**	**11.8%**
		No	0	0	0	0	**0**	**0.0%**
Total number of participants for workshop			20	20	18	16	**74**	

Appendix 5.5: Summary or 'Promises' made 1999-2001

	Promise/Region	1999			2000														2001				TOTAL	%	SECTION TOTAL	%
		Wangaratta	Cowra	Griffith	Adelaide Hills	Barossa	Hobart	Hunter Valley	Langhorne Creek	Margaret River	McLaren Vale #1	McLaren Vale #2	Mudgee	Nagambie	Queensland	Riverland	Robe	Clare	McLaren Vale	Geelong	Ararat				
Monitoring	Monitor for deficiencies/toxicities	2	1			1		1		1	1	2	1		1	1	1		1			**12**	**3.2%**	**41**	**10.9%**
	Observe visual symptoms when interpreting results				1		1	1		1	2	1		1							1	**7.5**	**2.0%**		
	Monitor for N leaching/acidification		1						1							1						**3**	**0.8%**		
	Monitor salinity						1														1	**2**	**0.5%**		
	Monitor pH				2		1						1					1			1	**5.5**	**1.5%**		
	Monitor response to feriliser inputs and vigour		1		1		1	3				1	1	1	1		2					**11**	**2.8%**		
Tissue, soil and water testing	Carry out tissue testing (petiole)	1	1	4	2	2	2	2	3	1		4	1	1	2	1	3	2		3	1	**30**	**8.0%**	**103**	**27.7%**
	Carry out sap testing to monitor seasonal nutrient movement		1	1																		**2**	**0.5%**		
	Own Interpretation of tissue testing results	1								3		1	1	1		1		1				**8.5**	**2.3%**		
	Monitor, tissue testing, interpret data, modify management	2			1	1	2	2		2	4	1	1	1	1	1	1	1		2		**21**	**5.7%**		
	Carry out soil testing	2	1	2	2		2	1	3			2	2				1	1		2	2	**18**	**4.7%**		
	Carry out petiole and soil testing to compare results			3	1	1	2		1	2			1			1	6	5		1	1	**22**	**5.9%**		
	Carry out water testing																1				1	**2**	**0.5%**		
Record Keeping	Improve record keeping	2	1		2	5	3		3	1	2	4	1	2	1		1		5	3	1	**36**	**9.6%**	**49**	**13.1%**
	Investigate options of graphing petiole nutrients over time										1											**1**	**0.3%**		
	Collate histroic data to modify current practices	1				3	1	1		1			2	1			2			1	1	**12**	**3.2%**		
Organics	Determine best covercrop for nutrient addition													1								**1**	**0.3%**	**10**	**2.7%**
	Incorporate/build up organic matter				1				1			1			2							**5**	**1.3%**		
	Trial the use of seaweed/kelp/fish emulsion								1									2				**3**	**0.8%**		
	Investigate organic fertiliser options	1																				**1**	**0.3%**		
Quality	Improve quality of fruit					2		4	3	1			3	3	4	1			1	1		**22**	**5.8%**	**28**	**7.4%**
	Gain greater understanding of N & K in relation to wine quality	2								1					1							**4**	**1.1%**		
	Monitor fertiliser use and effects on quality									1												**1**	**0.3%**		
	Look at N levels and flavour in Shiraz	1																				**1**	**0.3%**		
Extension	Improve involvement/recommendations on client vineyards							1											1			**2**	**0.5%**	**13**	**3.5%**
	Sell fertilisers to clients	1																				**1**	**0.3%**		
	Raise awareness of grapevine nutrition with growers/staff	1		2		1					2	2				1		1				**10**	**2.7%**		

	Promise/Region	1999			2000													2001				TOTAL	%	SECTION TOTAL	%
		Wangaratta	Cowra	Griffith					Langhorne Creek	Margaret River	McLaren Vale #1	McLaren Vale #2	Mudgee	Nagambie	Queensland	Riverland	Robe	Clare	McLaren Vale	Geelong	Ararat				
Fertiliser strategy	Improve timing & application of fertiliser application						1								1		1		1		1	4.5	1.2%	65	17.6%
	More strategic use of fertilisers		5		3	1	2	2	2	1	1		4	1	2	8		3	2			35	9.4%		
	More strategic use of N		3	2				2						1		1			2			11	2.8%		
	Improve/reduce K status															2	1					2.5	0.7%		
	Increase soil P										1		1									2	0.5%		
	Use of micronutrients					2				1								2				5	1.3%		
	Improve fertigation practices					1					1				1	1						3.5	0.9%		
	Obtain independent advice/question fertiliser recommendations and ammend program												1				1					2	0.5%		
Trial	Trial foliar V's soil application of boron							1														1	0.3%	5	1.4%
	Investigate yeild decline on Gewurtztraminer							1														1	0.3%		
	Investigate problems of Merlot and molybdenum												1									1	0.3%		
	Reduce chloride level														1							1	0.3%		
	Assess the use of calcium on berries												1									1	0.3%		
Management	Improve soil structure/balanced soil						1	1									1				1	3.5	0.9%	35	9.5%
	Improve vineyard management and nutrition strategy					2		2		1		1	2		1		1		3	2		15	4.0%		
	Control/reduce vigour							1						1								2	0.5%		
	Establish a healthy vineyard													1	3							4	1.1%		
	Improve the bottom line															1						1	0.3%		
	Improve vine balance (vigour, fertiliser, water, rootstock)				4	1			1							1	2		1			9.5	2.6%		
Update Knowledge	Update nutrient knowledge & apply to management decisions			1	3	2	3	1		1		2			2		1				2	18	4.7%	24	6.5%
	Investigate blade analysis						1									3						3.5	0.9%		
	Investigate local issues with use of reclaimed water																				1	1	0.3%		
	Investigate root penetration						1															1	0.3%		
	Understand more on fertigation			1																		1	0.3%		

Appendix 6: Budget Reconciliation

GRAPE & WINE RESEARCH & DEVELOPMENT CORPORATION

Statement of Receipts and Expenditure - **FORM B**

For the year ending 30 June 2002

Trust Fund :	RESEARCH TRUST FUND	FUNDING	$
Project No :		Salaries	
Grantee :		Travel	
Title of Project :		Operating	
		Capital	
		Total Funding	

EXPENDITURE

	Salaries		Travel		Operating		Capital		Total	
	$	¢	$	¢	$	¢	$	¢	$	¢
A Uncommitted (c/f 1 July)										
B Outstanding Commitments (c/f 1 July)										
C Refunds of funding										
D Cash Received From Trust Fund										
E Approved transfers (from Form C)										
F Cash available (A+B-C+D±E)										
G Expenditure										
H Outstanding Commitments (30 June)										
I Total funds Committed (G-H)										
J Uncommitted (30 June) (F-I)										
K Other income (Paid to Trust Funds)										

Note : *Row B should be the same as Row H from the previous year and Row A the same as Row J from the previous year.*

I hereby certify that this statement of expenditure is correct.

…….. …….. ……..

Signature Printed Name Date