

**Facilitating the
development of the
Australian almond
industry**

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Riverland Horticultural
Council Inc

Project Number: AL99001

AL99001

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Final Report: AL99001

Facilitating the Development of the Australian Almond Industry

Chris Bennett, October 2004

INTRODUCTION

This project was a continuation of an earlier project, SF98022 Stone fruit Industry Development Officer (SA) / Almond Industry Development Manager. Due to the expanding needs of the almond industry, the project was modified in April 2000 to allow the Chief Investigator to continue as a full time IDM for the almond industry as project AL99001.

The project objectives can be summarized as identifying and developing those strategies and activities that are necessary to 1) take the Australian almond industry to the position of the most efficient, productive and profitable almond industry in the world; 2) to develop and expand the industry to allow better economies of scale throughout the value chain; 3) to enhance export potential by addressing limitations in varieties produced and 4) implementing an industry based QA system encompassing the entire value chain from the producer to the packer/wholesaler.

The project activities were based on the outcomes outlined in the industry's strategic plan. However, this project also had a significant management component and did not undertake all the required activities directly. This would be impossible for a single project. Instead a significant number of activities were undertaken by the associated almond projects, both as HAL projects and those from other funding bodies. As a result, this project had a substantial role in instigating, funding, coordinating and in some cases, managing the portfolio of associated projects.

EXECUTIVE SUMMARY

This project has focused primarily on identifying and developing opportunities to implement the industry's strategic objectives. These objectives were (and still are) based on developing and expanding the Australian industry. This fundamental strategy was recognized as being crucial to the long term profitability and viability of the industry as the production levels were too low to provide adequate critical mass for competitive export trade, or adequate volumes for efficient processing.

The strategy was to be progressed by improving on farm productivity and therefore profitability. This would ensure a competitive industry that would then set the climate for further investment and subsequent expansion. The industry would then be in an excellent position to compete in the international markets, an imperative if the industry was to progress beyond dependence on the domestic market.

For this strategy to be successfully implemented, it was recognized that the world's largest producer, California, would need to be surpassed in the critical KPI's of product quality, on-farm productivity and profitability. It was well recognized that to be internationally competitive, the Australian industry needed to be more efficient and flexible than our competitors in California who were some 50 times larger.

This project has proven particularly successful in achieving the set objectives, and importantly has also identified and has put in place the key components of a program to ensure that the progress continues in the future and the gap widens.

It is a fact that the Australian almond industry has improved its average productivity by 45% (from 5.5kg to 8.0 kg per tree) since 1997. The “typical” well managed Australian orchard now produces 10 to 12 kg per tree, with trial work instigated by the IDM now achieving 18 to 20kg using new technologies. Adoption of these new technologies is occurring very rapidly, as results indicate.

The Australian industry is now well positioned to build on these productivity gains which came initially from fine-tuning traditional Californian based techniques for Australian conditions. The research work instigated from this project and carried out under AL01004 and continued under AL04002 will significantly improve on this position. Latest indications are that it is possible to achieve 4 tonnes of kernel per ha and there are strong indications this figure may go as high as 5 tonnes, depending upon the rootstocks, cultivars and management employed. This can be compared with the latest Californian production claims of 2,800 lbs per acre (3.1 tonnes per ha) *Freeman, 2003*.

Of course, this success also brings with it new challenges as the industry begins to identify new limitations and boundaries to further development and expansion. These primarily are limited natural resources, with the major ones likely to be suitable land, water and pollination services.

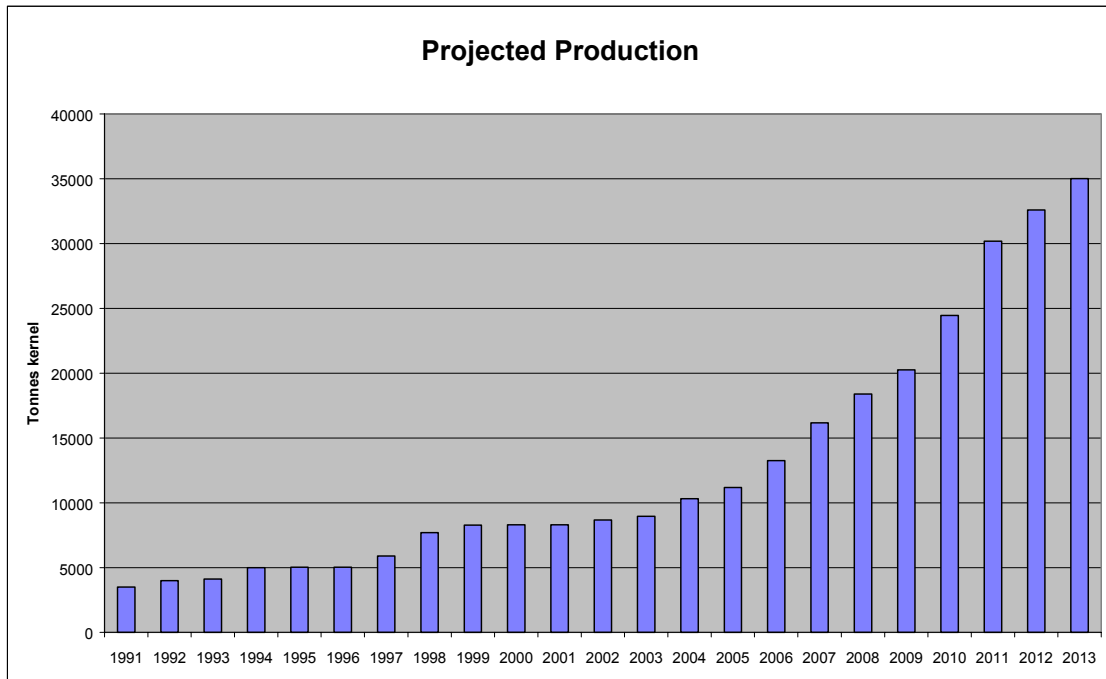
OUTCOMES

The major outcome of the work has been the success in the fundamental strategic initiative of making the Australian almond industry the most productive in the world. The Australian industry has, since the first strategic plan identified this priority in 1996, moved from an "emulator" of Californian techniques to the world leader in production technology.

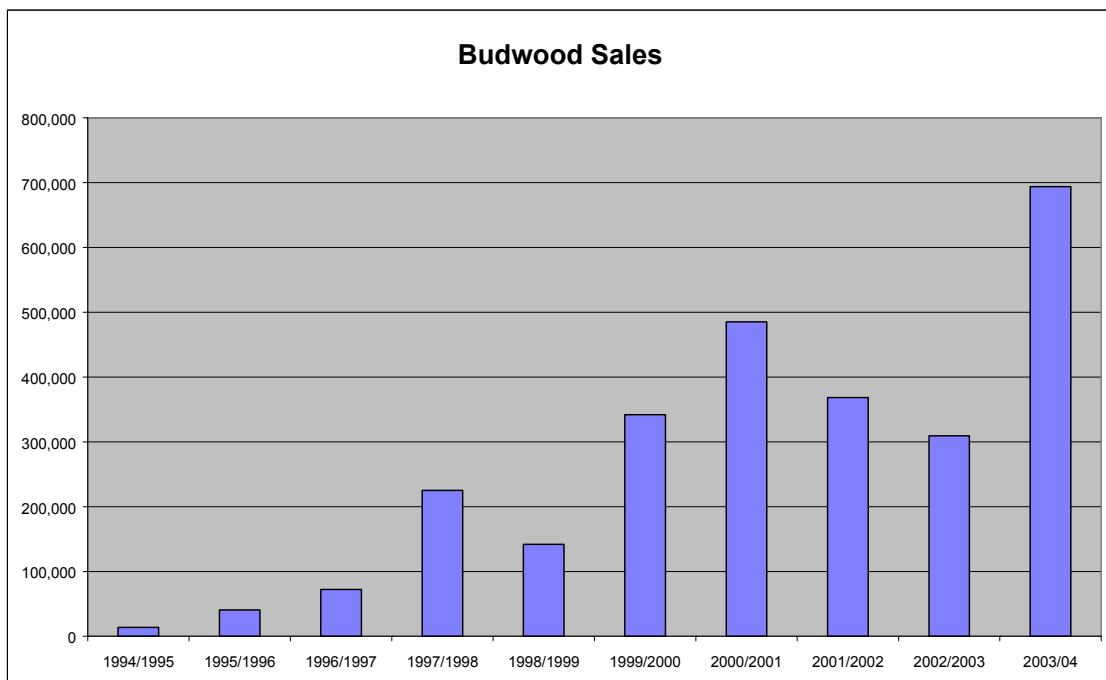
This gap continues to widen as the new technologies evolve and the technology transfer program takes effect. Grower implementation of these new technologies has been particularly high. The contributing factors have been a culture of performance competitiveness, high sense of ownership of the R&D program, and a high level of interest and subsequent active support for the R&D program from the industry leaders.

The following facts give a good overall picture of the outcomes of the industry strategy, as aided by the project.

- Almond production increased 34% from 7704 tonnes in 1999 to 10,327 tonnes in 2004.



- Total almond orchard plantings increased 72% from 6100 ha in 1999 to 10490 ha in 2004.
- Peak on-farm productivity improved from 2.4 tonnes per ha in 1999 to over 3 tonnes in 2004.
- Bud wood production increased 490% from 141,970 buds in 1999 to 693,690 in 2004.



- Key performance indicators for each region that were limiting productivity have been identified and addressed. These included:
 - Heavy, sodic soils and saline irrigation water at Angle Vale: demonstration trial in place to assist growers to overcome these limitations
 - Inefficiencies of the main rootstock, Nemaguard: GF677 identified as more suitable replacement, was imported and is now being commercialized. A range of other rootstocks are also being trialled formally.
 - Severe lack of registered chemicals for almonds: key requirements identified and permits obtained. Data currently being generated for registration.
 - Extremely limited selection of commercial cultivars which was compounded by the advent of the new diseases *Xanthomonas campestris* and *Colletotrichum acutatum*: Potential commercial cultivars in California, Spain and France identified, imported and now available for limited commercial planting. All cultivars now planted for evaluation, with one (Monterey) now planted commercially.
 - New diseases: separate projects were initiated to address the new diseases mentioned above.
 - The issue of irrigation water use efficiency being directly addressed by determining actual crop needs under Australian conditions and determining the most efficient way to provide these needs. The almond industry now leads the tree-fruit industries in the specific knowledge required to ensure efficiency, with this being backed-up with research data and yield results.
- Other important outcomes include structural and cultural changes in the industry which were deliberately fostered and encouraged under this project:
 - Technology transfer activities are now well established and part of the industry culture to the point where growers actively seek (and expect) a constant flow of information and data from the project focusing on new technologies and improvements.
 - A competitive (friendly) culture based upon inter-grower rivalry has developed, where most growers actively work to improve their performance in order to keep up with the rapid productivity changes.
 - The development of a very skilled and active IAC, which has high ownership of R&D activities with associated interest and enthusiasm.
- The development of grower ownership of all R&D projects through constant publicity, grower visits and progress updates. Associated with this are a number of regional demonstration trial sites.

- The development of a strong and long-term relationship between the industry and Adelaide University which has greatly enhanced the outcomes of the research work for all parties involved. This relationship has also developed a high degree of specific expertise and capability within the University which is proving an invaluable resource for the industry.
- The development of strong and specific data for almonds which accurately specifies the true crop requirements regarding irrigation and nutrition. This data is proving extremely useful in both ensuring the almond industry operates efficiently with these limited resources, but also adds an important level of scientifically based information to the current irrigation debate which is not currently available from any other horticultural crop.
- An increasing influence on horticultural consultants and service providers as the technologies from the research work become more accepted and implemented by growers. The consultants and service providers are being motivated to “improve their game”. As examples: 1) I am working with Sentek Ltd (Enviroscan soil moisture monitoring) to improve performance by calibrating and modifying the use of the equipment to allow incorporation of the management techniques being developed for almonds; 2) Irrigation companies and designers are becoming increasingly aware of the parameters that need to be incorporated if the new technologies are to be successfully incorporated; and 3) the commonly accepted nutrition “standards”, including leaf analysis, are now being challenged and will most likely lead to a review in the near future.
- An increased awareness by apiarists regarding the commercial potential for pollination services within the almond industry. The IDM has addressed apiarists conferences on this topic frequently over the last four years (WA once, SA twice, NSW once and Vic twice), to ensure that the rapidly expanding industry continued to have access to adequate high quality services.

OUTPUTS

A full list of published outputs is provided in the attached appendix.

- Strategic Plan: updated in 2000, the plan included a full analysis of the industry position to ensure objectives were appropriate and focused and that progress was able to be tracked and quantified.
- Almond Breeding Strategic Plan (instigated by the IDM and written by Jenny Witherspoon) which clearly articulated the aims and methodologies to be adopted and used in the project. This helped overcome earlier management difficulties and assisted greatly in raising performance efficiencies in this project.
- A set of industry statistics to define production, productivity and development trends by monitoring a range of key indicators.
- A booklet to assist new growers and those considering entering the industry to understand the basics of almond growing in Australia.

- Technology Transfer: The typical annual calendar of technology transfer events and ongoing activities is now:
 - One annual seminar (one formal day and one day of field visits).
 - At least one comprehensive technical article provided for each (quarterly) edition of the “Australian Nutgrower”. The IDM is responsible for all “almond” content in the magazine, and as such ensures a balanced level of technical content by a combination of outsourced articles and those written personally.
 - Industry “news” and brief updates on key issues and research provided for each edition of the “Australian Nutgrower”.
 - Three to four field days per year at appropriate times to view the latest developments at the management trial
 - An average of six regional meetings per year (over 3 regions).
 - An average of two regional field days.
 - Articles written for regional journals and newspapers (Country-wide Quarterly and Murray Pioneer) and interviews given regarding R&D results to various radio stations.
 - Web site www.aussiealmonds.com maintained and updated to provide a technical resource.
 - All industry activities are well attended, with typical attendance ranging from 30 for regional activities to 110 for events of wide appeal. These figures represent 70 to 80% of the target audience.
- R&D projects specifically targeted at identified impediments which are limiting industry performance:
 - Provision of superior cultivars to overcome the very limited range currently available:
 - 12 Californian varieties identified and introduced. Currently undergoing evaluation. One variety now being grown commercially.
 - 8 new selections from Spain and France introduced, as well as some hundreds of seedlings and superior selections from Israeli, Spanish and French breeding programs.
 - The most promising rootstock for Australian conditions (GF677) introduced and currently undergoing initial bulking-up to produce mother trees for commercial propagation.
 - A root-stock trial to evaluate the 11 most promising stocks under Australian conditions.
 - The expansion of the central budwood repository to meet increasing industry demand. Production is now in the order of 800,000 to 1,000,000 buds per annum (up from 70,000).
 - The development of more sensitive and cost effective PCR techniques for the indexing of PNRSV and PDV, now used annually in the budwood trees and the breeding program.

- The development of DNA testing techniques to ensure the integrity of planting material. (One commonly used rootstock in Australia was found to be misrepresented).
- The development of a nursery “accreditation” system will be completed for this coming season to ensure ongoing genetic and phytosanitary integrity of all planting material being delivered to growers. No propagation material will be supplied to nurseries unless they comply with strict conditions.



Collecting leaf samples from newly released introductions for virus screening at the Monash repository.

- The instigation and fostering of international collaboration with key almond researchers in Spain, France, Israel and California. The ABA and our research collaborators have now been formally inducted into GREMPA (the Mediterranean Research and Experimental Group for Almonds and Pistachios).
- The instigation and development of the Almond Management Trial (AL04002). This trial under the guidance of Prof. Assaf of Israel is proving the single most influential work in improving on-farm performance.



Crop currently showing on trees; estimated at over 5 tonnes kernel per ha, a world record.

Highlights include:

- Sprinklers virtually abandoned for all new developments. Drip irrigation is now the system of preference and many established orchards are also converting.
- On farm production is increasing due to the competitive culture fostered by the trial.
- In 2003/04 the trial broke new ground with almond production, recording the world's highest ever recorded productivity. The current crop is significantly higher.



The exceptional root-system being developed under the trial management protocols. This root-system is far more extensive and denser than normal, with the majority of roots being young, fine feeder roots.

- The trial is proving an exceptionally valuable and well regarded teaching (and learning) tool.
- “Satellite” demonstration plots are being used to fine-tune for specific conditions and provide a local teaching resource:
 - Management from initial planting is being developed/demonstrated at Omega Orchards at Murtho in SA. This will overcome the limitation at the main trial for teaching purposes, which commenced with trees in 4th leaf.
 - Specific issues are being addressed at Angle Vale which has difficult heavy soils and both limited and saline water.



Planting new demonstration block at Omega Orchards, June 2004. Aim is to define and demonstrate the management of young trees to develop the type of orchard required for optimal production, as defined by the trial at CT Farms.

- The on farm management approach is rapidly changing from the traditional process based decision making, (eg common fertilizer formulas and reliance on indirect monitoring of soil moisture to schedule irrigation), to one of monitoring tree and crop performance and applying all inputs as dictated by crop physiology and needs. This approach requires a much higher level of management and knowledge, but is proving very successful. It forms the fundamental basis of the quantum leap in productivity being demonstrated at the trial.
- Scientifically sound and valid data is being generated for the first time regarding the true needs of almond trees under Australian conditions to achieve optimum tree performance. This is proving invaluable input to the “water allocation debates”.
- An integrated and SQF based QA system was developed and has now been adopted throughout the industry. Growers have SQF1000, while processors and packers have SQF2000. This is currently being extended with the development of industry microbiological protocols (testing, recall etc) to further strengthen the integrity of the system.

- Industry development and expansion facilitated by instigating the development and production and coauthoring the booklet “Why Invest in Almonds?” and the financial analysis “Comparative Analysis of Almond Production”. Together these publications provided a detailed and factual analysis that provided a well received resource for producers and potential investors.
- The successful application for, and sourcing of a range of funding opportunities to extend and enhance the basic program delivered under the levy program. These included:
 - Regional Assistance Program (Department of Transport and Regional Services) funds for the development of primary evaluation facilities for new introductions and progeny from the breeding program..
 - ARC Linkage funds in collaboration with Adelaide University for projects covering Molecular Biology, Virus Indexing and Propagation.
 - Water Catchment Management Board funding for the Angle Vale Irrigation Management Trial.
 - FarmBis funding for the QA systems implemented by growers.
- The development and provision of an irrigation scheduling program to provide growers with a tool to match daily crop needs with water availability. This unique program uses crop physiology, daily e-pan readings and crop factors to calculate water application rates and matches these to water availability.

SPECIALIST ACTIVITIES ASSOCIATED WITH THE ROLE OF IDM

A significant part of the project provides for the specific role of Industry Development Manager for the industry. As such the Chief Investigator works closely with the Peak Industry Body, its Committees and the IAC to ensure that the outcomes of the industry strategic plan are effectively and efficiently achieved.

The almond industry operates its R&D program as an integrated program, as distinct from a portfolio of discrete, independent projects. This approach has proven very effective, flexible and has developed a high degree of integration across the program. However, under this structure there needs to be a high level of coordination and an ability to provide for a number of smaller “projects” that can be most efficiently undertaken as part of a more comprehensive program. AL99001 provided that flexibility and gave the ability to undertake a wide range of activities, some out sourced.

The IDM also had the role of overseeing and managing the activities of AL01001 and monitoring progress of all other almond projects, including the Breeding Program. As a result a number of issues and opportunities were identified and acted upon in allied projects which allowed considerable improvement to their outcomes. These included:

1. In conjunction with HRDC, instigating an independent review of the breeding program (project AL00002). This ultimately led to a successful restructuring of the management of the program and an adjustment in personnel involved. The result was a more focused team approach, with a more formal management and reporting structure. Overall performance was greatly improved and the relationship between collaborators greatly enhanced.
2. Instigating the writing of an Almond Breeding Strategic Plan, undertaken within this project by an independent consultant, Jenny Witherspoon. This plan greatly improved the definition of outcomes and methodology and assisted in focusing the project on timely and commercially important outcomes.
3. Initiating and developing an international collaborative approach to the almond R&D program. We now have a strong collaboration with the three Spanish breeding programs, the GREMPA organization, the Almond Genome Mapping Project, INRA in France and Israel. All these groups contribute directly to our programs, supplying advice, consultancies, genetic material and training.
4. Negotiating collaboration with Prof Raphael Assaf, who is fundamental to the success of the Management Trial being undertaken through projects AL99001 and AL04002. Assaf's assistance has also had a positive influence on many of the other projects.
5. Instigating the "Visiting Scientist Program" to encourage and ensure both effective collaboration and efficient projects. Four key scientists were sponsored under this initiative: Prof Assaf from the Volcani Institute, Israel; Dr R. Socias from SIA, Spain; Dr F Vargas from IRTA, Spain and Dr I Batlle from IRTA, Spain.
6. Negotiating "Testing Agreements" for new cultivars with the three major Spanish research institutes and a Californian nursery to allow access to patented cultivars for commercial evaluation and/or breeding purposes.
7. Including members of the IAC in visits to key Mediterranean research institutes and GREMPA conferences to increase their knowledge and understanding of overseas almond research and opportunities for Australia. One trip in particular, under HRDC project AL99009, investigated the research capabilities and trends in the Mediterranean region as well as a number of new production technologies. This tour also included the then HRDC Program Manager, and fundamentally changed our outlook and strategies regarding future R&D initiatives. This tour laid the foundations for the current research program and the collaborative approach we have taken.
8. Attended workshops and conferences that provided specific information relevant to progressing the R&D strategies. These included:
 - GREMPA Almond and Pistachio Conference, Turkey in 1999 (also part of project AL99009).

- Bacterial Spot Workshop, Melbourne in October, 2001.
 - Macadamia Industry Conference, Oct 2001. (Paper presented).
 - ISHS/GREMPA Almond and Pistachio Conference, Spain in 2001. (Poster presented)
 - GREMPA Almond and Pistachio Conference, Portugal in 2003. (Paper presented)
 - HAL Chemical Residue Management Forum, March 2004
 - Australian Irrigation Association Conference, Adelaide in May 2004. (Paper presented)
 - CRC for Irrigation Futures Forum, Sept 2004
 - Water Allocation and Salinity Zoning: numerous forums.
9. Commissioned two studies of the Spanish market situation with AusTrade. The aim was to provide an analysis of the future market possibilities in Spain and of “Spanish almond types” to provide guidance for future strategies in both marketing and breeding/introducing these almond types.
 10. Initiated the current move to develop “Industry Protocols” regarding the microbiological aspects of almond quality. The industry does not currently have agreed standards, nor an agreed response to these issues. The industry has a low-medium risk of such issues as salmonella, with California suffering a recent contamination incident.
 11. Regularly provided input into various forums and authorities regarding the issues of irrigation efficiency, water allocations and entitlements and salinity mitigation. The data from the management trial is increasingly being accepted and recognized as the strongest, most valid data regarding almond crop irrigation requirements for Australian conditions, supplanting the previous standard FAO 56. The irrigation technologies being trialed are also increasingly being recognised as providing useful guidelines for a range of other irrigated crops.
 12. Spoke at Apiarists’ Conferences in NSW, Victoria, WA and SA to promote the development and expansion of pollination services for the rapidly expanding almond industry. This issue, if not managed may eventually prove to be a limiting factor for the expansion of the almond industry.
 13. Managed the field work associated with the breeding program. This included the development and planting of two new primary evaluation sites at Monash. Additional funding of \$85,000 was also obtained by the IDM under a Regional Assistance Program grant (DOTARS) to assist with the capital costs of the development.
 14. Managed the propagation, supply and on-going evaluation of all new cultivar introductions on grower properties to ensure basic performance in Australia is potentially commercial.
 15. Managed the central budwood repository, overseeing the production and provision to nurseries of up to 700,000 buds annually. Expanded the repository to incorporate all new introductions, bulked up those generating commercial interest,

- updated the irrigation system and revised the nutrition program to increase production and bud quality.
16. Currently negotiating and facilitating the commercial production of the newly introduced rootstock GF677 by both rooted cuttings and *in vitro* to ensure ongoing supply of the industry's requirements.
 17. Instigating an "Almond Nursery Accreditation Scheme" to improve the genetic and phytosanitary integrity of the trees being supplied to the industry. Central to the scheme is the Monash Repository and a contract requiring nurseries to comply with a set of guidelines designed to improve product integrity. All nurseries must sign this contract if they wish to purchase budwood and/or become an accredited supplier to the industry.
 18. Ensuring maximum efficiency of the R&D program by sourcing funds from outside sources, where appropriate. These include the Regional Assistance Program (Department of Transport and Regional Assistance), the ARC Linkage Program (in conjunction with the University of Adelaide), and various Chemical Companies (supplying VC's for the chemical residue trials).

RECOMMENDATIONS

As the industry moves forward technically and expands both in terms of production and geographic boundaries, there will be a need to review strategic directions and R&D priorities and methodologies.

The industry strategic plan is scheduled for its five-yearly review and re-evaluation in 2005.

The levy-payers and industry generally will need to be provided with somewhat different services, especially in the area of technology transfer. The information coming out of the R&D program, especially the management trial, has the potential for completely changing the way almond trees are grown and managed. The level of management required will be much higher, requiring a much more detailed working knowledge of tree physiology, soil science, nutrition and irrigation scheduling. The data from the work is challenging much of the current assumptions and "best practice". This presents a formidable challenge to producers and the industry as a whole, if they wish to successfully implement this new knowledge. Many previous industry bench-marks are now completely out-dated and will need revision.

It will therefore be crucial that growers are assisted and strongly supported in the transition period, which will take some years to complete.

It will be vital that short courses are developed to train growers in the fundamentals of the key areas of science so that they can better understand the management issues involved

and thus be empowered to make good, well considered and scientifically based on-farm decisions.

Equally important will be the need for ongoing mentoring of the growers, especially in the transition period, to ensure that the risk is managed and the change implementation successful.

Support documentation will need to be developed as an ongoing resource and reference for the growers and this should be published on the web-site.

The web-site will require considerable effort and resources to develop to the level of sophistication required and will need constant updating. Further development must concentrate on making it a central resource for growers and aimed at assisting the growers implement the new technologies emerging. Central to this should be the provision of extensive and easily accessed technical information and the provision of key management data such as daily e-pan readings for relevant regions. This should be made a priority for 2005.

Simple management tools will need to be developed to ensure that the more complex decisions are simplified, especially in the cases where there are interactions of various management parameters or scientific disciplines. Suitable tools would include the provision of fertigation concentration calculators, annual phenological calendars, and written guides to outline the crucial aspects and key points of critical management decision areas. These should also be available on the web-site.

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APPENDIX: List of published articles, papers and presentations made under the technology transfer component of the project.

- 1. Australian Nutgrower Magazine:** A wide range of articles were provided from various sources. Only those written personally are listed below. In addition, each edition of the magazine contained from 500 to 1000 words of “News” written by the IDM. This provided short and current updates covering a wide range of industry topics. The major articles written were:
 - a. “Almond Management Trial Challenges Current production Knowledge” Sept 2004 Vol 18 No. 3
 - b. “Growth of the Almond Industry” Sept 2004 Vol 18 No. 3
 - c. “High Quality Propagation Material” Dec 2003 Vol 17 No. 4
 - d. “Irrigation Efficiency: survival tips” Sept 2003 Vol 17 No 3.
 - e. “Good Root Systems with Drip Irrigation” Sept 2002 Vol 16 No. 3
 - f. “Drip Irrigation: how to make it work” Sept 2002 Vol 16 No. 3
 - g. “Almond Canopy Management” June 2002 Vol 16 No. 4
 - h. “Australian Almond Management Trial” March 2002 Vol 16 No.1
 - i. “The Spanish Market”, Sept 2001 Vol 15 No.3
 - j. “Almond Varieties in Australia” March 2001 Vol 15 No. 1
 - k. “Quality Assurance” Conference Proceedings 2000
 - l. “Quality Nursery Trees” June 2000 Vol 14 No. 2
 - m. “Almond Study-tour Opens New Doors” Dec 1999 Vol 13 No. 4
 - n. “Almond Fact-finding Tour” Sept 1999 Vol 13 No. 3

- 2. Presentations at Conferences included:**
 - a. “Quality Management in the Australian Almond Industry” Macadamia Conference, Oct 2001
 - b. “Development Trends in the Australian Almond Industry” NSW Apiarists Conference, May 2002
 - c. “An Holistic Approach to Nut Crop Management: Some lessons from the almond management trial” M’ANIC Conference, Oct 2002
 - d. “Preliminary Observations Regarding the Effect of Daily Drip Irrigation by Pulsing on the Optimization of Almond Tree Management in Sandy Soils in Australia” GREMPA Conference, May 2003
 - e. “Rewriting the book on almond irrigation: the multi-disciplinary approach”. Irrigation Association of Australia Conference, May 2004.
 - f. “The Australian Almond Industry: a developing opportunity” Crop Pollination Association Conference, Aug 2004.

- 3. Formal presentations to Almond Industry Groups included:**
 - a. Angle Vale Region growers, Sept 2002
 - b. Riverland Region growers, Sept 2002

- c. **Sunraysia Region growers, Sept 2002**
 - d. **IAC Report, Oct 2002**
 - e. **“The R&D Program” Report to AAGA Executive, Jan 2003**
 - f. **IAC report Sept 2003**
 - g. **“Living with water restrictions” (full day grower seminar), Sept 2003**
 - h. **“The Almond R&D Program”. Presentation to ABA Executive.**
 - i. **Riverland Regional AGM Update Feb 2004**
 - j. **Adelaide Regional AGM Update Feb 2004**
 - k. **Updates to all three regions, July 2004**
- 4. Presentations to allied industries and organizations included:**
- a. **“The Almond Industry: Where lies the future?” Australian Academy of Technical Sciences and Engineering, May 2004**
 - b. **“Improving yield & quality using the annual crop cycle to optimize irrigation & nutrition”. WA Dept Agriculture Field Days Oct 2004**
 - c. **“The Almond Industry Plant Evaluation Project” Barossa Riverland Area Advisory Consultative Committee, May 2004**
 - d. **“The Proposed Almond and Stone Fruit Collaborative IDO project” Summerfruit IAC, June 2004**