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AVOMAN & AVOINFO: SOFTWARE TO IMPROVE THE MANAGEMENT OF AVOCADO PRODUCTIVITY AND QUALITY

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SUMMARY

Poor adoption of research results indicated a need for alternative methodologies for the transfer of technology to the Australian avocado industry. The establishment of local grower discussion groups and the development of information and decision aid products are the two main approaches that were used to foster the uptake and implementation of relevant technology by Australian avocado growers. The information and decision aid products include two software packages and one hard copy product. The software packages are AVOMAN, a farm management system incorporating record keeping and decision support, and AVOINFO, a reference database for avocado. The hardcopy product is a wall chart recording system. Seasonal growth information for commercial varieties was collected by cooperating growers throughout Australia and was used to generate location and variety specific growth cycle models. The AVOMAN software utilises this phenological information together with built-in knowledge, stored farm records and current information on orchard status, to customise application rates and timing for management activities. A range of reports can be generated that are useful for both management and quality assurance purposes. AVOINFO contains over 4000 references to published technical literature on avocados from around the world from 1911 to 1998. Where available, abstracts and/or entire papers are provided. A powerful search facility that uses key words, title, author, source or abstract, assists the user to find specific information required.

Additional key words: decision aid, phenology, reference database

INTRODUCTION

In 1992, the Australian avocado industry listed problems of low orchard productivity and irregular fruit quality among its research and development priorities. Despite the fact that the Australian avocado industry has been well serviced by research programs, only limited adoption of subsequent technology by industry has been observed in recent years. The AVOMAN project was created to provide a framework with which to standardise and package existing and future production technology and to provide a vehicle to transfer these to the Australian avocado industry. The full title of the project is "Improved Management of Avocado Productivity and Quality". It is a national initiative designed to achieve these objectives within the Australian avocado industry.

Those who contributed to the six-year project included research and extension officers, systems analysts, computer programmers, agribusiness professionals, consultants and commercial avocado producers. The AVOMAN project team comprised a multi-disciplinary group of professionals from around Australia. The majority of team members were extension officers whose roles included ensuring that the AVOMAN software accommodated the wide range of growing conditions in Australia. Researchers were responsible for providing and checking the accuracy of information built into the software as well as assisting with the development of decision frameworks. Software technology continues to advance at a rapid pace and the programmers had to write the software to suit changing industry standards. Agribusiness professionals and members of the avocado industry also played an important feedback role in the AVOMAN project with assistance in validating the recommendations produced from the software.

THE REGIONAL PRODUCTIVITY GROUPS

The inclusion of commercial growers in the project was formalised through the creation of regional productivity groups (RPGs). These were formed in each of the major production areas and apart from providing forums where local growers could exchange ideas and information, the RPGs provided a focus for comments, ideas and priorities for the project's direction. They were also ideal test groups for the three AVOMAN software prototypes produced prior to release of the commercial version. There are currently fourteen RPGs around Australia, from the Atherton Tablelands in North Queensland to Pemberton in the southwest corner of West Australia. Activities include farm walks, workshops, presentations by guest speakers and software training sessions. Members of RPGs also collected vital data for the construction of phenological cycles relevant to specific varieties growing in different regions. These data were subsequently incorporated into the software. Growers had a particularly valuable role in testing software prototypes. Involvement of growers throughout the project had a number of benefits:

- there was a high level of awareness about the project long before the final products were released
- feedback from prototype users ensured that the final products met their needs and was user-friendly
- users were exposed to software training over a period of four years
- the industry had a sense of ownership of the project and hence the final products

THE AVOMAN SOFTWARE

The AVOMAN software is designed to be used by commercial avocado producers, consultants and extension staff. Its primary purpose is to provide:

- record keeping and reporting facilities
- highly customised recommendations based on the combination of accumulated research knowledge with key information about the grower's own orchard
- agronomic information.

It consists of a number of highly integrated modules.

Records

The record keeping system simplifies and standardises the recording of descriptive and quantitative information relating to the management of avocado farms. A relational database management system is used to efficiently store and access information. The user interface of this software is presented in five parts, namely the farm details, block details, orchard operations, yields and prices:

- the farm details module is used to record information that relates to the whole farm, namely weather, water quality, employee and customer details
- the block details module allows growers to record vital descriptive information for each block of trees such as soil texture, variety, phenological cycle, tree size, number of trees, leaf and soil analysis results. Information such as tensiometer readings and fruit maturity results has also been catered for. Regular updating of information in the block details module enables the grower to develop an historical management profile for each block
- two modules take care of yield, quality and fruit price records
- the operations module enables users to record operations such as fertiliser applications, irrigations, sprays and pruning with associated details that include dates, costs and rates of nutrient, chemical and labour inputs.

A product database supports both the recording and recommendation modules. It allows the details of fertilisers, pesticides and other chemicals to be recorded and accessed. Details include trade names, active ingredients, nutrient analysis, registration details (pests and rates), suitable application methods, neutralising values (for limes and dolomites), withholding periods and costs. Copies of the software are supplied with the details of several hundred products already entered but users can customise this data and also enter new products themselves.

Recommendations

The program uses the descriptive information recorded in the records module in accordance with predefined decision frameworks to make customised recommendations relating to each block of trees described. Detailed timing and rate information is calculated by combining farm information with intrinsic physiological and phenological knowledge. In the absence of some information, such as leaf and soil analysis, AVOMAN will provide conservative recommendations, however the grower is reminded by means of a suitability rating that more accurate results will be achieved if additional data is entered.

Phenological cycles

AVOMAN contains more than 30 distinct phenological cycles for different varieties and locations around Australia. Since avocados are grown in a wide range of environments in Australia, reliance on calendar-based timing for recommendations would be inappropriate. The phenological cycles are used by the program to determine appropriate timing of management activities. The timing of each recommendation is linked to one or more specific growth cycle events as indicated by the points on the graphs (Fig. 1). Given that the phenology can vary from season to season the cycles have been designed so that users can easily adjust the date of any event on the graph to accurately represent the phenology for that year. The

cycle is automatically recorded for each season allowing annual comparisons to be made.

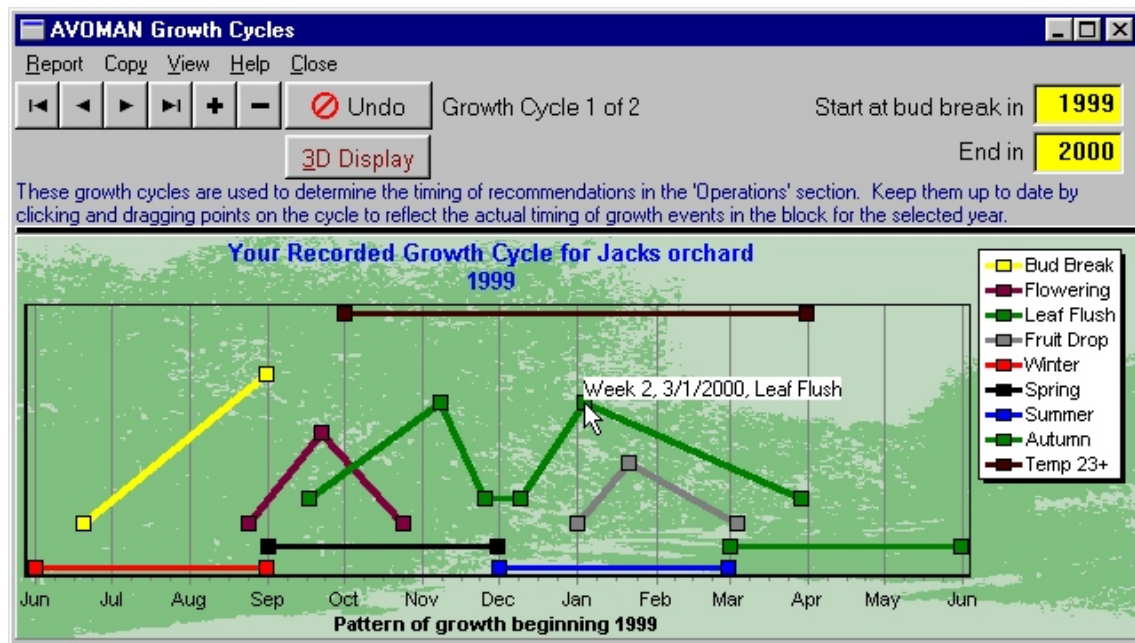


Fig. 1. An example of a growth cycle in AVOMAN, the point highlighted by the cursor indicates the peak of the second leaf flush. The date (and thus position) of each of the points can be easily updated.

Nutrient recommendations

Distinctive nutrient recommendations are available in AVOMAN for:

- Nitrogen
- Phosphorus
- Potassium
- Sulphur
- Boron
- Zinc
- Copper
- Manganese
- Iron
- Calcium
- Magnesium
- pH adjustment

The development of each nutrient recommendation was an extensive process. Initially, the factors governing whether or not the plant receives sufficient quantities of the element were identified. Pathways were developed that allowed each factor to be handled appropriately in relation to each of the others. Quantitative tables were then established to determine indices by which to modify the initial base rate to account for the prevailing conditions. Safeguards in the form of capping levels were established for each nutrient to ensure that rates could not be increased to the point of being toxic or counter productive. Finally, the appropriate timing was determined and linked to the phenological cycle. For the software user this process is of course unseen and automatic however background information on the factors influencing each recommendation is accessible in the Help files.

Recommendations are presented in a balance sheet (right-hand side of Fig. 2) which displays tree requirements on a weekly basis in grams of element per square metre of canopy area. A number of tools are available to enable users to match these requirements with a method of application, suitable product and rate (left-hand side of Fig. 2). The cost of the product at the rate and units selected is displayed. One advantage of a balance sheet is that recommendations can account for the use of products with multiple benefits such as fertiliser blends and broad-spectrum pesticides. For example, for any week of the year, the balance sheet will show the complete nitrogen, phosphorus and potassium requirements and the program is able to recommend the most suitable product (from the product database) to match the combination of the three elements (Fig.2).

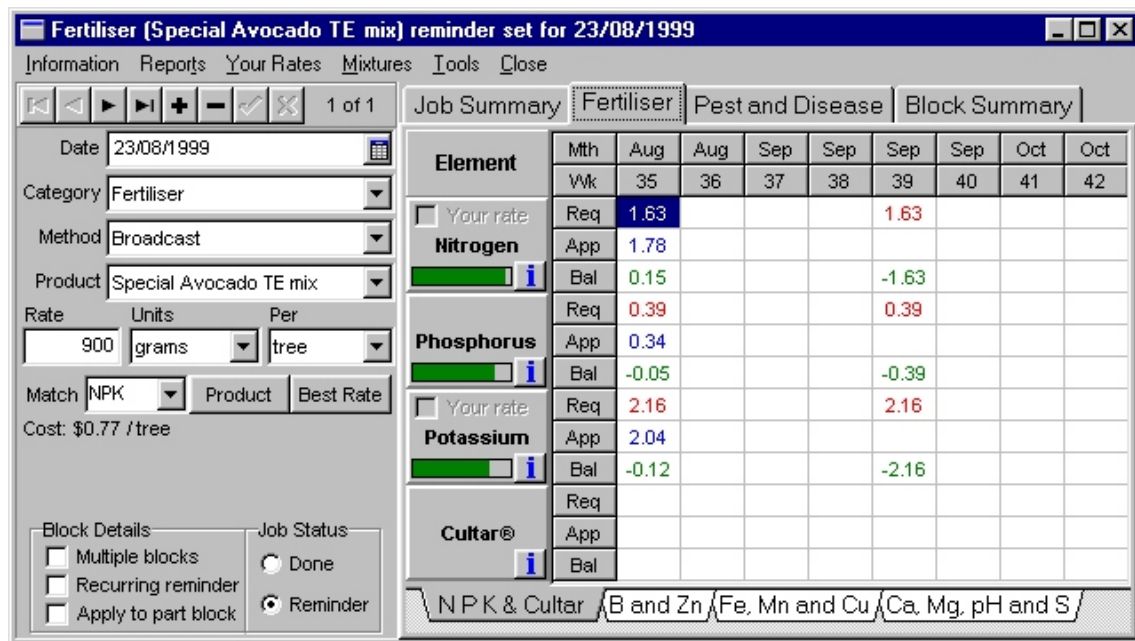


Fig. 2. An example of a nutrient recommendation screen showing a fertiliser that AVOMAN has chosen to best match the nitrogen, phosphorus and potassium requirements for week 35.

Users have significant flexibility in how they operate the program and in the level of detail they record. They can, for example, alter the details of each recommendation such as product, rate, method and date at any time or even choose to ignore the recommendations suggested by AVOMAN and simply use the software as a recording and reporting mechanism. Any variation from the recommended requirement will be displayed as a surplus or deficit for the week, indicating to the user how much their changes differ from the recommendation calculated by AVOMAN. Details such as labour and machinery costs, name of employee and notes can be recorded for each job. For foliar sprays the time of spraying, wind direction and strength can also be recorded. Users also have choices on how much of this detail appears in the reports. Once the details of a job are finalised they can be saved either as a reminder or a completed job. It is possible to generate lists of reminders for any specified date range for use as work schedules. Once a task has been completed, the status of a job can be changed from "reminder" to "done" with

one mouse click and, at the same time, the associated details can be updated to reflect any departure from the original reminder.

Other options offered by AVOMAN include the ability to alter the interval between fertiliser applications for each element (to say weekly, fortnightly or three monthly) and, for experienced growers, the option to vary the base rates for the nitrogen, potassium and boron recommendations. Time saving features allow the user to:

- record a job for several blocks at once
- pre-define mixtures of fertilisers and/or chemicals that are applied together
- record a number of jobs that are repeated at regular intervals via one entry

Pest and disease recommendations

Recommendations are available for thirty-one Australian pests and diseases. These include root rot, anthracnose, spotting bug and Queensland fruit fly. Links to the registration and rate details in the product database ensure that only those pesticides that are registered for that particular pest or disease are offered as options. The timing of these recommendations is also determined by points in the phenological cycles.

Planner

In order to provide growers with an overall perspective of their management, the planner was developed. It works in a similar way to a wall planner. Users can see a larger portion of the year at a glance than is possible in the operations window. Farm operations and reminders appear in the planner as squares that are colour coded according to which category of farm operation they fall into (Fig. 3). The presence of a diagonal line or cross through the square indicates the degree of completion of the job(s) that the square represents. The status of the job (whether it has been done or not) and the date and rate details can be changed from within the planner.

Reports

One of the benefits of keeping records electronically is that the data can be processed to generate a wide range of reports. The reporting facility in AVOMAN currently contains over thirty different types of reports and graphs that are useful for farm management, quality assurance and performance benchmarking purposes. Most reports allow the user to choose the reporting period, the degree of detail and the units used. Reports available include:

- spray diary
- fertiliser application summary
- leaf/soil analysis graphs and comparisons
- labour, machinery and chemical expenditure
- weekly job reminder lists
- fruit yield and quality summary
- prices by customer and fruit size
- water management graph
- operations report
- growth cycle graphs
- weather graphs and comparisons
- historical profile of orchard blocks

The reports provide a standard format on which comparisons may be made both on farm and within RPGs.

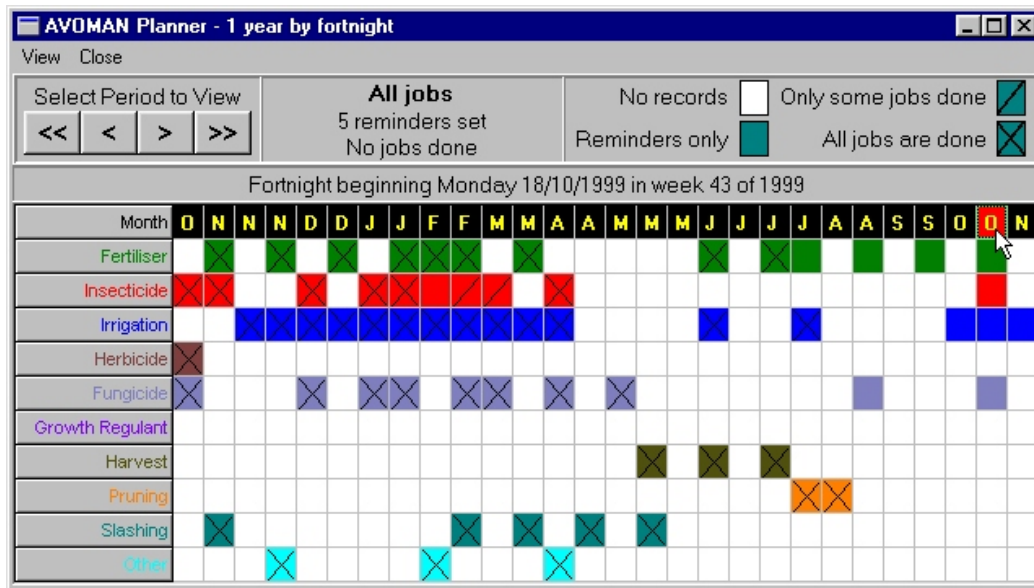


Fig. 3. An example of the AVOMAN orchard planner showing an overall perspective of the reminders set and jobs completed for the year. Clicking on any coloured square will display the details and status of the job(s) it represents and allow editing.

Information files

Approximately five hundred pages of agronomic information and instruction on using the program are provided in the AVOMAN help files with appropriate links from the program. The agronomic pages contain authoritative text and illustrations on topics such as canopy management, plant nutrition (Fig. 4), root rot control measures, post-harvest care and insect pests.

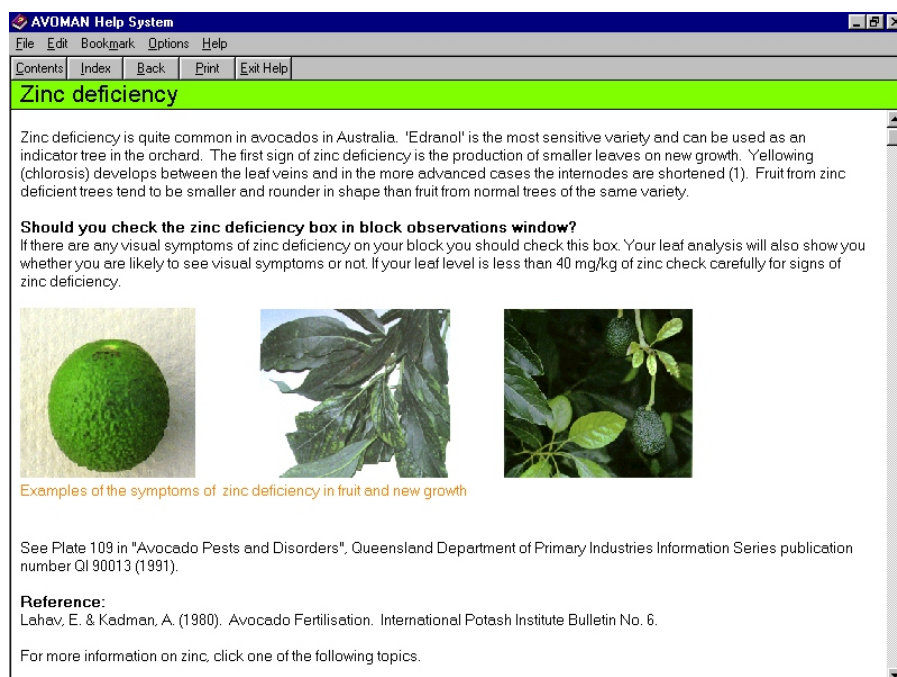


Fig. 4. A page of information from the AVOMAN help files.

AVOINFO SOFTWARE

An information system called AVOINFO was developed to provide easy and intuitive access to avocado-related references published around the world over a period of more than 85 years. It contains the bibliographic details of over 4000 avocado-related references and provides an abstract or summary for more than half of these. In some cases complete articles are reproduced and pictures included. All abstracts, summaries or full articles included in AVOINFO appear with the permission of respective copyright holders. No restrictions were imposed on the basis of language or publication date but abstracts of articles published in foreign languages were translated into English before inclusion. In addition to technical papers from international scientific journals, articles are also included from conference proceedings, yearbooks and other bulletins. The bibliographic details (Fig. 5) recorded for each reference are:

- title
- author(s)
- address
- source (journal)
- year of publication
- language of publication

The screenshot shows a web browser window titled "AVOINFO Reference Database". The interface includes a menu bar with "References", "Bookmarks", "Options", "Print", and "Help". Below the menu is a navigation bar with "Result 1 of 1", "Reference number 207", "Set bookmark" (with a checkbox), "See bookmarks", "See all", "Search", and "Sort". The main content area is titled "Bibliographic details" and contains the following information:

Title	Present activities for controlling <i>Phytophthora cinnamomi</i> Rands (avocado root rot) in the region of Uruapan, Mich., Mexico
Author(s)	Martinez, B.R.
Address	Fac. de AGrobiología, Univ. Michoacan, Paseo Gral. Lazaro Cardenas y Berlin, Uruapan, Mich. 60000, Mexico
Source	Revista Mexicana de Fitopatología, 7 (2): 240-242; 4 refs
Published	1989
Language of publication	Spanish

Fig. 5. Bibliographic details for a reference in AVOINFO.

Each reference is assigned a unique number and one or more key words from a key word set.

AVOINFO contains a powerful search facility (Fig. 6) that allows the user to search for information using one or more criteria:

- keyword
- title
- author
- source
- abstract

The customised search facilities include the use of a standard key word set to aid rapid location of specific references. The power and flexibility of the search mechanism is further enhanced by the inclusion of AND/OR join clauses linking up to two search strings per criterion. A facility is provided to print full bibliographic records, including the abstract for each reference.

Even though a large amount of literature has been published on avocados, a great deal of this information has previously been difficult and time consuming to access and beyond the reach of most growers. AVOINFO brings much of this information together into a package that is easy to access and quick to use.

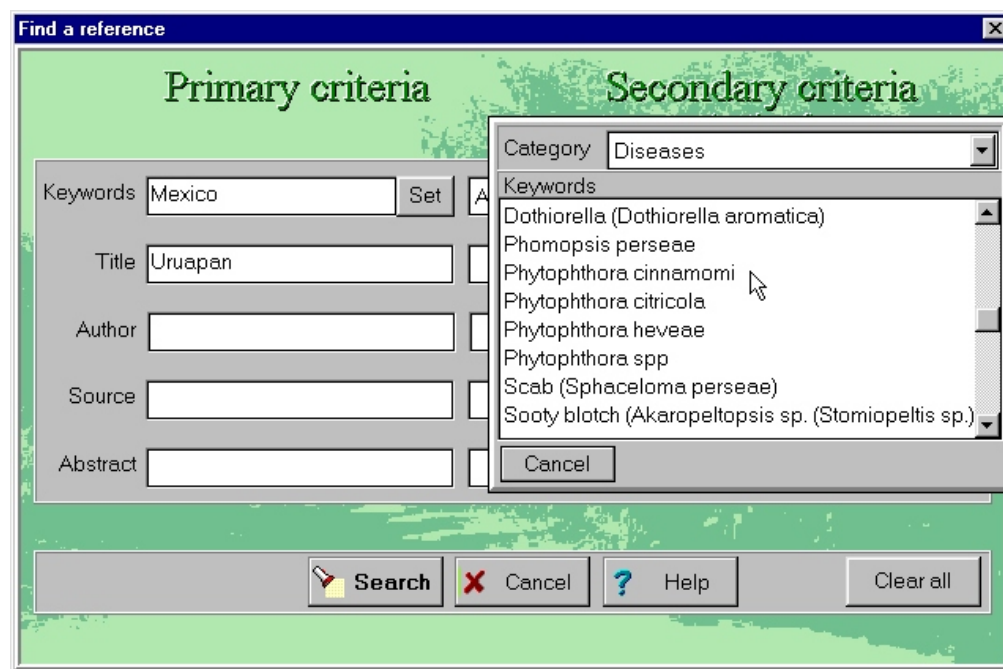


Fig. 6. The search facility in AVOINFO showing the criteria being chosen to find the reference displayed in Fig. 5. The window on the right shows the second key word being selected and how the key words are arranged in categories.

DISCUSSION

There was initially some concern about the expected levels of adoption of the software in relation to the resources being invested in the project. Low levels of

computer ownership by growers during the initial years of the project and a lack of awareness about the potential of this technology on farms gave cause for concern. However inclusion of growers in the development process through the Regional Productivity Groups and the increasing adoption of computers as business management tools have contributed to very encouraging levels of adoption of both the AVOMAN and AVOINFO programs. Three prototypes of the AVOMAN software and one of AVOINFO were released to the industry during development. Over one hundred growers tested each of the AVOMAN prototypes and provided valuable feedback during software training sessions and in subsequent surveys. Now, one year after the release of the completed versions of the software, sales of the AVOMAN program have almost reached the level of adoption set as a target. Copies have been sold to Australian growers who collectively produce more than 50% of the national crop and the program has also been adopted by two major avocado marketing groups in Australia as their preferred record keeping and management system. AVOINFO was expected to be adopted mainly by scientists and students but sales to producers have significantly exceeded expectations suggesting that they are actively seeking a greater level of understanding of the crop to improve their productivity and fruit quality.

Recognition by the development team of the importance of servicing the products and providing users with support has led to the second phase of the project which is one of adoption and maintenance. The project was in the fortunate position not to have to recover development costs, however funds were not available to support the program after the six-year development phase was completed. The price of the software packages was therefore set to cover the estimated costs associated with the second phase of the project. This phase involves publication, user training and support. A comprehensive and user-friendly manual (which includes tutorials) is provided with AVOMAN, together with hands-on software training and support from the development team via phone, fax or e-mail. Users of both programs are kept informed and up-to-date via software updates, newsletters and a web site that incorporates an electronic discussion group. Regional Productivity Groups also organise activities such as farm walks and software refresher training. The AVOMAN software is seen by the Australian avocado industry as one of their prime means of technology transfer. If sufficient funding exists, the software will be updated as required with new recommendations, information and reports, and the Regional Productivity Groups will be maintained.

Since the global pool of avocado knowledge is constantly growing AVOINFO must be updated regularly to remain useful. The frequency with which this is done will depend on how quickly new avocado literature and information becomes available. One advantage of using an electronic system is that it is relatively easy and inexpensive to maintain and update. The possibility of delivering this information via the Internet, which would allow updates to be done more frequently and at less cost, is being investigated.

CONCLUSIONS

The involvement of growers in the Regional Productivity Groups was a vital part of the project and not only achieved a high degree of awareness but also contributed significantly to the development of the software products. Adoption of both the

AVOMAN and AVOINFO software programs has been encouraging and reports are emerging of positive changes on orchards, however, the development team is aware of the importance of maintaining the products and providing ongoing support to users. The overall aim of the project remains that of improving orchard management in order to increase fruit quality and productivity on Australian avocado orchards.

Acknowledgments

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