Scoping study: identify research priorities t improve the ability of horticulturalists to manage rootzones for desired outcomes



FINAL REPORT to

GRAPE AND WINE RESEARCH & DEVELOPMENT CORPORATION

Project Number: **UA 02/01**

Principal Investigator: **Dr Cameron Grant**

Research Organisation: **The University of Adelaide**

Date: **December 31st 2002**

Final Report: Project Number UA 02/01 ($15,000)

Project Title: Scoping study: identify research priorities to improve the ability of horticulturalists to manage rootzones for desired outcomes

Organisation: Centre for Root Zone Improvement, The Land Technologies Alliance: University of Adelaide, PIRSA, SARDI, DNRE, CSIRO Land & Water

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Dr Rob Bramley, CSIRO Land & Water, Adelaide
Dr Dean Lanyon, CSIRO Land & Water, Adelaide
Dr Maarten Ryder / Dr Paul Harvey, CSIRO Land & Water, Adelaide
** Please note: members of this Steering Committee worked hard to contact growers for the Workshops and to review reports from the perspectives of growers & industry.*

Horticultural Consultant:
Dr Ben Robinson, Director, Scholefield-Robinson Horticultural Services Pty Ltd

Workshop Facilitator:
Ms Merri Tothill, Project Leader, PIRSA Rural Solutions, Port Augusta, SA.

Time Span: April 1st - December 31st 2002.

Objectives: For three key horticultural industries in southern Australia (viticulture, citrus and annual horticulture) this project aimed to:

- Identify the known rootzone constraints, the cost of these constraints to industry[1], our current knowledge for overcoming these constraints and the level of adoption of these practices.
- Identify the main opportunities for research, development, and extension that would be likely to result in a) overcoming constraints to greater yields and quality of product and b) reduced on- and off-site environmental impacts.
- Recommend the most likely R,D&E opportunities that would provide either the most certain or the greatest potential benefits for improved farm profitability and environmental sustainability.
- Identify the way growers perceived rootzone constraints to production and sustainability, and what management options are currently used to overcome these perceived constraints.

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[1] Cost-to industry: We were unable to canvass this issue properly. However, an economic analysis of land degradation in its various forms is already published in the National Land & Water Audit (2001).

"Scoping study: Identify research priorities to improve the ability of horticulturalists to manage root-zones for desired outcomes"

TABLE OF CONTENTS

ABSTRACT	2
EXECUTIVE SUMMARY (Includes research priorities)	3
BACKGROUND and AIMS	5
PROJECT OUTPUTS and PERFORMANCE TARGETS	6
METHOD	6
RESULTS and DISCUSSION	9
OUTCOMES / CONCLUSIONS / RECOMMENDATIONS	9
APPENDICES:	
1. COMMUNICATION	12
2. INTELLECTUAL PROPERTY	13
3. REFERENCES	-
4. STAFF	13
5. OTHER RELEVANT MATERIAL	14
5.1. Dr Ben Robinson's submission to Steering Committee (Evaluation of Regional & Strategic Workshops grouped according to Industry).	15
5.2. Summary of material presented to participants prior to Strategic Workshop (attached as an Excel file called "Appendix 5-2.xls")	19
5.3. List of participants at *Strategic-Planning Workshop* in Melbourne, Oct 10th 02.	22
5.4. Highest priority outcomes from *Strategic-Planning* Workshop for:	
5.4.1. a) Viticulture Group.	25
5.4.2. b) Citriculture Group.	28
5.4.3. c) Vegeculture Group.	31
5.5. Less-than-highest priority outcomes from *Strategic-Planning Workshop* for:	
5.5.1. a) Viticulture Group	35
5.5.2. b) Citriculture Group	36
5.5.3. c) Vegeculture Group	37

ABSTRACT

This study focussed on research and extension needed to reduce root-zone soil-constraints in horticultural operations. We evaluated the scientific literature and ran eight workshops to identify constraints as perceived by >100 growers, advisers, and researchers. We concluded many problems require technology-transfer to apply what is already known, however we know little or nothing about several root-zone constraints. Ideas for research & extension were prioritised in terms of their likely success in the short- & long-term. The literature review (for scientists), brochures on best practice (for growers and advisers), and some articles for the rural press, will appear during 2003.

EXECUTIVE SUMMARY

This Scoping Study was developed by the *Centre for Root-Zone Improvement* through the *Land Technologies Alliance (**LTA**)* – a group of researchers in PIRSA, DNRE, CSIRO and the University of Adelaide. The project focussed on root-zone (soil) constraints in viticulture, citriculture & vegeculture in southeastern Australian. In addition to in-kind support from the partner organisations in the LTA, this project had financial support from GWRDC ($15,000), HAL ($20,000), PIRSA ($25,000), DNRE ($25,000).

Aims

The aims of the project were, in brief:

- To identify the primary soil-related root-zone constraints, their costs to industry, how they are currently perceived by growers and how widely adopted they are.
- To identify the most certain opportunities for research & extension to increase product yield & quality, & to improve farm-profitability & environmental sustainability.

Approach

To address the **Aims**, a review of the literature was undertaken by Dr Cameron Grant (University of Adelaide), Dr Dean Lanyon (CSIRO Land & Water) and Dr Ben Robinson (Scholefield Robinson Horticultural Services), and used as a basis for discussion at seven *Regional Workshops* held for ~100 growers, advisers and researchers in Loxton, Mildura, Griffith, Camden, Melbourne, Kyabram, and Adelaide over an 8-week period June-August 2002.

All workshops were organised and run by a professional facilitator, Ms Merri Tothill (PIRSA Rural Solutions); members of the *Steering Committee* for this Project identified suitable participants and attended workshops relevant to their professional interests. Participants at the *Regional Workshops* were given a short presentation (based on the literature review) then separated into small groups to address four questions:

1. What soil (root zone) constraints prevent high yield and quality in your industry?
2. What management options exist to overcome these constraints, how adequate are they, and are they sustainable (economically, environmentally, socially)?
3. To what extent (and why) are these management options adopted by growers? What are the primary barriers to adoption?
4. What research and/or extension activities do you consider to be of greatest priority to address root-zone constraints in your industry?

Evaluation

The information gathered at each *Regional Workshop* was assembled by Merri Tothill and forwarded to both Cameron Grant and Ben Robinson so they could distil and evaluate it. Despite the inherent limitations of all workshop material, it was possible to assemble a set of tables for each industry (*cf.* Appendix 5.2) so that priorities for research and extension could be evaluated after consulting the *Steering Committee*.

Strategic-Planning Workshop

The material in Appendix 5.2 was distributed electronically to approximately 25 invited delegates (including researchers, industry advisers, consultants and growers) to allow them to prepare for a *Strategic-Planning Workshop* held in Melbourne on October 10th 2002. At the *Workshop,* delegates were placed in one of the 3 industries & instructed to:

1. Prioritise (High, Medium, or Low) the topics shown in Appendix 5.2 by taking into account the potential degree of *Benefit to Industry* (in Short- or Long-term), and the likely *Feasibility of Achieving the Benefit* (in Short- or Long-term); and…

2. Develop concise ideas for projects that could be considered by research-providers and industry funding-bodies for support in terms of Research, Development, Extension, or Policy-development.

Outcomes

It was agreed by the *Workshop* delegates that only topics with "*High Benefit*" – "*High Feasibility*" ratings would be considered for developing projects – the task would otherwise have been too large for a one-day workshop. (Nevertheless, the responses with lower priority ratings (particularly topics with *Medium Benefit – Medium Feasibility* have been recorded in Appendix 5.5 so that industry funding bodies or researchers can revisit the topics at a later date if they wish).

Recommendations

1. Program managers and IDO's who use the information shown in Appendices 5.4a-c should be aware that the priorities reflect the views of the industry people who attended the various workshops. In some cases these views may be unexpected. For example, R&D work may already be done, policy matters may already be under consideration, and extension material may already exist. For this reason, we inserted a (right-hand) column of "**Qualifying Comments**" in Appendices 5.4a-c to enable users of this document to evaluate the suggested research projects. We would expect this material to be reviewed, perhaps by Research Advisory Committees for each Industry. Where the results are unexpected it may point to a need for targeted changes in the extension approach being used within an industry.
2. Of the ten issues requiring research or extension in soil management, 3 were found to be common to all industries: i) problems managing soil structure, ii) problems managing crop nutrition, and iii) problems managing organic matter and soil biota especially, but not exclusively, in relation to cover-crops. We recommend that projects addressing these problems be given serious consideration and priority by GWRDC, HAL and other relevant research-funding bodies.
3. In Viticulture, two issues needing attention (in addition to those outlined in 2. above) were found to be: i) problems managing soil variability, and ii) problems managing irrigation. We therefore recommend these two problems receive priority and strong support from GWRDC (and HAL where appropriate) in both research and extension projects.
4. In Citriculture, three issues needing attention (in addition to those outlined in 2. above) were found to be: i) problems managing poor re-plant vigour, ii) problems managing soil variability, iii) problems matching rootstocks with hostile soils, plus a wide range of miscellaneous problems, which reflected a great need for technology-transfer and education in this industry.
5. The citrus industry has lost much of its good land to viticulture in Australia over the last 10 years and it has taken with it a lot of relevant soils expertise. This needs to be redressed, and we believe some considerable effort may be required to re-generate technical support for the citrus industry, and so the projects identified in Recommendation 4. above should include postgraduate training to PhD level.
6. In Vegeculture, two issues needing attention (in addition to those outlined in 2. above) were found to be: i) problems managing irrigation water, and ii) use and management of reclaimed grey water. To some extent, these are issues in technology transfer, and so we recommend support from HAL for extension work in these areas.

---------- END OF EXECUTIVE SUMMARY ----------

BACKGROUND and AIMS

This study arose from a two-day workshop organised in May 2001 by the *Centre for Root-zone Improvement (Land Technologies Alliance)* in Mildura, for researchers interested in root-zone constraints in horticultural soils, plus representatives from HAL, GWRDC, CSIRO, DNRE and PIRSA. There was wide agreement at this meeting that plant establishment and growth in horticultural industries can be severely limited by adverse soil biological and microbiological environments, degraded soil structure (causing reduced infiltration, aeration and drainage), and hostile soil chemical environments. Such constraints lead to lower water- and nutrient-use efficiencies and inevitably result in lower productivity, profitability, and sustainability. The complexity of the soil-plant interactions, however, meant that no agreement could be reached as to which problems might best be solved first.

It was concluded a thorough review of the literature was required and that broader consultation with growers, scientists, industry leaders and consultants would facilitate a clearer picture of where our efforts would best be spent to reduce root-zone constraints in the viticulture, citriculture and vegeculture industries of southeastern Australia.

It was agreed that a limited *Scoping Study* should be supported to identify research that would assist horticulturalists to better manage root-zone limitations and to increase productivity (yield and quality) while also reducing environmental impacts.

It was also agreed that the *Scoping Study* would highlight any requirements for better technology-transfer to close the gap between current and best management practices in horticulture.

The project proceeded with support from DNRE, PIRSA, CSIRO, University of Adelaide, GWRDC & HAL for a one-year project, having the following **Aims** (summarized briefly):

- To identify the primary soil-related root-zone constraints, their costs to industry, how they are currently perceived by growers and how widely adopted they are.

- To identify the most certain opportunities for research & extension to increase yield & quality of farm-produce, and to improve farm-profitability and environmental sustainability.

A *Steering Committee* was formed comprising members of the ***LTA*** who were willing and able to contribute significantly in time to the scientific, logistical, and organisational running of the Project.

[**Note from Principal Investigator:** The *Steering Committee* turned out to be a very effective body, particularly in relation to constructive criticism and direction offered at meetings, in written reports, in person, by email and over the telephone during 2002. The names of the people on the *Steering Committee* are listed at the beginning of this Report and they are to be commended for their hard work. The ***LTA*** partners should be pleased with the outcomes of this project, which would not have been possible without the time and effort committed by their staff. CDG].

PROJECT OUTPUTS & PERFORMANCE TARGETS

The five Outputs and Performance Targets planned for this Project (as given in the application) are listed and assessed in the Table below, along with an additional Output, which will be produced and reported on during 2003.

Outputs	Performance Targets	Assessment
Consultation	6 x regional workshops conducted representing at least 100 growers by Sep 30/02	7 x regional workshops were held between June and August, with >100 participants in Loxton, Mildura, Griffith, Camden, Kyabram, Melbourne, Adelaide
Consultation	1 x strategic planning workshop representing ≥20 scientists & key growers conducted by Oct 31/02	1 x strategic planning workshop with ~25 scientists and growers was held Oct 10th 2002 in Melbourne.
Literature Review	A review of the major research and review articles, government reports & funding-agency-commissioned reports, written by Nov 30/02.	A review of the relevant literature has been conducted, and is in the final stages of being written for publication in a refereed scientific Australian journal – it will be submitted during the first quarter of 2003.
Information booklet	5,000 information booklets printed and distributed by July 30/02.	The year 2002 was wrong – should be 2003(!), as Project funding not approved until October 2002. Draft information booklets have been prepared for each industry, called: *"14 Key Steps to getting Root Zone Management Right in (Viticulture/ Citriculture/Vegeculture)"*. Drafts are shown in Appendix 5.6 with the intention to publish by July 2003.
Final Report	A final report summarising workshops, industry consultation & literature review by Dec 31/02.	Final report submitted by mid-February 2003.
Additional reporting	Not planned originally	In addition to the information booklets, we have a series of articles prepared for the rural press that will be released during 2003 to promote some industry seminars arising from this project – no additional funds requested.

METHOD

A review of the scientific literature was undertaken by Dr Cameron Grant (University of Adelaide), Dr Dean Lanyon (CSIRO Land & Water) and Dr Ben Robinson (Scholefield Robinson Horticultural Services), and this formed the basis for discussion at 7 *Regional Workshops* held for ~100 growers, advisers and researchers in Loxton, Mildura, Griffith, Camden, Melbourne, Kyabram, & Adelaide over the 8-week period June 21–Aug 22 '02.

All workshops were organised and run in consultation with a professional facilitator, Ms Merri Tothill (PIRSA Rural Solutions). At least one member of the *Steering Committee*

for this Project attended every workshop. Participants at the *Regional Workshops* were given a short presentation (based on the *Literature Review*) then arranged into small groups to address four questions:

1. What soil (root zone) constraints prevent high yield and quality in your industry? (viticulture, citriculture, or vegeculture).
2. What management options exist to overcome these constraints, how adequate are they, and are they sustainable (economically, environmentally, socially)?
3. To what extent (& why) are these management options adopted by growers? What are the barriers to adoption?
4. What research and/or extension activities do you consider to be of greatest priority to address root-zone constraints in your industry?

Evaluation of the information collected

The information gathered at each *Regional Workshop* was quite substantial, and it was assembled by Merri Tothill then forwarded to both Cameron Grant and Ben Robinson to evaluate. In doing so, we took into account a number of factors (as explained in Ben Robinson's reports – *cf.* Appendix 5.1), including:

- Topics from the *Regional Workshops* ranged in quality from rather off-the-cuff remarks on the one hand, to very clearly considered ideas on the other.
- Some (more dominant) individuals at *Regional Workshops* promoted research for their own particular interests/problems, and in some cases, the technology to solve the problems already existed but was not being applied for one reason or another.
- Topics were defined rather broadly at the *Regional Workshops* and sometimes lacked a concrete focus in terms of what research or extension could be done.

Despite these limitations, it was possible to draft the *Regional Workshop* material into tabular format for each industry (viticulture, citriculture, vegeculture), containing several columns as follows (with an example):

Broad Issues	Observations on Broad issues (from Regional Workshops)	Possible Responses to Observations	Response Number	Benefit to Industry		Feasibility of Achieving Benefit	
				Short-term	Long-term	Short-term	Long-term
Example: Poor soil structure	Compaction, hard-setting, coalescence are all difficult to manage even with careful tillage	Research to develop management systems maintain good soil structure.	1	High	High	Medium	High

The tabulated material was presented to the *Steering Committee* for its consideration and discussion, after which, a preliminary priority-setting exercise was conducted with the *Steering Committee*, and the information distilled into that shown in Appendix 5.2 for use at the (final) *Strategic-Planning Workshop* held in Melbourne, October 10th 2002.

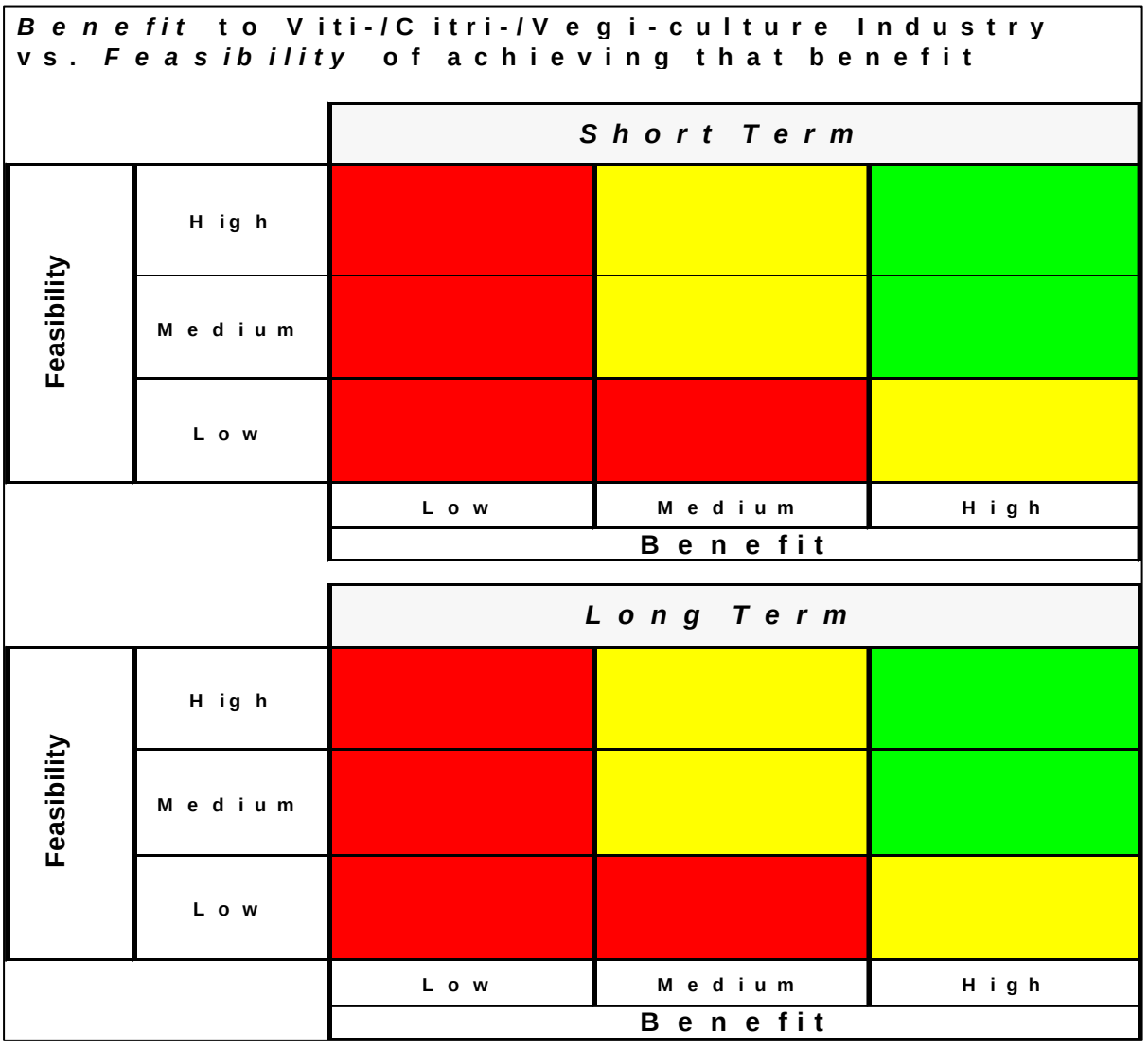
Strategic-Planning Workshop

Approximately 25 delegates (researchers, industry advisers, consultants and growers – names shown in Appendix 5.3) were selected to represent a broad cross-section of the three industries, having a particular interest in research and technology-transfer. The material in Appendix 5.2 was distributed electronically to these delegates (including researchers, industry advisers, consultants and growers) to allow them to prepare for the *Strategic-Planning Workshop* (held in a meeting room at the Hilton Melbourne Airport, to reduce travel time and costs for interstate delegates).

Instructions to delegates

Cameron Grant briefly presented the *Steering Committee's* findings and then gave the following three instructions to the delegates (divided into their industry groups), which were to be conducted during the day:

1. Prioritise the various topics for your industry using material shown in Appendix 5.2 (colour hard-copy was supplied on the day) plus the blank 3 x 3 matrix showing ***Benefit to Industry*** (in Short- or Long-term), and the ***Feasibility of Achieving Benefit*** (in Short- or Long-term), given below. Place each ***Response Number*** from your copy (of Appendix 5.2) into one or two of the 9 boxes in both of the 3 x 3 matrices below. Responses placed into **green** boxes are considered to be of *high benefit* and *medium-to-high feasibility*. Those placed into yellow boxes are considered to be of *medium-to-high benefit* and *medium-to-high feasibility*. Those placed into red boxes are considered to be of *low-to-medium benefit* regardless of feasibility.



2. Raise any glaring omissions that you find in the material you received prior to the Workshop, and clarify any ambiguities you encounter.

3. Develop concise ideas for projects, which could be considered by research-providers and industry funding-bodies for support in terms of Research, Development, Extension, or Policy-development.

RESULTS and DISCUSSION

Within the limitations of a one-day meeting, the delegates quickly grasped their allotted tasks with good humour and stayed within the time framework provided. When Tasks 1 and 2 were completed by the three industry groups, it was agreed that only topics which were rated *High Benefit* and *Medium-to-High Feasibility* would be considered for the purposes of developing projects in Task 3. Nevertheless, the other responses (obtaining lower priority ratings) are found in Appendix 5.5, because industry funding bodies and research providers may wish to re-visit the topics at a later date, particularly topics with ratings of *Medium-to-High Benefit* and *Medium Feasibility*.

Evaluating the material generated from the *Strategic Workshop* was more difficult than expected, because despite the instructions provided, each group approached the tasks in a slightly different way. The outputs from the Viticulture Group and the Citriculture Group, for example, were highly focussed, so it was possible to adopt the material virtually in the form it was presented after the Workshop (Appendices 5.4a & b). The outputs from the Vegetables Group (Appendix 5.4c), however, needed some work to bring it into the same format that the other two groups produced. To do this, we relied upon the material provided in Appendix 5.2 (Issues & Priorities), then used the priority-weightings given by the Vegetable Group in their broad-brush comments produced at the *Strategic Workshop*, plus our own ideas on projects to address their comments.

Program managers and IDO's who use the information shown in Appendices 5.4a-c should be aware that the priorities for research and extension reflect the views of the industry people who attended the various workshops. In some cases these views may be unexpected. For example, R&D work may already be done, policy matters may already be under consideration, or extension material may already exist. For this reason, we inserted a column of "**Qualifying Comments**" in Appendices 5.4a-c. This should enable users of the document to evaluate the suggested research projects more effectively. We would, however, expect this material to be reviewed, perhaps by Research Advisory Committees for each Industry. Where results are unexpected it may point to a need for changes in the extension approach being used within an industry.

OUTCOMES / CONCLUSIONS / RECOMMENDATIONS:

Ten major soil problems

In relation to the original aims of the Project (*viz.* to identify soil-based root-zone constraints, their impact on industry, their perception and management by growers, plus opportunities for research and extension), the most valuable tools were the *Literature Review* and the material gathered at the *Regional Workshops* and the *Strategic Workshop*. Through these, we identified 10 major soil-related root-zone constraints (plus 3 constraints not related to soils), which are poorly understood and require either research or more targeted extension efforts.

Some of the identified constraints were common to more than one industry. For example, participants found that all 3 industries were constrained by problems classed in the following three broad topics:

1. Problems managing soil structure.

2. Problems managing soils for crop nutrition.

3. Problems managing soil organic matter and soil biota.

In addition, both viticulture & vegeculture industries were thought to be constrained by:

4. Problems managing irrigation water.

Furthermore, both viticulture & citriculture industries were thought to be constrained by:

5. Problems managing soil variability, particularly in relation to water and nutrients.

Finally, five problems specific to the citriculture industry were considered as serious limits to sustainability:

6. Poor re-plant vigour.

7. Rootstock selection in relation to soil type.

8. Appropriate Environmental Management Systems for citrus.

9. Problems managing soil acidification.

10. Problems with water quality and effects on soils (becoming more saline).

Three additional problems were industry-specific and not necessarily related to soils:

11. Use & acceptability of reclaimed grey water for irrigation of vegetables.
12. Techniques for *Integrated Farm Management* in citriculture.
13. Grower training and eduction in citriculture.

This above list of problems has purposely been presented in a rather general format for the benefit of readers trying to gain a broad perspective of the needs for research and extension in Australian horticulture.

Readers with more specific interests in viticulture, citriculture or vegeculture should view the more detailed material presented for each industry in Appendix 5.4a (viticulture), Appendix 5.4b (citriculture), or Appendix 5.4c (vegeculture). [In this report we attempt to strike a balance between presenting too much information which might overwhelm the reader, and simplifying things to such an extent that it is rendered useless to each industry]. If you are a reader evaluating research-grant proposals in viticulture, citriculture or vegeculture, the detail shown in the Appendices will be most useful and we commend their contents for your perusal. They identify specific activities or projects that deserve consideration for support in either research or extension.

Consultation: Extra Regional Workshop

We originally planned to run only six *Regional Workshops* but an additional, seventh, was run to accommodate the demand raised by industry groups where they could not be combined with other industries / locations / times (mainly in Riverina and Riverland districts). We had not anticipated the extra workshop and some additional expenses were incurred as a result; these have all been covered by the University of Adelaide.

Consultation: Strategic Planning Workshop

This was a successful event held for ~25 scientists, growers and other industry personnel in Melbourne. With assistance from our horticultural consultant, Dr Ben Robinson, the strategic information on the needs for research and extension gathered at this workshop was highly focussed and usable. After much discussion by the *Steering Committee*, it was decided that the detailed material summarized by Ben Robinson for each industry should not be diluted further – the three industries involved were considered to be in a better position to generalise the information where they saw fit to do so.

Consultation: Workshop Attendance

Interest in the Workshops was very encouraging, and ~25 people/workshop committed to attending (by telephone, in writing or by email). We checked for possible conflicts while planning the Workshop dates and accommodated various participants where possible. On the day of each workshop, however, we were surprised at how many people pulled out (or simply didn't show up). Nevertheless, we met and consulted with over 100 IDOs, growers, consultants, and other industry personnel during the Project and participants were offered follow-up contact (a report on their Workshop). We had good feedback from many attendees.

Literature Review

Much of the work on the Literature Review was conducted early in the project by Cameron Grant, but additional new material continued to surface during the project (particularly in relation to costs of land degradation to industry) and is being incorporated into a review paper, which will be submitted to GWRDC and HAL when completed during the first quarter of 2003. This Literature Review will also be submitted for publication in the *Australian Journal of Agricultural Research,* and is aimed primarily at industry scientists.

Industry Information Booklets / Brochures

This was the subject of much discussion by the *Steering Committee*, which debated the content and format required. In the end, an executive decision was made to proceed with some ideas suggested by our consultant, Dr Ben Robinson, and the *Brochures* are currently in draft form for each industry – they will be finalised and printed by July 2003. It should be noted that the date for publication of these *Brochures* was listed in the application as July 2002, but this was a typographical error – the project had only just started at that time!

Costs of root-zone constraints to industry

One of the aims of this project was to get a handle on the costs to industry of the various root-zone constraints – it was hoped an explicit value could be placed on soil-based limitations. This, however, turned out to be a far greater task than anticipated and we were unable to canvass the issue beyond what has already been published in the National Land and Water Resources Audit, and this was not raised at any of the Workshops. As mentioned above, however, economic issues will be raised in the Literature Review.

APPENDIX 1: COMMUNICATION:

Reporting in 2002

Outcomes were reported to industry during 2002 in several different ways:

- Reports to *Regional Workshops* as new findings came to light.
- An article was written about the Project for the industry magazine, *Citrus Insight*
- An article was written about the Project for the industry magazine, *Vegetables.*
- An article was written for a DNRE vegetable-industry review.
- Cameron Grant presented an oral paper on the outcomes of the Project at the Australian Society of Horticultural Science Conference at University of Sydney on October 2nd 2002.

Reporting in 2003

Outcomes will be reported in 2003 in the following ways:

- Articles for the rural press during 1st quarter of 2003.
- Industry brochures to be released by July 2003.
- *Review article* to be submitted for publication during 1st quarter of 2003 in the *Australian Journal of Agricultural Research* entitled: "Root-zone constraints as limits to sustainable production in citrus, grape and vegetable industries of south-eastern Australia: A review". This is co-authored by Cameron Grant, Dean Lanyon, and Ben Robinson.
- Industry talks to be given to citrus, grape and vegetable growers, depending on availability of time and funds.

APPENDIX 2: INTELLECTUAL PROPERTY:

The primary intellectual property gained from this *Scoping Study* is the collation of a large number of potential research ideas/projects that can be used by researchers and extension people to prepare research-grant applications over the next several years. It may be particularly useful to new scientists wanting to contribute to horticultural research in Australia.

There is also a draft-manuscript entitled: "**Root-zone constraints to sustainable production in citrus, grape and vegetable industries of south-eastern Australia: A review**", co-authored by C.D. Grant, D.M. Lanyon, and J.B. Robinson. We will submit this paper for publication in the *Australian Journal of Agricultural Research* during 2003.

APPENDIX 3: REFERENCES

(No references cited)

APPENDIX 4: STAFF

Name	Activities	Paid from project?
Dr Cam Grant, University of Adelaide	Project leader, senior author in Literature Review, Preparation of material for *Strategic-Planning Workshop*, Final report writer.	Yes
Ms Merri Tothill, PIRSA Pt Augusta, SA	Workshop facilitator; organization of workshop-venues, equipment, invitations, refreshments for delegates, preparation of Regional Workshop reports, other…	Yes
Dr Ben Robinson, Scholefield-Robinson Horticultural Consultants	Project consultant, evaluation of all reports, preparation of material for information booklets, co-author Literature Review	Yes
Mr Rob Guy (casual assistant)	Assistance in retrieving reference citations from library for the Literature Review	Yes
Dr Paul Dalby, PIRSA Adelaide, SA	Project coordinator, chairman *Steering Committee*	No
Dr Rob Bramley, CSIRO L&W	*Steering Committee*	No
Dr Dean Lanyon, CSIRO L&W	*Steering Committee*, co-author Literature Review	No
Dr Maarten Ryder, CSIRO L&W	*Steering Committee*	No
Dr Paul Harvey, CSIRO L&W	*Steering Committee*	No
Dr Peter Fisher, DNRE Tatura, VIC	*Steering Committee*	No
Ms Angelika Zierhl, DNRE Knoxville, VIC	*Steering Committee*	No
Mr Gerrit Schrale, PIRSA Adelaide, SA	*Steering Committee*	No

APPENDIX 5: OTHER RELEVANT MATERIAL

This section contains the following five separate Appendices:

Appendix 5.1
Dr Ben Robinson's submission to the Steering Committee (Evaluation of Regional & Strategic Workshops grouped according to Industry)

Appendix 5.2
Summary of material presented to participants prior to *Strategic Workshop* (attached as an Excel file called "Appendix 5-2.xls").

Appendix 5.3
Participants at *Strategic Workshop*, Melbourne, October 10, 2002.

Appendix 5.4
Highest Priority Outcomes from Strategic Workshop (grouped by industry).

Appendix 5.5
Lower Priority Ratings from Strategic Workshop (grouped by industry).

Appendix 5.1

Dr Ben Robinson's submission to the *Steering Committee*
Evaluation of Regional & Strategic Workshops grouped according to Industry

Introduction

Reports from 7 Regional Workshops were supplied to me for evaluation – these Reports summarised the proceedings of the Workshops in which groups of Growers, Extension Officers, Research Scientists, and Consultants participated at the following locations:

Date	Location	Crops covered
21 June 2002	Loxton, SA	Vegetables, Citrus
28 June 2002	Mildura, VIC	Citrus, Grapes
19 July 2002	Griffith, NSW	Grapes, applicable to Citrus
1 August 2002	Sydney (Camden), NSW	Vegetables, Citrus
8 August 2002	Melbourne, VIC	Vegetables (potatoes and others)
15 August 2002	Kyabram, VIC	Grapes, Vegetables (tomatoes)
22 August 2002	Adelaide, SA	Grapes, Vegetables

In evaluating the Reports, I took into account the following characteristics of workshop-priorities developed in this study:

- Thoughts coming *off the top of mind* were very prevalent (this might provide a reason for the focus on salinity in some of the workshops)
- Individual growers & others were able to influence the outcomes according to their own agendas or in the direction of their particular interests.
- Topics were defined rather broadly instead of being focussed on what could be easily done in research or extension programs.
- Topics were sometimes seen as being very important by participants at a given Workshop, even though the science or technology to deal with them already exists, but is not being applied for one reason or another.

The information from the *Regional Workshops* was presented to me in an evolving format, and the content was often wide in scope. One of the members of the *Steering Committee*, Mr Gerrit Schrale, commented that the reports from the *Regional Workshops* reflected a "lack of basic training and skills on the part of growers, and that many participants seemed to express a cry for help for (largely existing) knowledge and lack thereof at the leading grower level". My initial reaction was similar to Mr Schrale's. In the *italicised material* below I have summarized the issues raised from the *Regional Workshops* by industry. Questions that came to me when I read the reports are highlighted in **bold-face type**.

Issues from Viticulture Workshops

- ***Do we really want (or need) to remove root zone constraints in all cases?*** *Production of quality wine grapes sometimes requires that vine potential be restricted in some way. What seems clear is that:*
  - *Need for soil to be predictable(?)*
  - *Salinity and RDI do not seem to be well understood.*
  - *Wheel track compaction may or may not be a problem.*
  - *Cover-crop competition vs. no cover-crops in dry areas. Roles of cover-crops need either research or extension inputs.*
  - *Soil biology is seen as good, but not understood in relation to organic matter.*

    - *Acidity and/or alkalinity were raised as problems at different places even though methodology to manage these soil characteristics are available.*
    - ***How to stabilise amelioration (eg mounding and ripping)?***
- *There is frustration with perceived problems with soil testing (not predictive enough) and plant tissue testing (lack of acceptance of limitations in perennial crops)*
    - ***Where does one focus on the 'growth-response curve' (eg out on flat part of curve or on the rising leg?)***
- *Drainage and salinity work has been done at many levels but there seem to be cries for help**. Is this related to insecurity about water in this drought year?***
- *The potential nutrient content in grey water from wineries and waste-water treatment plants is not being taken into account properly.*
- *Soil variability is frustrating to growers but a fact of life in most districts.*
    - *What level of uniformity can be achieved economically?*
    - *What scale should we be thinking about?*
    - *Hence soil survey approach needs refinement*
    - *Note that better growers manage blocks with different soils differently.*
- *Grape marc compost presents some unknowns in the short and long term*
- *Cover crop management is not well understood (competition, place in arid zone vineyards with drip irrigation etc.)*

Issues from Citriculture Workshops

- ***Some 'agendas' were not easy to understand (eg.):***
    - *Capillary action*
    - *Soil temperature*
    - *Cover cropping etc where drip irrigation is used*
    - *"Hideous chemicals" involved in soil amelioration.* ***What are these?***
- *Open Hydroponics presents a number of challenges:*
    - *Input / output*
    - *Long term impact on soil chemistry*
    - *Where does the leachate go?*
- *Growers are frustrated that nutrition is not an exact science* ***(but my guess is there is a lot in literature from the 1960s and 1970s that has not been used by the current younger generation of managers)***
- *Growers are frustrated that soils vary.* ***The research challenge here may be to show the extent to which soil modification can be used to minimise the extent of variation in crop performance.***
- *Salinity and drainage are mentioned as problems in most meetings, yet there is not a lot of new information needed to deal with these.* ***Is this really a reaction to limited water availability and the drought this year?***
- *Specific R&D topics that come through seem to include:*
    - *Stabilising soil after amelioration (eg ripping or mounding).*
    - *Cover-cropping and drip irrigation*
    - *Soil pH and citrus quality?*
    - *Are root-zone constraints from soil compaction in traffic zone a real problem?*
- *pH management. There are very limited areas of very acidified soils in citrus growing districts.* ***We know lime can be used to raise pH in sandy soils easily (observation on Messenger property at Colignan) but this information may not be widely understood.***

Issues from Vegeculture Workshops

- *Each soil type provides a separate problem in managing irrigation or drainage, but the difficulties that are reported seem to be related to uncontrolled irrigation and the limited flexibility of centre pivot irrigation leading to various soil-specific problems, including:*
    - *Waterlogging on duplex soils (eg. Sand over clay).*
    - *Compaction due to poorly-timed cultivation on red clays.*
    - *Problems with infiltration, waterlogging and compaction on heavier clay soils.*
    - *Do 'full-stop' irrigation monitors have a place here?*
- *Growers are frustrated that soils vary.* ***Can soils be made more uniform by management, alternatively should we define variability and irrigate to suit?*** *Centre Pivots systems received some derogatory comments in relation to the inability to vary application rates where soils vary around the circle.*
- ***Clearly the level of understanding of the nutritional requirements of vegetable crops is patchy. Eg while Norbert Maier's work in SA provides well based soil test and plant analysis data, this may not be seen as useful or is simply not used in Victoria (cf. Melbourne workshop).***
- ***There will always be problems in developing good standards for new crops & minor crops, but a huge data-base is available. Conflict is noted between soil test recommendations & leaf test recommendations. This may be real or due to interpreter ability (qualifications).***
- *Excessive fertiliser-use is at last being recognised as a problem.*
- *Use of reclaimed water is accepted in SA but is meeting some resistance in Victoria in relation to issues of perceived safety, accumulation of heavy metals and other contaminants.* ***Is there a credible basis for this difference in attitude?***
- *Various problems with soil borne diseases exist within each crop.*
- *Profitable rotations are not well understood.*
- *Environmental impact (eg. Nutrient-loss) warrants consideration.*
- *Organic matter, manures (QA risks), composts are not well understood.*
- *Soil management (eg use of beds) varies in sophistication between States and regions.* ***Is this related to variation in regional soil-types, or is this a general issue for R&D?***

Non-technical issues in vegeculture

There seemed to be a subset of non-technical issues:

- *Accreditation of advisers (eg in plant nutrition)*
- *Other ways to match or standardise approaches to interpreting soil- and plant-tests across Australia (eg. frustration about varying recommendations and responses).*
- *People grow crops on marginal soils and then expect it to be easy (eg. see vegetables and the associated quality- and irrigation-related problems).*
- *Environmental management (EMS) policies.*

Economic analysis should be considered as one approach to setting priorities (eg what sorts of additional costs can come from overuse of fertilisers, or inappropriate irrigation-scheduling on variable land?)

EVALUATION OF REPORTS FROM *REGIONAL WORKSHOPS*:

We (Ben Robinson and Cameron Grant) tried several different approaches during September to prioritise and synthesize the topics raised at the seven *Regional Workshops*. In early October, a tabular approach was agreed upon, and a draft document prepared for discussion at a meeting with the *Steering Committee*.

Following this meeting, Cameron Grant took the ideas, which had partly been developed with me, and assembled them into tables for use at the *Strategic Workshop* held in Melbourne. These tables were an extraordinary achievement and made the deliberations of the delegates from the three industries at the *Strategic Workshop* relatively easy. (see Appendix 5.2a-c).

STRATEGIC WORKSHOP – October 10th 2002, MELBOURNE AIRPORT

The delegates to the *Strategic Workshop* were divided into three groups according to their primary interests: Viticulture, Citriculture or Vegetables (members of each group are listed in Appendix 5.3) and they were instructed to do the following things:

- Prioritise (into High, Medium, or Low priority) the various topics drawn from the *Regional Workshops* for their industry group. This was carried out in light of the priority-setting exercise already conducted by the *Steering Committee*, which took into account ***Benefit to Industry*** (in Short- or Long-term), and the ***Feasibility of Achieving Benefit*** (in Short- or Long-term).
- Raise any glaring omissions and clarify any ambiguities.
- Develop concise ideas for projects, which could be considered by research-providers and industry funding-bodies for support in terms of Research, Development, Extension, or Policy-development.

OUTCOMES OF *STRATEGIC-PLANNING* WORKSHOP

Within the limitations of a one-day meeting, the delegates set about their allotted tasks with good humour and the results were pleasing particularly in relation to the evaluation of priorities and the likely success of outcomes. In the end, it was agreed that only topics that were given a rating of **High Benefit** / **High Feasibility** would be considered for the purposes of developing projects. Nevertheless, the other responses (obtaining lower priority ratings) are found in Appendix 5.5 because industry funding bodies and research providers may wish to revisit the topics at a later date, particularly those topics with a priority-rating of ***Medium Benefit / High Feasibility*** and ***High Benefit / Medium Feasibility***.

Evaluating the material from the *Strategic Workshop* was more difficult than expected, because despite the instructions provided, each group approached the task in a slightly different way. The outputs from the Viticulture Group and the Citriculture Group were highly focussed and it was possible to adopt the material virtually in the form it was presented after the Workshop (Appendices 5.4a & b). The outputs from the Vegetables Group (Appendix 5.4c), however, needed some work to bring it into the same format that the other two groups produced. To do this, we relied upon the material provided in Appendix 5.2 (**Issues & Priorities**), then used the priority weightings given by the Vegetable Group with their broad-brush comments on the day of the *Strategic Workshop*, plus our own ideas on projects to address their comments.

Furthermore, an additional column of **Qualifying Comments** has been inserted in Appendix 5.4a-c -- these are primarily my comments (Ben Robinson), so users of this document may wish to contact me for further clarification. My email address is: <ben.robinson@srhs.com.au>.

IMPORTANT NOTE:
Program managers and IDO's who use the information shown in Appendices 5.4a-c should be aware that the priorities listed there reflect the views of the industry people who attended the various workshops -- in some cases these may be unexpected. For example, R&D work may already have been done, or Policy matters may be under consideration, or Extension material may already exist etc. We would expect Appendices 5.4a-c to be reviewed, perhaps by the Research Advisory Committees of each Industry. Where the results are unexpected it may point to a need for targeted changes in the extension approach being used within the industry.

Appendix 5.2
Summary of material presented to participants
prior to *Strategic Workshop*

(Attached as an Excel file called "Appendix 5-2.xls")

Notes

- Material in this Appendix Table is tabulated according to industry; each industry is colour-coded (eg. Viticulture, Citriculture, Vegeculture).

- Sections called *Issues* and *Observations* were distilled from the *Regional Workshops* and combined with *Suggested Responses* from *Steering Committee*.

- The Excel file was distributed in advance (electronically) to all participants for use at the final *Strategic-Planning Workshop*

- Space was provided in each industry-Table for delegates to prioritise the suggested responses in terms of Benefit to Industry and Feasibility of Achieving Benefit in the Short-term or the Long-term

Viticulture (see Excel file)

Citriculture (see Excel file)

Vegeculture (see Excel file)

Appendix 5.3

Participants at *Strategic-Planning Workshop* on Root-Zone Constraints
Melbourne, October 10th 2002.

VITICULTURE	CITRUS	VEGETABLES
Ann-Marree Boland (DNRE, CRC Vit)	Cameron Grant (Uni Adelaide; facilitator)	Peter Cornish (Uni Western Sydney)
Rob Bramley (CSIRO)	Shane Phillips (Tandou Ltd)	Bruce Dalgleish (Agric Mgmt Consultant)
Paul Dalby (PIRSA, facilitator)	Ben Robinson (Scholefield-Robinson)	Peter Fisher (DNRE)
Gayle Grieger (CRC Vit)	Kelvin Voullaire (Grower, SA)	Craig Fuetrill (IDO - SA Vegetable Ind)
Richard Hamilton (Southcorp)		Liz Mann (IDO - APTRC)
Mike McCarthy (SARDI)		Barry Philp (PIRSA)
Rob Stevens (PIRSA/SARDI)		Ian Porter (DNRE)
Robert White (Uni Melbourne)		Maarten Ryer (CSIRO)
		Merri Tothill (PIRSA, facilitator)
		Trevor Twigden (Wesfarmers Landmark)
		Angelika Ziehrl (DNRE)

People invited, but unable to attend:

VITICULTURE	CITRUS	VEGETABLES
DeAnn Glenn (GWRDC)	Leigh Sparrow (HAL)	Harold Adem (DNRE)
Brian Loveys (CSIRO)	Gerard McEvilly (HAL)	Ian Goodwin (DNRE)
Mike Treeby (CSIRO)	Phil Nicholas (PIRSA)	Wendy Morgan (DNRE)
Peter Clingeleffer (CSIRO)	Peter Gallasch (PIRSA)	Norbert Maier (SARDI)
Rob Walker (CSIRO, CRC Vit)	Ashley Lipman (IDO -PIRSA)	Richard Stirzaker (CSIRO)
Steve Tyerman (Univ. Adelaide)	Ken Bevington (NSW Ag)	Peter Lyons (Grower, VIC)
John Blackwell (CSIRO)	Pat Barkley (NSW Ag)	Paul Frost (SAFries)
Jeff Dance (McWilliams Wines)		
Bill Slattery (NRE / Univ. Melbourne)		
Dean Lanyon (CSIRO)		

Appendix 5.4:

Highest Priority Outcomes from Strategic Workshop
(i.e. High Benefit / High Feasibility)
for

a) Viticulture

b) Citriculture

c) Vegeculture

Note:
As indicated in the tables shown below, some of the activities are highlighted in blue ink. This indicates they constitute potential extension projects, as opposed to research projects.

Appendix 5.4a:
Highest Priority Outcomes from Strategic Workshop (i.e. High Benefit / High Feasibility)
Viticulture Group

General Issue from *Regional Workshop*	**Observation** on General Issue from *Regional Workshop*	**Priority** to address Observation	**Activity** (to address Priority) (NB: Blue activities are largely extension projects)	**Feasibility of Activity**		**Qualifying Comments (by Ben Robinson)**
				High, Medium or Low	Short- &/or Long-term	
Soil structure	Compaction, hard-setting, coalescence are all difficult to manage even with careful tillage.	To maintain soil structure against slumping & compaction due to traffic & irrigation.	Research to develop a tool kit & management system (chemicals, organic matter, mechanical action, water retention gels, primer crops) to maintain good soil structure.	High	Short- & Long-term	**Compaction etc can be a problem on a range of soils, but the causes can be different (Structure per se, sodicity, compation etc) so the task varies from district to district.**
Soil variability	What scale is important for irrigation design?	To understand nature & extent of factors controlling soil variability.	Watch for outcomes from Rob Bramley's project.	Medium	Long-term	**Industry-expectations may be unrealistic in terms of what can be done to eliminate soil variability.**
	Many growers (particularly small) hesitant to use precision agriculture tools & processes.	To demonstrate economic benefits of precision agriculture to growers.	Demonstrate how to manipulate water supply to meet yield/quality requirements based on inherent soil variability in trial carried out in collaboration with growers as an industry demonstration.	High	Short-term	**This assumes the major cause of variability across vineyards will be water-related. (probably the case for yield).**
	Mapping of variability occurs, but information not being used effectively.	To produce guidelines for soil variability sensing.	Watch for outcomes from Rob Bramley's project.	High	Short-term	**Potential for cross over with irrigation & drainage policy here.**
Crop nutrition	Growers do not understand how to manage nutrition for grape quality.	To develop protocols for fertiliser recommendations based on petiole sampling & analysis.	* Review (significant) work done in France on relationship between crop nutrition & wine quality. * Research to understand links between quality/quantity & crop nutrition in Australian conditions.	High High	Short-term Long-term	**One issue here may be the need to feed the vine N to feed the yeast in Europe vs the ability to add DAP here.** **Precision Vitic has raised some other possibille links between Quality and nutrition.**

General Issue from *Regional Workshop*	Observation on General Issue	Priority to address Observation	Activity to address Priority	Feasibility of Activity		Qualifying Comments (by Ben Robinson)
				High, Mediumor Low	Short- &/or Long-term	
Irrigation management	Nutrients in waste water often not taken into account during irrigation	Communicate to growers side-effects of irrigating with waste water	Regionally specific extension to both growers & consumers on use & consequences of using waste water for vineyard irrigation	High	Short-term	**This has been done in the McLaren Vale/ Willunga area, and models are available from (eg Davidson Consulting) who have been working with Willunga Pipeline Co.**
	Effects of sub-surface irrigation on soils & crops not understood	To better understand long-term effects of subsurface irrigation	Watch for outcomes from upcoming *Irrigation Workshop*	High	Short- & Long-term	?
	Poor understanding of (actual) water-holding properties of soils & their role in deficit irrigation & management.	To evaluate relationship between variety & plant-available water.	Research to calculate PAW for each rootstock based on RAW-data for diff. soil types & root distributions of diff. rootstocks.	High High	Short- & Long-term Long-term	**The issue here is related to need for understanding of any interactions between soils and rootstocks.**
		To define & maintain optimum root volume for yield & quality.	Research to better understand the relationship between root volume and yield/quality for red and white varieties.	High	Long-term	
	People still do not understand how to apply water for quality (eg. when to stress or not to stress)	To increase grower-understanding of principles of irrigation management & practice.	Increase number of people involved in extension directly with growers.	High	Short-term	**Should be seen as cry for help as Gov't Depts that have responsibility for PI's gradually change approach to extension work. Major review of R&D-extension in Grape Industry is underway.**
			Target support for irrigation mgmt educ'l packages for Agr courses in top-30 schools to supply next generation of growers.	High	Long-term	**Background not clear. (objective seems to be to increase education of growers & vineyard management staff).**
			Sociological research on how to increase uptake of improved management by growers.	High	Long-term	**Does this mean R&D-workers not clear on best ways to communicate research results?**
	Reducing off-site impact	Minimising leakage of nutrients, water & agricultural chemicals from vineyards	Identify mechanisms to reduce leakage from vineyards through a) irrigation management, b) drying soil profile with cover crops (eg. lucerne), c) increasing WHC of soil	High	Long-term	**This may be covered in outcomes of *Leaky Soils Workshop of GWRDC*.**

General Issue from *Regional Workshops*	Observation on General Issue	**Priority** to address Observation	**Activity** to address Priority	**Feasibility of Activity**		**Qualifying Comments (by Ben Robinson)**
				High, Medium or Low	Short- &/or Long-term	
Soil Organic Matter and Soil Biology	'Beneficial micro-organisms' widely thought to be 'good', but little hard science behind it; sales push uses guilt re: 'soil health'.	To conduct a rigorous evaluation of biological inoculants.	Extension: Prepare fact sheet on soil inoculants based on review of scientific literature	High	Short-term	**In my view a literature review will not be sufficient to counter strong push by advertisers. Really need some well designed experiments on diff. soil types & climates.**
	Mulches/grape marc/ compost not well understood in viticulture.	What are benefits & risks of using grape marc as a mulch?	* Research to develop guidelines on use of grape marc & other mulches in terms of benefits to soil structure, moisture retention, & risks (frost, nutrient pollution/ oversupply). Also guidelines on degree of composting required. * Refer to outcomes from upcoming workshop	High	Short-term	**Need detail of workshops mentioned for this Activity.**
	Vineyard floor management		Refer to outcomes from recent workshop	High	Short- & Long-term	**Final report of GWRDC Cover-crop project by R. Porter in '90s may be useful; emphasis from Regional W/shops was on choice of cover-crops & swards for drier areas with drip irrigation (dependence on autumn & winter rain to establish).**

Appendix 5.4b:

Highest Priority Outcomes from Strategic Workshop (i.e. High Benefit / High Feasibility)

Citriculture Group

General Issue from *Regional Workshop*	**Observation** on General Issue	**Priority** to address Observation	**Activity** to address Priority	***Feasibility of Activity***		**Qualifying Comments (by Ben Robinson)**
				High, Medium, or Low	Short- &/or Long-term	
Soil variability	Tree-to-tree variability in citrus orchards is recognised as a problem but its importance is not well understood	To gain understanding of variability across selected citrus orchards & understand economic effects of this variability.	* Demonstrate yield-mapping (tree-by-tree) in apparently (visually) uniform citrus orchards in 3 different regions; link yield-map to soil variation & irrigation-systems. * Evaluate effect of variability on fruit-size (quality) & economics of production. Minimum several years of data required to eliminate impact of *potential biennial bearing* issue.	High	Short- & Long-term	**Query was raised about likely scale of such a project, but, it is clear that unless variability is measured & its impact quantified, growers will tend to accept it rather than try to do something about it (i.e. manage it).** **Industry expectations may be unrealistic in terms of what can be done to eliminate soil variability**
Rootstock selection as a means of managing root zone constraints	General belief there is poor match between available root-stocks & diff. soil types, & other environmental factors such as salinity, water-logging etc.	To evaluate or develop rootstocks that can cope with breadth of soil conditions likely to be used.	Develop & evaluate rootstocks adapted to various soil types & tolerant of saline, dry, waterlogged (ie. stressed) conditions. As an interim measure, develop an extension project to create awareness of rootstocks currently available.	High	Long-term Short-term	**Rootstock selection has (historically) considered these matters.** **Could it be that info. not widely disseminated (ie need extension program) or that available selections do not offer sufficient flexibility?**
Environmental management Systems	EMSs becoming more important, but citrus growers do not understand it.	To raise awareness of how growers can link soil management to EMS-requirements.	Commissioning preparation of an information paper would be good start, with a view to influencing policy for EMSs & soil management.	High	Short-term	**Workshop participant raised this.**
Plant nutrition: Use of soil and plant analysis	Only small proportion of growers use soil- & tissue-testing as guide to nutrient use.	To help growers understand benefits of using soil- & plant-testing services (esp. around Sydney).	Extension project targeted at s pecific regions & grower groups.	High	Short- & Long-term	**This issue is considered to be a regionally important one**

General Issue from *Regional Workshops*	**Observation** on General Issue	**Priority** to address Observation	**Activity** to address Priority	***Feasibility of Activity***		**Qualifying Comments (by Ben Robinson)**
				High, Medium, or Low	Short- &/or Long-term	
Poor re-plant vigour	Young citrus trees replanted in land previously used for citrus do poorly for first few years; root diseases NOT considered to be major problem, but other causes not understood.	To understand cause of problem.	Research in laboratory & field to determine cause of problem, & identify possible solutions.	High	Short- & Long-term	
		To demonstrate effectiveness of what-ever treatments are found to be useful.	Set up demonstration plots to lead extension effort. (Cover cropping, pathogen testing, fumigation, fertilizer regimes, quality of nursery stock, water monitoring, irrigation, could all be part of this investigation).	High	Short- & Long-term	
Grower Training	Horticultural press full of hard-sell ads for products of dubious value to commercial growers, whose ability to evaluate the marketing information is not well developed.	To raise the level of education among growers & advisers to allow them to discriminate 'marketing' information about fertilizers, soil amendments	Extension project targeted for growers & advisers, offering seminars or discussion groups to equip them with questions & tools to evaluate marketing information.	High	Short- & Long-term	**Final model for this idea not well developed during Workshop. Could the Research-to-Practice model be grafted on to the Citrus Groups, which ostensibly provide a structured extension service to growers already. It would be interesting to know if problem is as important as workshop attendees viewed it.**
Soil acidification in some citrus growing areas.	Variable pH to depth was reported as a problem at a number of workshops. Acidification was noted at Waikerie and Nangiloc.	To raise awareness of soil acidification & its causes, and to help growers deal with it before it occurs.	Regional extension to demonstrate value of liming (eg. Waikerie, Nangiloc where soil pH < 4). Develop extension material to encourage growers to monitor & raise pH for better nutrient uptake & plant health, where continued N- & S-fertilizer-use has resulted in soil acidification.	High	Short- & Long-term	**An important regional problem for those areas with very coarse grained sandy textured soils.** **The issue of high pH soils was not considered to be widely important.**
Cover crops and soil organic matter and biological activity	A number of issues were grouped into one broad set of observations: Low infiltration rates, prevailing view that it is important to increase soil biota.	To understand links between cover cropping, soil management & irrigation efficiency.	Research to evaluate water- & nutrient-use efficiency under cover crops, to maximize biofumigation, increase OM & beneficial soil biota, and to improve soil structure within different irrigation-management strategies.	High	Short- & Long-term	**A major issue may be discrimination of appropriate techniques to manage soil biology and soil structure in either drip or sprinkler irrigated orchards, particularly in inland arid zone conditions.**

General Issue from *Regional Workshops*	**Observation** on General Issue	**Priority** to address Observation	**Activity** to address Priority	***Feasibility of Activity***		**Qualifying Comments (by Ben Robinson)**
				High, Medium, or Low	Short- &/or Long-term	
Plant nutrition	High-nutrient-input systems (Open hydro-ponics) being promoted as way to improve fruit size & quality	To evaluate efficacy of such systems, particularly in relation to environmental sustainability.	Research to evaluate economics & long-term sustainability of open hydroponic systems for citrus (South African & Spanish systems currently being tried).	Medium	Long-term	**Open hydroponics systems have potential environmental risks even if the objectives of high production and good fruit size can be realised.**
	Current standards developed when fertilizers were broadcast 1–2x per year (usually spring) may not apply with fertigation, drip-&microirrigation ; excessive N & K being applied.	To evaluate current standards (for orchards managed with frequent N & K fertigation) in relation to fruit quality.	Research to survey orchards & set up field experiments in number of regions for diff. varieties, over period of several years, with aim of adjusting standards where necessary to avoid excessive nutrient applications.	High	Short-term	**It is interesting that the Mildura Fruit Company has issued amended (much higher values thant previously accepted for some macro-nutrients) leaf analysis standards based on survey work amongst growers of export fruit.**
Salinity of water supplies	Long term use of water even of current salinity in MDB may reduce sustainability of horticulture, esp. citriculture. Widespread de-salination of water may be required.	To evaluate options (eg. desalination) to ensure long-term supply of irrigation water for citrus (& other horticulture).	Project to develop policy (& an options paper?) for de-salination of irrigation water to reduce salt-loading of soils. Explore options to understand long-term sustainability of irrigated horticulture, involving changes to irrigation, economics of salt disposal, rate of rising water tables. Workshop to raise awareness using options paper.	High	Long-term	
Integrated farm management	A wide range of electronic monitoring devices is now available but their value has not been demonstrated in citrus industry to same extent as in other industries.	To increase awareness & use of water-monitoring devices by citrus growers (to increase water use efficiency & reduce excessive irrigation.	Research to develop an integrated approach to using crop- & soil-water sensors & services for citrus growers. Identify a set of monitoring devices that integrate soil, plant, & atmosphere relations & relate these to plant performance (eg. yield & quality) to help with soil & water management.	High	Long-term	**It is difficult to see how such a project could be developed as a stand-alone exercise. Perhaps compromise could be the use & demonstration of value of sensors in all R&D projects funded by industry (where appropriate of course). In this way a good body of knowledge could be developed & extended to industry & its advisers.**

Appendix 5.4c:
Highest Priority Outcomes from Strategic Workshop (i.e. High Benefit / High Feasibility)
Vegeculture Group

General Issue from *Regional Workshops*	**Observation** on General Issue	**Priority** to address Observation	**Activity** to address Priority	***Feasibility of Activity***		**Qualifying Comments (by Ben Robinson)**
				High, Medium, or Low	Short- &/or Long-term	
Irrigation management	Centre pivot & extensive irrigation methods not well adapted to cope with inherent high variability in Australian soils. Alternative methods are needed.	To evaluate centre pivot systems & identify irrigation systems that distribute water accurately on soils with variable hydrological properties.	Research to measure variability of water distribution across centre-pivot- or furrow-irrigated fields, calculate potential benefit of implementing better irrigation techniques.	High	Short-term	**Each crop sees itself as separate rather than as part of the greater Vegetable growing Industry** **Any R&D or Extension efforts need to be tailored for range of grower groups** **Time & place for each new piece of technology or for changes in management** **A likely driver for adoption of more efficient irrigation practice and monitoring will be shortages of water or increased prices. Potential opportunities this year in wake of drought affecting many areas & hence many irrigators.**
	Soil-water monitoring adopted to a larger extent in some regions than in others.	To help growers understand how they can better use available soil-water monitoring tools & to encourage wider routine use of this technology.	Benchmarking (extension) studies, like those done for horticulture in Qld & for grapes in various districts of NSW, SA, VIC, could be extended to appropriate areas.	High	Short-term	
			Extension work to develop management-support tools that would help growers use such things as crop phenology, weather forecasts, disease cycles, etc.	High	Long-term	
	Questions remain in growers minds as to applicability of drip irrigation in vegetable cropping	To identify most applicable irrigation methods for different vegetable crops	Field research on drip irrigation for diff crops & soils to gauge its usefulness. Tomato work in Riverina of VIC & NSW might be good model. Need demo work in number of districts & for various crops in order to illustrate adaptability of drip-irrigation.	High	Long-term	
Use of reclaimed or grey water	Growers reject it due to consumer response; lack of knowledge on nutritional value of grey water.	To raise knowledge base & change grower & consumer attitudes to grey water.	* Develop better fact sheet material about value of reclaimed water & standards applied. * Piggy back in on work done in past or being done now. * Adapt current information to other situations.	High High High	Short-term Short-term Short-term	**This is clearly a regional issue. Reclaimed water is being used in SA but the attitude towards it from the Melbourne workshop was quite strongly negative.**

General Issue from *Regional Workshops*	**Observation** on General Issue	**Priority** to address Observation	**Activity** to address Priority	***Feasibility of Activity***		**Qualifying Comments (by Ben Robinson)**
				High, Medium, or Low	High, Medium, or Low	
Nutrition	Overuse of fertilisers, leaching losses, inappropriate mixed fertilisers are all common problems. Low level of training & objectivity of advisers & growers in relation to critical evaluation of fertiliser requirements.	To raise the level of training of advisers & growers in the critical evaluation of soil & plant-tissue testing & evaluation so they can make informed decisions about fertilizer use.	* Develop crop-specific info-packages on nutrient requirements & soil & plant analysis standards. * Develop nutrient budgets. * Set up demonstration trials to show cost-savings & yield- or quality-benefits that can be achieved by matching inputs to soil nutrient status & crop requirements. *Demonstrate utility of plant tissue-testing as a monitoring tool where this technique is not currently adopted.	High Medium Medium High	Long (especially for newer crops) Long Long-term Short-term	**The idea of encouraging independence in advice & severing the product & advice linkage is desirable but probably not achievable. A more useful approach might be education & demonstration. There may be some role for "variability" studies here because not all variability is linked to irrigation as has been assumed above.**
Soil structure	Problems with hard pans, surface sealing, non-wetting sands and other soil physical problems were identified as problems at each workshop.	To raise awareness of problems with soil structure, & to link appropriate soil management practices to soil type.	* Develop training package for advisers, growers, product-sellers to help communicate what is already known about soil structural management. * If data do not exist, develop some criteria for ideal physical environment for range of soil types – this would help in diagnosing problems with drainage, root penetration & infiltration. * Benchmarking (or other economic approach) to help growers see benefits of using appropriate amelioration methods.	High Medium High	Short-term Short-term Short-term	**There were clear regional differences between soil physical characteristics seen as potential problems.** **Some regional tailoring of any project-work is needed to make information acceptable.** **The Research-to-Practice model might be useful here as starting point to communicate various options.**

General Issue from *Regional Workshops*	**Observation** on General Issue	**Priority** to address Observation	**Activity** to address Priority	***Feasibility of Activity***		**Qualifying comments (by Ben Robinson)**
				High, Medium, or Low	High, Medium, or Low	
Organic matter mulches and and beneficial organisms	Presence of organisms in soil claimed important for soil health.	To develop tools to help growers understand or measure soil health.	Develop extension material on tools available to define a healthy soil.	High	Long-term	
	Use of applied organic matter, mulches, manures & composts is widely promoted as key to healthy soil, but positives & negatives not well understood by growers. Issues include cost, practicality, nutrient effects, crop suitability, health risks.	To evaluate utility of organic mulches, manures, composts for vegetable production.	* Review work already done in Australia & overseas. * Develop protocols for grower use where sufficient info. exists * Some field trials & demos as basis for extension or for targeted research on cost, product quality, plant nutrition, soil characteristics, water relations of crops, and any human health risks	High Medium High	Short-term Long-term Short-term	**Range of issues related to use of products form diff. primary materials must be taken into account.** **Sustainability & environmental issues are also involved.** **There has to be relationship with following project on rotations. These projects might be carried out jointly.**
	Role of rotations & break crops to increase amount of organic matter in soils & to combat soil-borne diseases not well understood by growers. Soil & climatic conditions may be important here.	To increase grower-knowledge on utility of break crops to increase soil organic matter and control soil-borne diseases for a range of diff. classes of crops.	Review current practice and knowledge. Research in various districts with various crops to evaluate costs & benefits of rotations, break- & cover-crops with respect to organic matter & soil-borne diseases.	High High	Short-term Long-term	**In view of current cost of water, cultivation & irrigation of break crops & green manure crops may be an economic factor to consider.** **The project suggested above on use of applied organic matter or mulches is related to this project & might be carried out jointly.**

Appendix 5.5:

Lower Priority Outcomes from Strategic Workshop for

5.5a. Viticulture

5.5b. Citriculture

5.5c. Vegeculture

Appendix 5-5a: Benefit to Viticulture Industry vs. Feasibility of achieving response

Short Term

Feasibility	Low Benefit	Medium Benefit	High Benefit
High	1, 16	(24=mounding)	7, 8, (10=extension), 12, (14, 15, 17 & 18=extension), 25, 26, (27, 28, & 29=extension + research), (34=some areas)
Medium	13	19, 33	32
Low	2, 3, 9	6, 9, 22	4, 21

Long Term

Feasibility	Low Benefit	Medium Benefit	High Benefit
High	7, 13	9, 10, 11, 12, 16, 19, 20, 21, 22, 23, 30, 31, 32, 33	(1, 2, 3, 4, 5, & 6), 8, (14, 15, 17, & 18=extension), (24, 25, 26), (27, 28, & 29=extension & research), 34
Medium			32
Low			

Instruction to participants: Place each *Response No*. into the boxes above for both Short-term and Long-term

Appendix 5-5b: Benefit to Citrus Industry vs. Feasibility of achieving response

Short Term

Feasibility	Low Benefit	Medium Benefit	High Benefit
High			1, 6, 9, 12, 13, 19
Medium	7	10, 11, 21	3, 16, 20
Low	17, 18	2, 4, 5, 14	8

Long Term

Feasibility	Low Benefit	Medium Benefit	High Benefit
High		4, 5, 10, 11, 14	1, 3, 6, 9, 12, 13, 15, 16, 19, 21
Medium	7	20	2
Low	17, 18		8

New projects identified at Workshop:

20. Open hydroponics may be better than standard management, but high capitol cost (Extension project to evaluate water and nutrient use efficiency & product-yield
21. Fertigation increasingly used in citrus production, but timing of nutrients not understood (Project to evaluate standards for soil & plant-tissue suitable for fertigation

Instruction to participants: Place each *Response No* . into the boxes above for both Short-term and Long-term

Appendix 5-5c: Benefit to Vegetable Industry vs. Feasibility of achieving response

Short Term

Feasibility	Low	Medium	High
High		7, 20, 34	1, 2, 4, 6, 12, 17, 23, 26, 28, 29, 30, 34
Medium	31	8, 9, 10, 13, 18, 21, 22, 23, 24	3, 16, 25, 27, 32
Low	5, 14, 22	15, 19, 22	11

Benefit

Long Term

Feasibility	Low	Medium	High
High	5	1, 4, 6, 7, 8, 13, 18, 19, 20, 21, 22, 23, 31, 34, 35	2, 3, 4, 6, 9, 12, 16, 17, 25, 27, 28, 29, 30
Medium		19, 24	10, 11, 15, 24, 26, 32
Low			

Benefit

Instruction to participants: Place each *Response No*. into the boxes above for both Short-term and Long-term