Final Report

Australian Almond Innovation and Adoption Program

Project leader:

Tim Jackson

Delivery partner:

Australian Lychee Growers Association

Project code:

AL19001

Project:

Australian Lychee Growers Association (AL19001)

Disclaimer:

Funding statement:

This project has been funded by Hort Innovation, using the Almond industry research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

Publishing details:

Published and distributed by: Hort Innovation

Level 7
141 Walker Street
North Sydney NSW 2060

Telephone: (02) 8295 2300

www.horticulture.com.au

Contents

Public summary

The Australian almond industry innovation and adoption project contributes towards the implementation of the industry's strategic plan that relies on the outputs from the Hort Innovation's almond research program and other sources to address gaps in knowledge and develop new technologies to support the sustainability and competitiveness of the industry. This project, ran from April 2020 to October 2023, and facilitated the provision of information generated within the Australian and international research communities as well as drawing on the expertise within the industry to establish best practice and enable better business decisions. The target audience was Australian almond growers; industry stakeholders and value chain members.

On farm adoption of research outcomes was a major focus of the extension activity addressing priority areas identified in the industry's strategic plan and responding to industry needs including: irrigation; pollination; pests and disease management; food safety and product integrity; spray application; biosecurity; new production systems; plant improvement and maintaining industry capacity.

The project was delivered by a small team of industry development (ID) staff who have well established grower and stakeholder networks as well as regularly participating in industry and government forums, events as well as overseas relationships to identify relevant emerging issues, research findings, new technology, best on-farm practices, trade requirements, biosecurity, climate change and environmental issues, chemical regulation, labour issues and government policy changes.

The ABA has maintained strong cohesive relationships with industry leaders, researchers and provider organisations, both in Australia and overseas and utilise this extensive and diverse network for trusted communication and information sharing so that Australian almond growers have the information needed to adapt to the increasingly dynamic physical, political and economic environments to make smart business decisions and remain competitive in the global market.

In consultation with the project reference group (PRG) and in consideration of grower feedback the ID staff delivered a program of extension activities using various delivery methods to meet different learning styles. All published information is held on the ABA grower resources page on the ABA website. Key achievements include:

- 9 ABA Field Days/ demonstrations - 409 participants
- 6 ABA Workshops– 286 participants
- 12 ABA Webinars– 466 participants and a further 472 downloads from the ABA website
- 1 ABA Tool– fungicide planner (fertilizer planner in development)
- 3 ABA Regional Forums(online + Riverina) – 135 participants
- 1 international guest speaker attending the ABA Conference 2022 - 550 participants
- 16 ABA hosted domestic tours showcasing local growing regions and processing facilities – 153 participants
- 19 ABA Magazine articles "In a Nutshell"
- 8 ABA Videos– 620 unique views
- 17 ABA Factsheets, Guidelines & Grower notices
- 17 ABA Presentations to stakeholder groups – 635 participants
- Assisted with program development of 1 R&D forum - 260 participants, and 1 Australian almond conference - 550 participants
- 1 ABA Study tours– 25 participants
- 2 international ABA Study tours to California and attendance at the ISHS almond and pistachio symposium – ID staff
- 17 PRG meetings
- ABA Project Plans– annual work plan, stakeholder communication and engagement plan
- 1 project mid-term review
- 1 ABA Extension strategy 2023-2028

Keywords

Almond(s); extension; innovation; adoption; industry development; quality; productivity; profitability; sustainability.

Introduction

Over the past decade, ABA has driven innovation and adoption through previous industry liaison and extension projects funded through Hort Innovation levy fund (AL07008, AL09021, AL12000 and AL16001). The Australian almond industry innovation and adoption project (AL19001) builds on these efforts in implementing the industry's strategic plan that relies on the outputs from the Hort Innovation's almond research program and other sources to address gaps in knowledge and develop new technologies to support the sustainability and competitiveness of Australian almond growers. As the peak industry body representing the interests of 99% of growers, the Almond Board of Australia's (ABA) aim is to maximise the industry's profitability across the supply chain ensuring its sustainability into the future.

The objectives of the project were to:

- deliver a national industry development and extension service in a strategic and coordinated manner with a team of appropriately skilled and respected staff and partners.
- deliver industry development and extension activities that result in an informed industry which has the necessary tools (technologies and management practices) and capacity (knowledge and skills) to manage on-farm risks from a production and biosecurity perspective and meet market requirements and consumer expectations. This will involve:
    - improving the reach of the almond R&D program
    - creating improved industry capabilities for adoption and innovation from levy funded R&D outputs
    - driving and monitoring the adoption of levy funded R&D outputs by Australian almond businesses
- facilitate the feedback loop between growers and researchers to ensure that R&D outputs are relevant and accessible to end users, and that industry R&D gaps/needs are known.

The project, ran from April 2020 to October 2023 and targeted all Australian almond growers facilitating the provision of information generated within the Australian and international research communities as well as drawing on the expertise within the industry, growers and service providers, to establish best practice and enable better business decisions. There are five almond growing regions in Australia including Adelaide Plains and the Riverland (SA & Lindsay Point (Victoria), Sunraysia (Victoria/NSW), Griffith, Darlington Point and Hillston (NSW) and Swan region (WA).

Project delivery occurred during an extremely challenging time for the almond industry. The COVID pandemic created unprecedented labour shortages and disruptions to global supply chains. Uncertainty in logistics elevated prices for imported agricultural goods such as fertiliser, chemical, fuel, and machinery. Input costs were further compounded by the Russian-Ukraine war and a global energy price shock. Locally, three successive wet years under LaNina challenged productivity with destructive winds, hailstorms and relentless rains preventing time-critical operations, river flooding and orchard inundation, heightened pest and disease pressures, poor water quality, poor weather during pollination, and 30% shortage in forecast 2023 crop. At the same time the almond industry has experienced the impact exotic incursions inflict on industries with Varroa destructor entering Australian shores in June 2022, with border closures further limiting access to healthy hives, inflating hive prices and costing the industry millions of biosecurity dollars to contain this threat.

The production area continued to expand from 51,541 hectares in 2019 to 62,400 hectares in 2023 demonstrating continued confidence in Australian almonds in both domestic and export markets. This increase in production area has seen annual tonnage grow to over 140,000 tonnes in 2022-23 and is anticipated to increase to more than 200,000 tonnes by 2028 as new orchards are planted and trees mature (Figure 2).

While most Almond orchards are located in Victoria (56%) recent orchard expansion has largely occurred in NSW which now represents 24% of the total number of hectares planted. This area is characterised by different landforms, alluvial soil types, different water sources and climate presenting new production challenges.

While ABA staff have maintained delivery across the rapidly expanding regions over the last three years it was important to maintain extension capacity to service the larger planted area, establish new relationships in particular in the Riverina, and keep abreast of the extraordinarily high number of critical issues being faced by industry over the last three years.

The ABA team utilised complementary ABA projects including 'communications' (AL22008), 'statistics and data collection' (AL19005) the 'Almond Centre of Excellence - Experimental and Demonstration Orchard' (AL19000) and 'Australian almond industry conferences and field days 2017-2021' (AL16700) to increase the rate, reach and effectiveness of grower engagement.

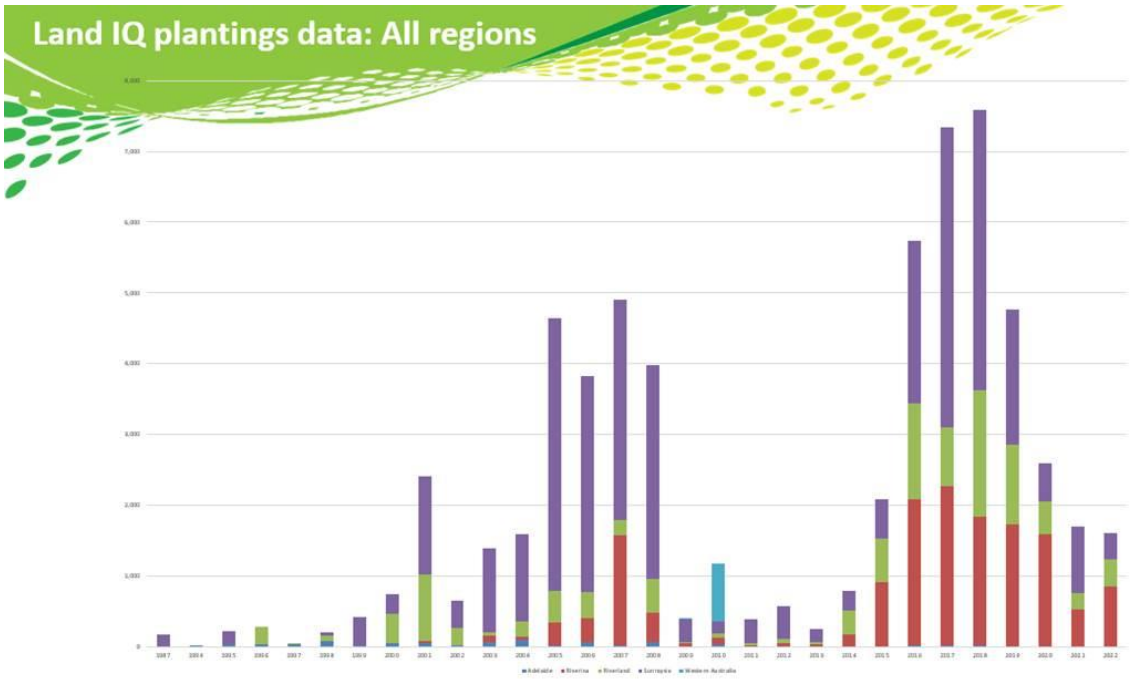

Figure 1. Area planted to almonds from 1993 to 2022 illustrates a doubling in area planted to almonds since 2016.

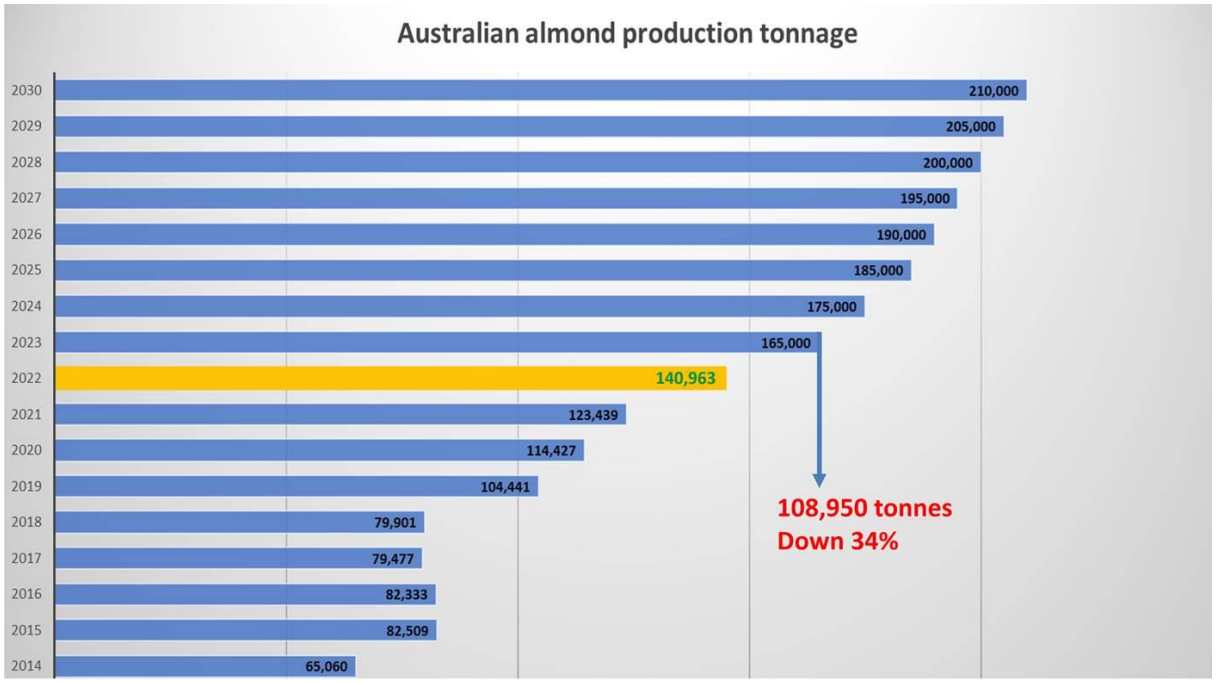

Figure 2. Australian almond production from 2014 to 2022 and forecast to 2030.

Initiated under the previous Hort Innovation Strategic Investment Plan (SIP) 2017-2021 the project focused on outcomes 3 and 4, as well as playing a role in transferring the knowledge from existing projects focusing on the strategic plan outcomes 1 and 2. The outcomes are listed below:

- Outcome 1 – Pest and disease damage to almonds has been reduced through enhanced integrated pest management (IPM) and integrated disease management (IDM).
- Outcome 2 – A major productivity gain in almond pollination by 2022 through a 25 per cent reduction in bee stocking rates with no loss in pollination efficiency.
- Outcome 3 – An almond industry crop production system that supports further efficiencies in Horizon 1 orchards and the development of Horizon 3 orchards and has lifted industry yield from 3 to 4 tonnes per hectare. This will

include new almond varieties featuring self-fertility and sealed shells, a new nursery accreditation scheme, 4 megalitres of irrigation water per tonne of almond kernel yield and proven 'shake and catch' harvesting and post harvesting systems.
- Outcome 4 – An informed industry that adopts R&D outcomes and has the capacity to support current and future industry needs.

In 2022 the SIP was reviewed and renewed with the project remapped to three new outcomes and key performance indicators under the Hort Innovation strategic investment plan (SIP) 2022-26:
- Outcome 1 - Industry Supply, Production and Sustainability. The Australian almond industry has increased profitability, efficiency and sustainability through innovative R&D focusing on an integrated approach to plant improvement, orchard productivity, soil health, water-use efficiency, pollination, IPDM and emerging technologies.
- Outcome 3 - Extension and Capability. Improved capability and an innovative culture in the Australian almond industry maximises investments in productivity and demand, with demonstrated increase of industry (Ha) with positive change in KASA, practice and impact in targeted high priority areas e.g., IPDM, biosecurity, soil and water management.
- Outcome 4 - Business Insights. The Australian almond industry is more profitable through informed decision-making using consumer knowledge and tracking, trade data, production statistics and forecasting, and independent reviews.

The following projects were funded through Hort Innovation almond strategic investment plan (SIP), which the ID team collaborated with project leads and assisted in dissemination of new learnings and results to growers:
- Almond minor use permit program AL16002
- National Almond Breeding Program AL17005
- Evaluation of potential prunus rootstocks for almond production - stage 3 AL20001
- Pathway to carbon neutral – life cycle analysis in almond orchards AL20005
- Pathway to carbon neutral – whole orchard recycling in almond orchards AL21000
- Optimising almond production systems AL21001
- Cover crops for soil health and productivity AL21004
- An integrated disease management program for the Australian almond industry – Phase 2 AL16005/ AL22002
- An integrated pest management program for the Australian almond industry – Phase 2 AL16009/ AL22003
- National Tree Crop Intensification in Horticulture AS16000/ AS18000
- Regulatory support and response coordination (pesticides) MT20007
- National Bee Pest Surveillance Program: Transition Program MT21008
- Development of non-invasive methods and systems for the assessment of hive health PH17001
- Demonstration of Functional Driverless Tractor for Aust Horticulture AS17002

This report describes the program of activities and products delivered to extend new knowledge and technologies to Australian almond growers; industry stakeholders and value chain members that have been integral to implementing the Australian almond industry strategic plan addressing risks and opportunities faced by the industry.

Methodology

The project was delivered by the Industry Development Team employed and supported by the Almond Board of Australia (ABA). The ABA have strategic sub-committees (Production, Pollination, Plant Improvement, Chemicals, Sustainability, ACE Orchard, Marketing, Processing, Water) which represent a community of practice and foster exchange of ideas between regions and provide industry leadership. The ID team provides support to six of these committees with a calendar of meetings each year.

Project Reference Group informed annual work plans

The ABA Production Committee served as the project reference group (PRG) providing guidance and feedback in developing project plans and annual work plans each calendar year. The PRG had representation from large and small almond growing businesses and from each growing region, as well as marketers, resellers, and a representative from Hort Innovation. The PRG met on 16 occasions during the life of the project. Project update reports were provided at each quarterly meeting against the annual work plan and minuted provided to Hort Innovation through project milestone reports.

In developing annual workplans the ID team worked closely with complementary ABA communication projects and conference/ R&D forums to deliver a co-ordinated package of knowledge transfer and awareness raising initiatives. Where possible the Almond Centre of Excellence was utilised to showcase best practice and demonstrate research outputs.

Monitoring and evaluation (M&E) plan and mid-term review

A grower survey at the end of the previous extension program helped inform key priority areas and gaps in knowledge to inform extension program needed to achieve the industry objectives. These were documented in the Monitoring and Evaluation Plan and program logic to provide direction to the ID team and track the value and impact of the program.

A mid-term review was undertaken by Meaningful Social Research in 2022 via phone interview with 18 stakeholders from the almond industry who each had a relationship with the ABA. This review provided useful insights on what the growers who are engaged with ABA find valuable, what they would like more of, and what they think ABA needs to focus on in the future. This report has been used and ideas incorporated into extension activities following the review.

Delivering industry development and extension services

A stakeholder engagement and communication plan was developed at the start of the project and updated annually describing key target audience, messaging and special considerations for regionally specific issues as well as issues of national significance so as to ensure best-fit for local needs and industry stakeholders.

Utilising the ID team's extensive and diverse network of local and international researchers, service providers and marketers' information has been made available through a flexible and adaptive extension program delivering several extension mechanisms to suit different levels of understanding, addressing the needs of each specific growing region, using various mediums and formats to retain grower interest and satisfy a diverse range of learning styles.

With the advent of COVID in early part of the project (March 2020), the delivery mechanism for extension pivoted away from face-to-face activities to online webinars, videos, and written form to convey research project findings. After COVID restrictions were lifted and confidence regained in convening face-to-face events the industry embraced the return of orchard walks, field days, farm visits, study tours and workshops. The ID team also assisted with the planning and delivery of the ABA Conference in 2022 and R&D Forum in 2023 (AL22008).

A template was created to assist with ID planning, implementation, review and improvement of delivery efforts. These were useful when collaborating with R&D project teams and commercial organisations to clearly communicate the learning objectives and target audience. A concerted effort was made to involve industry leaders as presenters into each activity providing a grower voice to extend new information to industry complementing research insights.

A registration survey was established for all events to inform presenters on key grower questions. In some cases, new topics have been identified for additional publications and events e.g. 'managing animal pests' resulted from the 'integrated pest management' webinar and 'management of birds' factsheet.

All almond publications were saved on the ABA website with appropriate Hort Innovation acknowledgment and branding.

Grower liaison and farm visits

The ID team regularly fielded enquiries from growers and industry stakeholders. While farm visits were put 'on hold' for the first half of the project during COVID the enquiry mechanism via emails and phone calls was still well utilised covering a wide range of technical knowledge (refer Appendix 19. Enquires summary.). These enquires were monitored and used to support further activity and investigation e.g. permit applications for emergency chemical use.

Establishing a benchmark for adoption of R&D

At the onset of the project, home isolation resulted in an onslaught of online surveys. As such proposed surveys to establish what is being done on farm to determine a benchmark at the start of the project were not pursued. As an alternative approach surveys on registration to webinars, field days and workshops were used to glean information on each topic e.g. 'what have they observed', 'what are the barriers to adopting best practice', 'what information do they want to know', coupled with segmentation of 'role in the industry', 'time in the industry', 'location' and 'size of property' to better understand the learning requirement. The responses are maintained within a feedback spreadsheet and is utilised in preparation of annual work plans. The questions asked during this process has changed over time and is now refined so that a better understanding of on-farm practice can be collected.

The almond industry has invested in developing an industry-wide benchmarking tool using the Hort360 framework to enable progress towards adopting best management practice to be tracked. The ID team has assisted in the development and review of two modules in priority areas for almond pollination and irrigation to ensure R&D learnings are incorporated into the BMP continuum. Almond Hort360 will continue to be developed and will provide the industry-wide benchmark for BMP to meet the needs of the almond industry through a separate sustainability project. This has taken the place of presenting a benchmark report.

Liaising with R&D project leaders to facilitate delivery of current R&D outputs

R&D project leaders (current and past projects) have been a pivotal component built into all extension activities where research updates were provided in various mediums including webinars, field days, Almond Conference and R&D Forum, videos of research trials particular at the ACE Orchard and magazine articles. The ID team played a coordination role to optimise the timing of publication, and opportunities for growers by avoiding overlap and competition for grower's time.

In the support provided for ABA sub-Committees, the ID team have made provision for direct contact between almond producers and R&D project leads with inclusion of project update reports and presentations in the relevant forum facilitating two-way exchange of information and ideas.

The ID team actively participated in 13 Hort Innovation project reference groups to ensure an in depth understanding of project objectives, progress and delivery of timely and practical outcomes to improve adoption.

- ST16000 Advance Production Systems
- AL16005 Integrated Disease Management
- AL16009 Integrated Pest Management
- AL16006 Evaluation of potential prunus rootstocks for the Australian Almond industry
- AL19000 Almond Centre of Excellence
- AL19001 Almond Industry Innovation and Adoption
- AL19004 Almond industry economic analysis project RMGC
- AL19004 Economic analysis of the almond industry
- AL20005 Life Cycle Assessment
- AL21000 Whole orchard recycling in almond orchards
- AL22009 Australian Breeding Program
- AS18000 National tree crop intensification project
- PH17001 Development of Non-invasive methods and systems for the Assessment of Hive Health
- PH20001 Crop and varietal data to better understand the importance of pollination.

Liaising with Hort Innovation

Six Hort Innovation extension and adoption personnel have aided the extension program including: Adrian Englefield, Jay Cummins, Nicole Dimos Byrnes, Bronwyn Walsh and Susie Murphy White addressing project needs and opportunities and participating in PRG meetings, field days, industry tours and events.

The ID team also provided direct input into the renewal of the Hort Innovation strategic investment plan (SIP) 2022-26. including the Extension and Adoption unit, to amplify impact and behaviour change arising from key R&D investments.

Global scans of relevant R&D

The ABA continued to maintain close relationships with the Almond Board of California (ABC) who control the research program for the US almond industry. Global scans of online media and ABC research reports were frequently conducted to remain aware of international developments while international travel was prohibited during COVID.

The California Conference was attended by two ID staff in December 2022 covering a comprehensive program on current research and industry development as well as attending the Almond industry Californian study tour 2022 (AL22006) providing insight into the Californian industry advances. Through previous study tours and attendance at the US Conference, relationships with researchers were built with US researchers / extension staff.

Identification of regional industry development and extension needs

Participation in post event feedback has been low and at times only one or two responses especially after field day events. Response rates from workshops were greatest when participants were provided a hard-copy to complete at the end of the day. Greater emphasis has been placed on a pre-event registration survey to identify the issues being faced by those who are interested in specific topics. This information has informed subsequent delivery and the tailoring of events to suit grower needs. If not immediately addressed this feedback has been used to design future extension opportunities. The feedback questions have evolved over the course of the project to improve the information collected without over-burdening the registration process. Participant responses have been maintained in an 'event feedback summary' spreadsheet, provided to Hort Innovation.

Industry segmentation built into stakeholder engagement

A stakeholder communication strategy was developed at the project start identifying key stakeholders and engagement strategies to tailor messages to the needs of each group using specific methods, and timing that takes into consideration specific needs and characteristics of these groups to overcome potential barriers to adoption. Refer Project Plans – Communication and engagement, Monitoring and Evaluation. Segmentation data was collected for each event through the registration surveys and post event surveys assisting with analysis of the feedback and stakeholder needs based on their 'role' in industry (grower, researcher, service provider), 'length of time' in the industry (<5 years, 5-10 years, >10years), 'location' (region) and 'size of property' (<50, 50-100, 100-800, >800).

Develop and maintain a regional contact list

Under the ABA confidentiality policy a register of all growers, processors, advisors/consultants, researchers and other industry stakeholders attending ABA extension activities was maintained in an 'event feedback summary' spreadsheet (provided to Hort Innovation). This list enabled analysis of the representation from across the industry in terms of location, and percent of the almond production area involved in the extension activity.

Facilitate the feedback loop between growers and researchers

In addition to the 'event feedback summary' the ID team supported ABA Committee meetings to enable project updates to be provided to the relevant committee and that growers had opportunity to provide feedback to researchers and identify R&D gaps. These were reported to Hort Innovation via the SIAP.

Garner industry feedback on R&D, relevant R&D projects

Feedback is gathered by the ID team in various forms and discussed with the relevant ABA supply chain committee. The ID team has worked collaboratively with research agencies to access alternative (other than almond grower R&D levies) funding streams through various state and federal government funding initiatives to augment the R&D investment into almonds. The ID team has been a pivotal member of the core bid group in the development of the funding bid for CRC

Pollination Security. The ID team has assisted with defining the scope for new projects in the journey towards carbon neutrality – life cycle assessment and whole orchard recycling, cover crops, IPDM, and breeding programs.

Reporting to the Almond Industry Strategic Investment Advisory Panel (SIAP)

The ID staff have played an active role in reviewing and renewing the Almond SIP strategic plan 2022-26 ensuring the needs and priorities identified in the ABA supply chain committees are addressed through presentation to the SIAP as-needed. While there was a hiatus in formal SIAP meetings during Covid, liaison with Hort Innovation's Industry Strategic Partner enabled the identification of priority projects and the continuation of the R&D program.

In consultation with the ABA the Hort Innovation investment advice mechanism was established providing a framework for efficient and effective consultation with the ABA supply chain committees via the ABA Board. The ID team has played a key role in facilitating and implementing these changes.

Almond Industry Extension Strategy

An extension strategy for the almond industry was co-designed with Hort Innovation staff and the ABA Production Committee and endorsed by the ABA Board providing an important supplement to the ABA five-year Industry Strategy and Hort Innovation SIP (2023-26).

Results and discussion

Integrated Pest and Disease Management

The extended wet conditions over the last three years have prevented timely access to orchards to conduct all required control measures and/or enable effective control (Appendix 2. Monthly rainfall – Eastern states 2020-2023.). This together with a shortfall in processing capacity meant product was stockpiled on farms for extended periods under cover. These challenges have resulted in elevated pest and disease pressures. The ABA have worked closely with researchers, service providers and growers to document and disseminate the latest knowledge in terms of integrated pest and disease management (IPDM).

- **IP&DM management strategies, benefits and costs are documented with a focus on: Hull Rot; Carpophilus Beetle and Carob Moth;**

Working closely with Agriculture Victoria's economist (AL16009 and AL16005) providing connection with a range of growers using different management strategies a 'baseline' measure of benefits and costs associated with pests, Carpophilus beetle (CB) and Carob moth (CM), and diseases, Hull Rot and Trunk Disease (Phytophthora) was generated. The results are yet to be published by AV but the study found that grower actions to combat priority pests and diseases were generally economically desirable except for hull rot which was only positive 33% of the time for higher cost options.

The ID team have worked with IPDM researchers to coordinate the design and delivery of a range of extension activities and publications with a focus on IPDM monitoring, identification, and sustainable management practice on-farm and stockpile management. A significant body of knowledge has been documented and published on the ABA website that provides a legacy of information readily available for growers to access into the future.

Attendance records and website analytics indicate strong interest in these events and use of the IPDM publications generated during the project reporting period:

- 7 ABA webinars specifically on IP&D management attended by 263 participants.
- 7 ABA field days attended by 220 participants.
- 14 ABA videos with 446 unique views and 47 downloads.
- 14 factsheets published (or updated) with 1,205 unique views.
- 5 In-a-Nutshell magazine articles with 2854 unique opens.
- 1 ABE tool – fungicide planner
- 26 grower notices promoting IPDM extension activities and publications including chemical updates (3), CSIRO mice updates (9).
- 2 ABA webpages established and maintained to host grower resources for each integrated pest management, integrated disease management.
- 7 PRG meetings.
- 16 IP&DM project updates to the ABA Board and Production Committee.

Measured industry awareness (<66%) of these resources held on the ABA website in October 2023, as part of the Disease Masterclass registration process, suggested there was opportunity to further promote these resources through regular industry communications In-a-Nutshell and Almond Bytes.

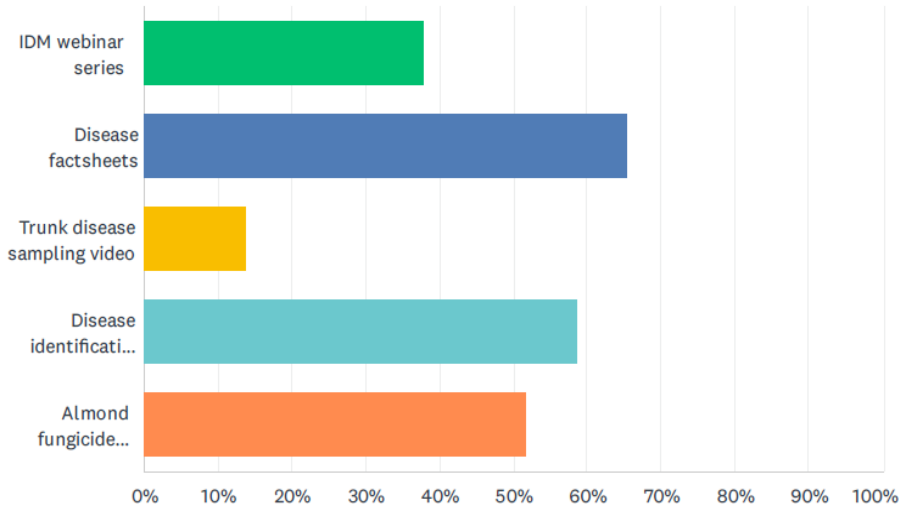

Figure 1: Disease masterclass registration survey responses to question: which IDM tools and resources offered on the ABA website are you aware of?

- **90% of growers know and understand integrated Pest & Disease management principles and strategies with a focus on: Hull Rot; Carpophilus Beetle and Carob Moth.**

A high number of questions in webinars, workshops and field days, suggest growers were interested in the topics presented, and valued the ability to ask questions of the researchers. Significant effort went into the design of these activities to assist with pest and disease identification, monitoring and management strategies including sustainable chemical treatments in almond orchards and on-farm stockpiles.

While Hull Rot, Carpophilus Beetle and Carob Moth were a strong focus, feedback from growers resulted in webinars, factsheets and grower notices on the management of other pest animals causing economic impacts such mice and birds.

- **IP&DM adopted by 90% of production area with a focus on: Hull Rot; Carpophilus Beetle and Carob Moth.**

It is difficult to get an accurate measure across the industry of the proportion of the production area using IPDM practices. However, grower reports indicate monitoring and hygiene activities are part of the standard practice. In the last three years with extended wet conditions, it was difficult, especially for larger properties, to complete management practices (hygiene passes and sprays) at the desired time. The inclement weather has been conducive for pest and disease development elevating the levels of damage across the industry.

An indication of IPM activities was provided via a poll during the Integrated Pest Management Webinar (Sept 21) indicated that monitoring activities for CM and CB are being undertaken in various forms using traps (50%), looking at nuts on the tree before shaking and on the ground after shaking as well as mummies during winter.

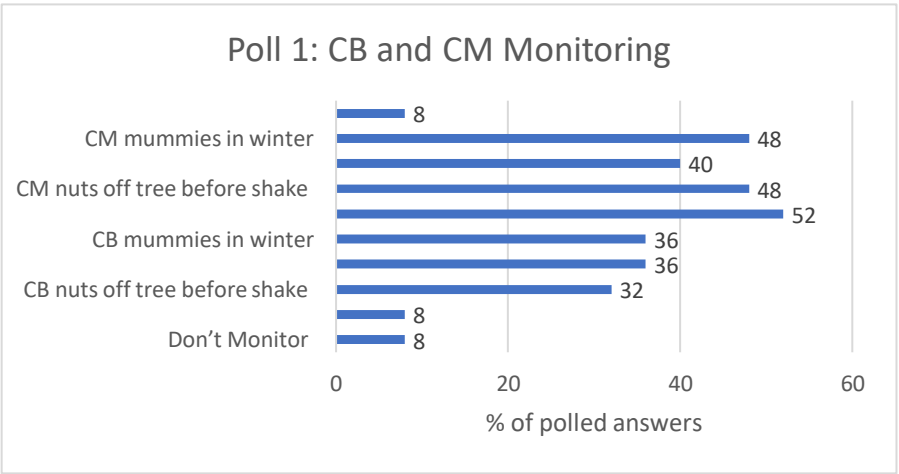

Figure 2: IPM webinar poll results on what monitoring activities were undertaken for Carpophilus Beetle and Carob Moth.

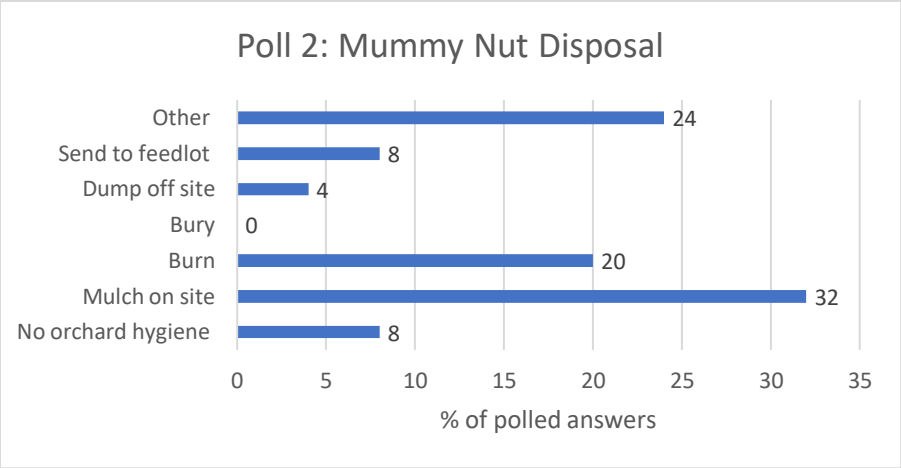

Figure 3: IPM webinar poll results on what activities were undertaken to dispose of mummy nuts.

Similarly, the poll indicated that 'Mulching on site (32%)' was the main form of mummy nut disposal. When asked why all the crop wasn't removed during harvest, the poll indicated that most thought this was due to 'disease', 'uneven nut maturity' or 'tree structure'. Interestingly 8% reported they did not undertake any orchard hygiene.

Biosecurity

Over the course of the project maintaining industry representation in Biosecurity forums has put a large demand on ID team resources and time required to attend meetings (over 100 biosecurity meetings including CCEPP, NMG, PHA general meetings, and Plant Industry Forums (PIF)) and review associated meeting papers, response plans, situation reports, and other independent studies needed to ensure business continuity for almond enterprises.

- **Emergency response systems in place and industry representatives trained.**

The ABA have continued their commitments under the Plant Health Australia Emergency Plant Pest Response Deed (the Deed) in providing industry representation in the Consultative Committee (CCEPP) and National Management Group (NMG) constructs to consider the feasibility of eradication of exotic detections of almond pests and diseases and updated Biosecurity statements. There have been four exotic pest detections requiring almond industry attention namely:

- Khapra Beetle (*Trogoderma granarium)* - two separate incidents 2020 and 2021
- Varroa mite (*V. Jacobsoni*) 2020
- Varroa mite (*V. destructor*) 2022
- Red dwarf honey bee (*Apis florea*) 2023

PHA emergency response training - Industry Liaison Officer training was undertaken by two ID staff and enabled the IDM to act as ILO in the control room (Orange, NSW) for horticultural industries during the first week of the Varroa response in June 2022. In doing so the almond industry was able to inform the response team about pollination demands, hive migration and assisted in developing movement protocols for NSW beekeepers.

During the project period a new species of powdery mildew was identified in an almond nursery however it was deemed not to be technically feasible to eradicated. A factsheet was developed by AV in consultation with the ID team on Powdery mildew of Prunus caused by *Podosphaera cunningtonii.*

- **Industry's biosecurity plans developed/reviewed and updated.**

Plant Health Australia (PHA) facilitated discussions with the ID team about the information requirements to develop an ABA specific Biosecurity Incident Standard Operating Procedure (BISOP) and a framework for the Owner Reimbursement Cost (ORC) should an incident occur on almond orchards. PHA have prepared a draft plan for the almond ORC framework however data sources are needed to finalise the document. PHA is yet to provide the draft BISOP.

The ID team have identified the need to review the 'Nut Industry Biosecurity Strategic Plan' in PHA forums and is working with PHA and the Australian Nut Industry Council (ANIC) in the process of review with a technical workshop planned for 1

November 2023 to categorise pests that pose a serious threat or economic impact to the seven Australian tree nut industries. The ID team was involved in the review and update of the implementation of the National Xylella Action plan 2019-2029.

- **90% of growers are aware of exotic P&D.**

Due to the high demand of ABA resources to address exotic pest incursion, planned activities to improve grower awareness of exotic P&D were not undertaken but will be pursued in future program and this will be an appropriate activity to do after the review of the Almond industry biosecurity strategy.

- **60% of growers have adopted on-farm biosecurity measures.**

Due to the high demand of ABA resources to address exotic pest incursion, planned activities to improve grower awareness of exotic P&D were not undertaken but will be pursued in future program and this will be an appropriate activity to do after the review of the Nut Industry biosecurity strategy.

Pollination efficiency

Pollination efficiency was identified as a high priority by the PRG because without pollination there are no crops. A concerted effort was made into documenting best management practices (BMP) guidelines to look after hives for their short stay in almond orchards and a portfolio of supporting resources was produced to assist almond growers in working with beekeepers. Beekeepers are members within the ABA Pollination Committee and assisted in the development of the BMP guideline as well as featuring in ABA videos that support the guidelines. The BMP guidelines have been well utilized by almond growers and pollination stakeholders alike and an example for other pollination dependent industries.

In addition to planned activities, border closures due to COVID (2 years) and then Varroa incursion in 2022 created great uncertainty in being ability to deliver hives to farms in both the beekeeping and almond industries. 30 stakeholder meetings were convened/ attended to navigate through these constraints and have ensured knowledge of the latest regulations enabling business continuity for beekeepers and the almond industry alike.

The ID team have worked together with Wheen Bee Foundation to promote ‘powerful pollinator’ publications suitable for almond growing regions and encourage planning of floral resources in line with the ABA BMP guideline. The ABA also applied to qualify as certified Bee Friendly Farmer (BFF) and received a tree planting grant at the ACE Almond orchard, Loxton. This will help demonstrate the benefits of improving pollinator diversity on farms. In a Nutshell Winter 2022 Vol 23 Issue 2 – Planting for a bee friendly future page 17 & 18. The ABA has promoted the BFF for primary producers resulting in 24,000ha of BFF Certified land representing 41% of the total area of almonds (58,000ha) in Australia.

The ID team has provided input into a number of Honey Bee projects including: Feasibility of artificial pollination in Almonds – PFR/GHD, Australian Horticulture Pollination Service Statistics – AgEconPlus and Australian Bee Services, PIRSA’s Pollination Services Demand Assessment and was a member on PRG for the ‘development of non-invasive methods and systems for the assessment of hive health (PH17001). The ID team has been intrinsically involved in the development of the CRC Pollination security funding bid to ensure industry priorities are included in the hope to optimize funding opportunities in the future.

The ABA have provided written ‘letters of support’ to address various Honey Bee related issues such as access to national parks and forests in SA and Queensland, and establishing certificate level III training courses in basic bee keeping in SA and Victoria.

Despite these efforts it is a continual struggle to access hives and negotiate price with beekeepers given the increase in demand associated with the expansion of the almond industry and limited capacity of the beekeeping industry to meet these demands. Growers have had to utilize all hives available and at times less than desirable quality.

- **Technologies to measure hive health investigated/documented.**

A summary of technologies that may provide assistance during pollination was compiled, circulated and discussed in the ABA Pollination Committee meetings. Refer Appendix 3. ABA Report - Pollination technologies.

Other activities to investigate hive health technologies include:

- Californian based mechanical pollination services company Antles to discuss prospects of providing similar services in Australia. Reported under Almond industry Californian study tour 2022 AL22006.
- Californian based Bee Mate and presentation made to the almond industry R&D Forum regarding the

technology. Bee Mate entered the Australian market in 2023 in partnership with Monson's honey.

- Israeli based Bee Hero discussing potential to introduce robotic apiary into Australia.

- **Honey bee BMP for Australian almonds documented**

Using the Californian publication as the starting point the ID team compiled known information together to create a draft BMP for honey bee pollination in Australian almond orchards with growers as the target audience. A working group with members from the Pollination Committee provided critique to the document and photos illustrating key aspects. A number of supporting resources have been developed to support different learning styles.

Website analytics and attendance records indicate strong interest in the pollination resources generated during the project reporting period:

- 2 ABA webinars specifically on pollination attended by 86 participants.
- 4 ABA videos with 219 unique views.
- 1 BMP Australian Honeybee Best Practice Management – 137 unique downloads.
- Pollination agreement template – 90 unique downloads.
- 2 factsheets published (quick guides) for Honey bee BMP - 126 unique views.
- 7 presentations to almond growers and pollination stakeholders – 340 participants.
- 1 grower letter template to notify neighbours of pollination – 9 views.
- 1 trade display at the 4th National Bee Congress, Sydney June 2022.
- 1 In-a-Nutshell magazine article – 502 unique opens.
- 10 grower notices promoting pollination extension activities and publications – 4,451 total opens.
- 1 ABA webpage established and maintained to host grower resources for pollination.
- 9 pollination updates to the ABA Pollination Committee.
- 1 online application for Wheen Bee - Bee Friendly Farming certification at the ABA ACE Orchard.
- 1 online tree planting grant application.
- 9 pollination topics at the Almond industry R&D Forum in August 23.

- **90% of growers are aware of honey bee BMP for Australian almonds**

Given the significance of Varroa incursion to the almond industry the R&D Forum August 2023 predominantly focused on pollination aspects that influenced pollination efficiency including the ABA published BMP document as well as other projects relating to improved hive health. Previously online webinars were held, and presentations made to beekeeping associations promoting the document together with grower notices annually linking to the ABA Webpage.

- **60% of production area is covered by pollination agreement.**

This has not been measured however anecdotally farms have reported the use of pollination agreements.

- **Maintain support for incursion response for honey bee P&D**

The Varroa destructor incursion and the 'eradication' response morphing into a 'transition to management' response during the project period has taken extensive time from the ID team in attending meetings and reviewing meeting papers and iterations of response plans – Refer Biosecurity section.

The National Bee pest surveillance program (MT16005/MT21008) project has been promoted through 'In-a-nutshell' articles and a 'poster' presentations at the R&D Forum in August 2023.

Irrigation efficiency

During the wet conditions irrigation efficiency was focused on understanding tree water demands and soil water holding capacities and scheduling tools to ensure trees received the water they needed in between rainfall events.

- **Irrigation demands for new varieties and densities investigated/documented.**

Research trials established in 2017, 2018 are reaching commercial maturity and starting to show some interesting observations and illustrated that trees in higher densities are receiving less water per tree than conventional densities. The ABA has worked with each research agency to promote the findings from the ACE Orchard and AV Smart Farm through tours and orchards walks. Trial results have been published in In-a-Nutshell, R&D Forums and the ABA Webpage – ACE Orchard, provides updates on trial results provided by the researchers.

- **90% of growers are aware of BMP for irrigation.**

The ID team worked together with Agriculture Victoria, Netafim and PIRSA to develop a series of drip irrigation training workshops in almond growing regions designed to achieve BMP. Refer Appendix 4. ABA Drip Irrigation Workshops 2022 and 2023. These workshops provided on-ground irrigation staff with the skills and knowledge about soil and water interactions, how to interpret irrigation designs, and using scheduling equipment information when making management decisions. After the success of the initial delivery in 2022 the training workshops were again delivered in 2023. Feedback indicated improved motivation to avoid over or underwatering, and confidence in knowing how to check system losses and understanding the importance of system maintenance. These forums were able to engage with new people that generally hadn't attended ABA field days or online webinars.

The ID team have collaborated with researchers and suppliers to deliver a portfolio of grower resources on irrigation BMP including:

- 9 ABA/AV/Netafim drip irrigation training BMP workshops with 177 participants.
- 2 ABA field days on irrigation and soil health attended by 68 participants with a further 76 total plays of the Soil Science Australia video recording of the field day.
- 2 ABA webinars on irrigation management and scheduling equipment attended by 65 participants with a further 23 unique views of the webinar recording.
- 2 ABA videos on the results from the irrigation audit for almond properties and how to undertake a system check with 219 unique views.
- 1 ABA factsheets published (quick guides for using soil water extractors) and 1 in development on monitoring tools for irrigation scheduling, 1 AV factsheet on Drip Drainage.
- 1 water study tour up to Dartmouth Dam and 9 stops along the way with 25 industry participants.
- 3 In-a-Nutshell articles with BMP principles, water study tour results and workshop summary – 2045 unique opens.

- **90% of growers use irrigation scheduling equipment.**

The registration survey, undertaken prior to the field day on irrigation and soil health trials in May 22 indicated that of the 38 growers who participated in this event, most used a number of scheduling tools to help with irrigation management - other devices used included a hand auger and pressure bombs. Interestingly 16% (or 6 respondents) did not use any monitoring equipment.

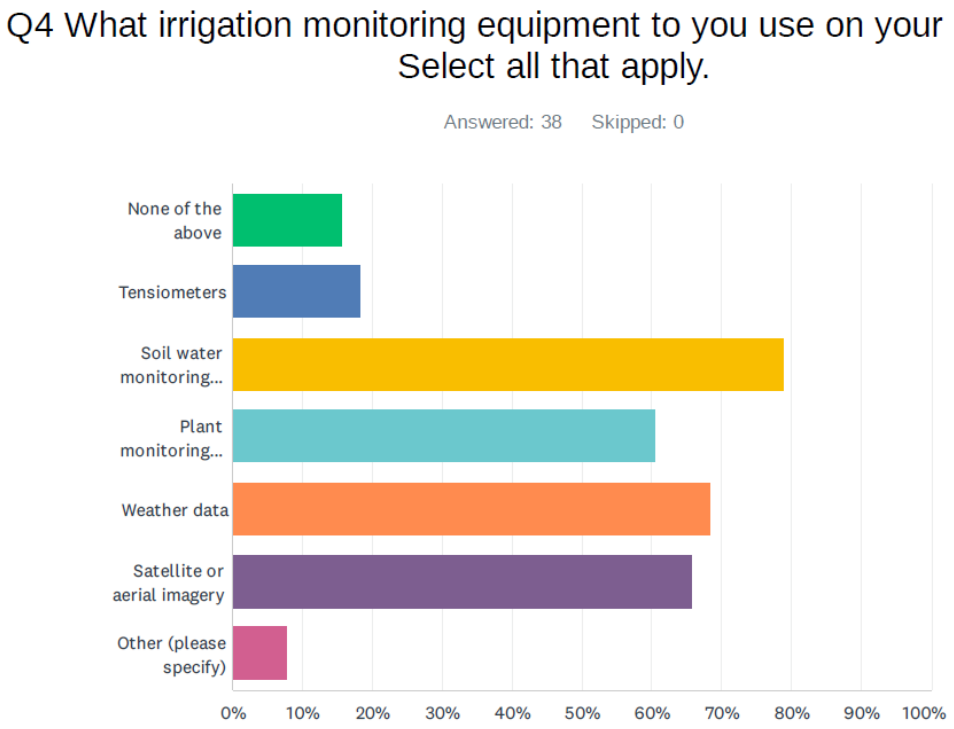

Figure 4. Pre-registration survey results for the ABA Field Day on Irrigation and soil health trials, May 22.

The webinar on Irrigation Scheduling: Growers' Experiences with Tools & Integration (September 2023), registration survey provided further detail on the type of scheduling equipment used including: capacitance probes (15), dendrometers (8), irrigation controllers (7), Et_0 (3), scheduling software (2), soil digs (2), remote sensing, canopy sensors, pressure sensors.

An ABA factsheet that describes the different types of irrigation monitoring equipment is in development to assist growers in working out what system best suits their management operations.

- **80% of growers have participated in the SARDI irrigation tool and demonstrate improved WUE.**

The SARDI irrigation scheduling tool has been included in the drip irrigation training workshops July 2022 and July/Aug 23, and the participants were shown how to access and use this tool to apply their learnings from the workshop training and assess their farm's performance via the ABA website. Analytics from the website indicate continued use of the irrigation tool throughout the year. Unfortunately, the tool does not capture individual results or allow further analysis on WUE to demonstrate improvement over time.

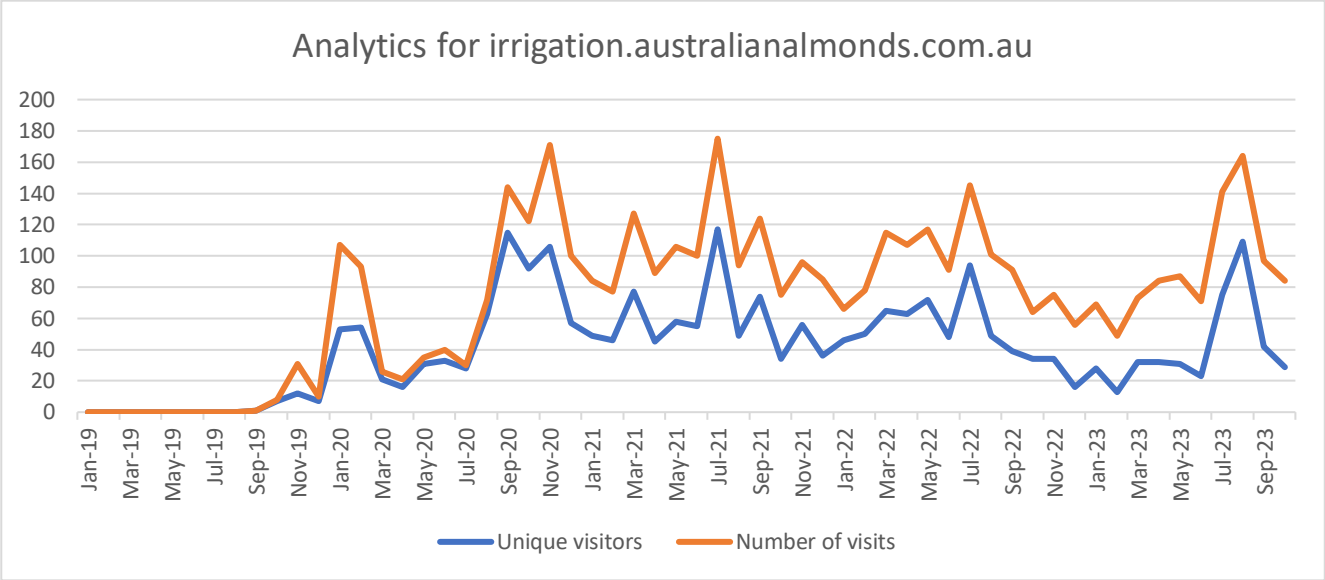

Figure 5. ABA Website analytics on the use of the almond irrigation auditing tool.

Production Systems

Intensive farming trials established in 2017 and 2018 under the Advance Production Systems Frontiers Fund at ACE Orchard, Loxton and ACE Smart Farm, Irymple are coming into commercial production. Early results and observations in regard to improve productivity and profitability have been conveyed to growers however these systems are a work in progress and will require more detailed assessment as tress mature before clear recommendations on BMP can be made.

- **Cost:benefits associated with renewing and recycling orchards documented.**

An almond orchard recycling trial was established in Merbein Victoria in January 2022 (AL21000 Pathway to carbon neutral almond whole orchard recycling). The trial in Merbein provided an opportunity to work with contractors to determine an appropriate approach using machinery currently available in Australia. Two contractors were used with total costs of $61,591 for 2.6ha, or $23,827/ha. The cost of the activity is the major constraint for uptake within the almond industry and will need to be addressed to make this a viable option for grower uptake. Refer Appendix 5. ABA Report – Whole orchard recycling. update provided to the ABA Sustainability and Production Committees.

The Californian Study Tour following the ISHS Symposium in May 2023 provided the opportunity for the IDM to visit orchards and grower field days where whole orchard recycling was demonstrated and discussed. Growers and machinery suppliers are heavily subsidized in the US through air pollution and soil health initiatives to achieve the deadline of 1st Jan 2025 when open-air burning will be prohibited by the US government. The government incentives are assisting in providing an alternative and affordable option. The estimated cost in the US ranges from $1,212 - $1,618 per acre ($490-$655/hectare). Refer Appendix 6. ABA Study Tour – ISHS Almond and Pistachio Symposium California.

SARDI project team have undertaken baselines measure before treatment application and have been collecting data at key phenological stages to measure: soil total organic carbon assessment, nitrous oxide and carbon dioxide, tree growth and development, soil compaction, soil water nutrients. The ID team are part of the project reference group to facilitate the uptake of the learnings at this site.

The ABA have been working with the leading expert Dr Brent Holz (University of California Cooperative Extension in San Joaquin County) to visit Australian almond orchards in January 2024 and will provide information on replant issues and the benefits that have been achieved through whole orchard recycling in the US.

- **Management practices that improve soil health investigated/documented.**

SARDI soil amendment trial (AL21001 optimising almond production systems) planted in 2018 has illustrated the impracticality of super-soil treatments creating weed control issues and interfering with harvest operations. While compost amendment trials have improved soil condition, they are yet to show positive impacts on canopy size or yield. Trial updates have featured in ABA magazine articles and R&D Forum 2023 and ACE Orchard open days and ABA tours.

A cover crop trial established in May 2023 by The University of Adelaide (AL21004) at the ACE Orchard and Darlington Point investigates five different seed blends. One constraint for uptake of cover crops is the inability to water the mid-row under drip irrigation – 95% of industry. An ACE Orchard open day in November 2023 is scheduled to promote the aims of the trial and the ABA grower resources webpage – ACE Orchard for project updates.

Grower-led trials conducted by Select Harvests at Lake Powell investigating the combined effect of deficit irrigation and compost application were featured in an ABA field day convened in May 2022. SHV shared their results and observations with other almond growers regarding nitrogen use efficiency, soil acidification, soil carbon and microbial populations and the influence on flowering, nut set and size and yield. Coupled with machinery demonstration of compost inclusion, soil water extractors, and new stem water potential technologies, Agriculture Victoria researchers provided an update on their satellite-based soil water balance modelling to improve estimates of crop water use and root zone drainage.

- **90% of growers are aware of new production systems.**

Trials established in 2017 and 2018 under the Advance Production Systems Frontiers Fund which aimed to improve productivity and profitability at ACE Orchard, Loxton and ACE Smart Farm, Irymple are coming into commercial production with results and observations made available to industry through open days (October 2022, August 2023 and November 2023), onsite PRG meetings (AS18001 National tree crop intensification) and project updates at R&D Forums and the ABA grower resources webpage – ACE Orchard.

While projects are still in their infancy (4th leaf) it has been clear that genotypes need more than three years to have confidence in their productive potential however some interesting results have been observed and have informed more recent ultra-high-density trials planted at the ACE including:

- Only minor yield differences between pruning / training methods.
- A cultivar has been selected (R36T212(UA102)) with narrow shape, few upright scaffold branches and a mix of spurs and short-medium shoots for planting in ultra-high-density plantings.
- Higher cumulative yields were observed for more intense plantings however the difference is more pronounced for some varieties. Hedging has been applied to overcome excessive shading in close row spacings.
- Ultra-high-density plantings were established in August 2022 at 1,111 and 1,428 trees/ha, and an informal planar cordon at densities of 740 and 952 trees/ha with a focus on mechanized harvest.
- Higher density plantings resulted in less wind damage (tree loss) however an increase in competition for water/nutrients resources.
- Varying rootstock influences on varietal growth (optimizing production systems AL21001).

COVID restricted the number of events that could be held at the ACE Orchard and AV Smart Farm until the second half of the project. The number of ACE Orchard tours and attendance records indicate a strong interest in the results:

- 2 ABA field days attended by 106 participants.
- 2 ABA videos with 93 unique views.
- 11 ABA tours of the ACE Orchard trials with 93 participants.
- 2 ABA webpages established and maintained to host grower resources for ACE Orchard project trials, and almond growth and development.
- 3 factsheets 242 unique views.
- 9 PRG meetings AS18000 National Tree Crop Intensification project.
- 1 presentation at the ISHS international almond and pistachio symposium on the establishment of the ACE Orchard. Appendix 6. ABA Study Tour – ISHS Almond and Pistachio Symposium California.
- 1 paper submitted for publication in the *Acta Horticulturae* on the establishment of the ACE Orchard.

Varieties and Rootstocks

The Australian Breeding trial is one of the longest running investments by the almond industry looking for varietal attributes that have the same look, taste and versatility as Nonpareil (NP) while at the same time address production constraints such as high and consistent yields, self- fertility, pest and disease resistance, even maturity and suitable for

mechanical harvest. While a number of new varieties have been released there has been slow uptake by industry as NP maintains market share. A review of the breeding program commenced at the end of the project period and will determine the future focus for the breeding program. Hybrid rootstocks are being tested in Australian conditions and showing promise in terms of their performance in comparison to industry mainstay Nemaguard. It is expected that greater call on these rootstocks will occur with replant scenarios as 40% of the industry reaches 20 years and nematode tolerance/resistance will be a consideration for replant situations.

- **Characteristics of new varietals and rootstocks investigated and cost:benefits of production systems documented.**

The ID team provided on-ground support in the establishment, data collection and assessment of primary, secondary and tertiary evaluations through the AL22009 Australian almond variety evaluation program planted at the ACE Orchard and earlier trials at Lindsay Point. Advice from the ABA Plant Improvement Committee (PRG) has culminated in PBR approval of Almond 36 (Aurora-B) being the best performing self-fertile variety. Consultation with processors and marketers is being undertaken to determine market potential prior to release.

The ID team also provided advice for a grower-trial site established at Hillston, NSW for heavy soil comparison of many varietals developed by the University of Adelaide.

The ID team accompanied the ABA Board during the Almond industry Californian study tour December 2022 (AL22006) to investigate potential new varieties, rootstocks and production systems. The newly released Sierra Gold rootstock SG5, has tolerance to waterlogging similar to plum rootstock, although it has a peach-almond parentage which might have potential for heavier soils in the Riverina.

Over the wet period Monterey increasingly showed leafing out failure in particular in the Riverina region. The ABA undertook an initial industry-wide survey to better understand the extent of the issue with 11% of the industry planted to this variety and if there were any commonalities between properties by way of rootstocks, age of planting, material source etc. Additional pathological investigations were undertaken by NSW DPI under the IDM project. However, no causal pathological agents have been found and isolates are indicative of secondary infections possibly resulting from a stressed or weakened tree. What is clear is this is a complex issue needing multidisciplinary approach to develop management strategies specifically for Monterey may need to be developed in the future program. Refer Appendix 7. ABA Report – Monterey Leaf failure.

The ID team have collaborated with researchers and suppliers to deliver a portfolio of grower resources including:

- 1 ABA field day looking at almond variety and rootstock performance with 15 participants.
- 2 updated factsheets about almond breeding, self-fertility with 187 unique downloads.
- 1 ABA Standard operating procedure for Budwood production – internal document.
- 6 In-a-Nutshell magazine articles – unique opens 3389.
- 4 videos on the breeding program and new varieties – 114 unique plays.

- **Evaluating almond rootstocks under Australian conditions.**

Results from the evaluation of prunus rootstocks project (AL16006) were published in a technical document on the ABA website outlining the findings from the trial work at Lindsay Point and a summary of the characteristics of each rootstock. These results were presented at the almond variety and rootstock field day August 22.

Research trials in Australia are showing similar trends as to what has been observed in California during the Californian study tour December 2022 with Peach-almond hybrids being most productive, peach rootstocks having a mid-range productivity and plum-almond hybrids having the lowest productivity.

- **Maintaining disease free and diverse genetic material.**

The ABA has provided overarching support for maintaining and supplying on average 600,000 buds per annum to almond nurseries. The ID team have developed an Almond Budwood Standard Operating Procedure including protocols for virus testing. This was performed by the ABA budwood team once annually at all three budwood sites, Monash, Loxton and Colbinabbin and processed at AgriBio Laboratories Victoria. Any tree with a positive result is removed thereby maintaining virus free source trees.

Plant Improvement

- **Nursery tree standards developed into agreement template.**

A legal firm was engaged to assist the ABA in the development of a 'Nursery Tree Supply Agreement' and 'Nursery Tree Classification Standard'. Refer Appendix 8. ABA Nursery agreement and standards. These documents were developed in consultation with the ABA Plant Improvement Committee and ABA Production Committee and nurseries to help facilitate successful transactions between nurseries and growers and a mechanism to document the agreed understanding at the time of ordering to avoid disputes at the time of delivery. The Standard works in conjunction with the Agreement and describes desired characteristics of material being supplied by nurseries including: the source of material; the grade; and health status. The Standard provides a mechanism to ensure:

- Planting material grades are characterised and distinguishable.
- Material description is consistent and commonly applied across the industry.
- Trees can be ordered and received against the specified criteria.
- The protection of the almond production environment from serious pests and pathogens

Both documents are available on the ABA grower resources webpage – varieties and rootstocks.

- **60% of growers are using nursery tree standards and agreement.**

While there has been some push-back from nurseries, feedback from growers indicate the standards and agreement template were welcomed by industry providing a way to measure quality consistently between providers and how to order their nursery material. One grower has used the ABA nursery tree agreement + standards during a tender process to procure nursery trees. In their experience there was some resistance from some nurseries who were not willing to enter into any agreement other than their own and were uncomfortable being compared with other nurseries in this process. The grower said "while there is still a way to go to get everyone onboard I think what you are doing is a good step forward and that the templates were a useful starting point." Refer Appendix 8. ABA Nursery agreement and standards.

- **95% of budwood material supplied from 2021 to 2022 is virus tested.**

The ID team have developed an Almond Budwood Standard Operating Procedure including protocols for virus testing. This is performed by the ABA budwood team once annually at all three budwood sites, Monash, Loxton and Colbinabbin and all trees are tested with trees removed it they have a positive result.

- **All ABA budwood orders filled in line with customer requirements.**

All ABA budwood orders were filled in line with customer requirements.

Food safety and product integrity

The expansion of the industry over the last seven years combined with wet conditions at harvest challenged both growers and processors in maintaining nut quality with wet/soiled fruit causing delays in processing which then extended the period that product remained on-farm in stockpiles until it could be received. The extension program focused on on-farm fumigation needed to prevent the degradation of the stored almonds and reduce mold and insect damage.

Additionally, there has been heightened concern in overseas markets (in particular the EU) with respect to chemical use and lowering of allowable residue detections in food. This has led to removal of commonly used chemicals and pressure on growers to find effective alternatives.

- **Best Management Practice (BMP) for harvest and post-harvest handling techniques updated.**

Investigations into on-farm storage and drying were undertaken by growers, however no active research is currently being undertaken. Past research findings were presented by past project leads to promote BMP and maintaining fruit quality especially during the wet season.

Two of the key learnings from the fumigation trials was the difficulty in achieving and maintaining effective levels of fumigant in stockpiles with airtight seals required using tarps and chemical absorption by the hull preventing effective levels of fumigant and potential resistance issues as seen in the grains industry.

The ID team have collaborated with researchers, suppliers and processors to deliver a portfolio of grower resources including:

- 2 webinar Food Safety and Quality and fumigation with 50 participants and a further 59 unique views of the webinar recordings.
- 2 ABA field days looking at almond fumigation on-farm and at Carwarp processing facility with 60 participants.
- 6 presentations on sustainable chemical use in almonds to over 182 industry stakeholders.
- 2 factsheets about harvesting in adverse weather with 58 unique views and 1 factsheets (in development) on 'fumigation 101'.
- 1 In-a-Nutshell magazine article A seasoned harvest - coping with a wet season – unique opens 790.
- 2 videos on food safety and quality – 114 unique plays.
- 1 ABA grower resources webpage developed and maintained.
- 1 fungicide planning tool – 128 unique downloads.
- 4 grower notices about chemical updates – 1,261 total opens and 308 clicks.
- 5 ABA Chemical Committee meetings.
- 3 emergency use permit applications – aerial application for Azoxystrobin and Propiconazole within NSW (Syngenta), and Metalaxyl-M for phytophthora control (Syngenta) – yet to be approved.

- **90% of growers are aware of food safety BMPs.**

Fumigating on-farm is a relatively new practice in almonds and a specialist field requiring licensed application. While only 8% of almond enterprises attended the field days this represented 37% of the production area. Of those growers who attended the fumigation field day 58% of those who have been in the industry more than 10 years indicate they fumigate most of their stockpiles whereas only 30% of those are new to the industry fumigate less than 10% of stockpiles.

Years' experience	Q1. How many stockpiles do you fumigate?
<5	30% of growers fumigated 10% of stockpiles
5-10	30% of growers fumigated between 70-90% of stockpiles.
>10	58% of growers fumigated between 50-100% of stockpiles.

- **90% of growers have adopted food safety BMPs.**

The National Residue Survey (NRS) monitoring residues in overseas markets reported 94.12% compliance with Australian MRL standards for 136 samples. While there were some samples with residues above the Australian MRL, no samples were found to have residues non-compliant with the destination market. The NRS testing program for almonds covers multi-residue and metal program, extended herbicide screening, metal, phosphine but does not currently include aflatoxins or bitterness compounds however individual processors do tests for aflatoxins pre-shipment.

While grower feedback indicates a good understanding of food safety and quality, best management practice (BMP) principles for chemical application, fumigation, harvest, drying and stockpile management across the industry the recent years of extreme wet has challenged this understanding and on-farm application with substantial damage reported from processing organisations.

- **Sustainable chemical use and resistance management principles are documented.**

The ID team in collaboration with chemical companies investigated the opportunity to publish a summary of chemicals and recommendations for use in almonds to avoid exceeding residue limits (MRLs) in overseas markets - similar to the 'dog book' published by AWRI for the winegrape industry.

The ABA Chemical Committee was established with membership from various chemical companies, retailers, CropLife and Hort Innovation. A draft document was developed however difficulties arose preventing the finalization of this

document due to the legalities of making recommendations for often unpublished information. Additionally, recommendation for use is reliant on knowing the agreements between sellers and their markets. As sales agreements are confidential and not available to the ABA there was potential for this publication to misguide growers especially if they supplied multiple marketers. As an alternative the ABA assisted by facilitating connections between chemical companies and marketers so that the marketers could communicate which chemicals, they were willing for growers to use. As a result, the ID team has developed a great deal of knowledge and established a network of chemical specialists.

A fungicide planning tool reinforcing Crop Life principles of sustainable chemical use to avoid resistance was developed by the ABA to help growers plan their spray programs. The ABA fungicide planning tool has been demonstrated to multiple grower forums including regional forums, Almondco grower meetings, Chemical and Production Committee meetings. The registration survey undertaken for the AV Disease masterclass (November 2023) indicated that 52% of the attendees were aware of the tool (Figure 6).

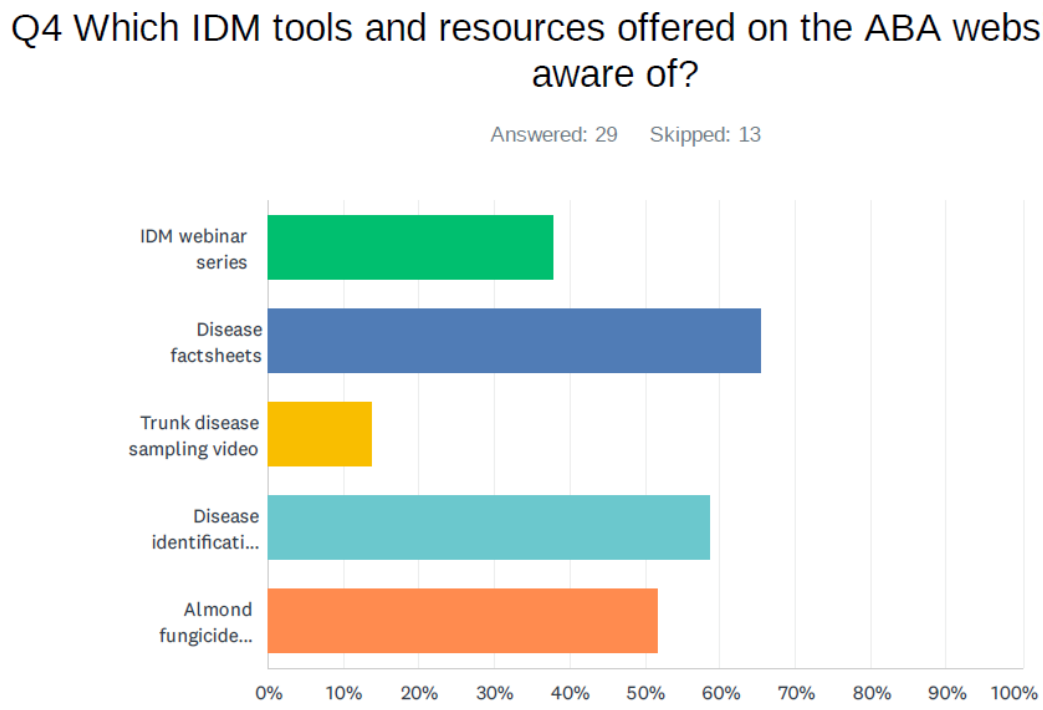

Figure 6. Responses from AV Disease Masterclass registration survey.

- **90% of growers know and understand principles of sustainable chemical use and resistance management.**

While the principles may be well known and understood by growers' feedback from chemical suppliers suggest that there is room for improvement in terms of spray application noting that application method and timing of chemicals was critical factors for the 2022/2023 growing season. It was highlighted that growers need a better understanding of wetters, adjuvants and their uses. This will be a focus for the future extension program.

- **90% of growers are aware of the 'chemical tool kit' for almonds.**

A summary of new and removed Active ingredients registered for use in almonds plus registration expiry for the European Union sourced from EU Pesticides Database (europa.eu) and permit details were presented to the ABA Chemical Committees as per APVMA website.

- **Gaps in available chemicals are addressed with new registrations or permits.**

There is concern within industry about the continual removal of broad-spectrum chemicals available to almond growers as a result of European Union and APVMA reviews.

The ID team have circulated the updates on regulatory activities that impact on product access and use in Australia and internationally (MT20007). New chemicals are generally 'softer', target specific and generally more expensive. New products and gaps in available chemistries have been discussed in the ABA Chemical Committee meetings.

The ABA have worked with chemical companies to highlight the return on investment and encourage them to develop new products and undertake R&D in Australian almonds.

During the course of the project the ID team has worked closely with Hort Innovation minor use permit applications team (AL16002) to apply for three emergency use permits as a result of the excessive wet and high disease pressures experienced including: aerial application for Azoxystrobin and Propiconazole within NSW (Syngenta), and Metalaxyl-M for phytophthora control (Syngenta) – yet to be approved.

Industry development and intelligence

The last three years have brought many challenges impacting on the industry's ability to maintain profitability largely outside of their control with pandemics, supply chain disruptions, wet weather, Varroa, to name a few. Varroa impacted on the ID team's ability to engage face to face with industry however online alternatives were utilized and welcomed by growers and even preferred by some. In addition, changes in personnel (two IDO's) took time away from delivery in order to recruit specialist skills. Despite these challenges the ID team have maintained continuity of delivery, working closely with research agencies, service providers, marketers and growers to deliver a portfolio of resources using different mediums to suit different learning preferences addressing the key important topics.

- **90% of growers have participated in the extension program, of which 90% have increased their knowledge and skills and 60% have adopted on farm.**

There was strong participation of growers in the extension program with approximately 146 unique companies attending ABA events including webinars, field days and workshops representing 86% of the production area.

A grower extension survey was undertaken to ask how they would prefer to receive information with field days (71%) clearly the most desirable approach followed by emails (60%), Conference and R&D Forums (56%) and Workshops (56%). The survey revealed a high level of awareness of the ABA's extension website, 77% of respondents indicating they knew it existed and 67% had used the ABA website to access resources and services. Refer Appendix 9. ABA Extension survey.

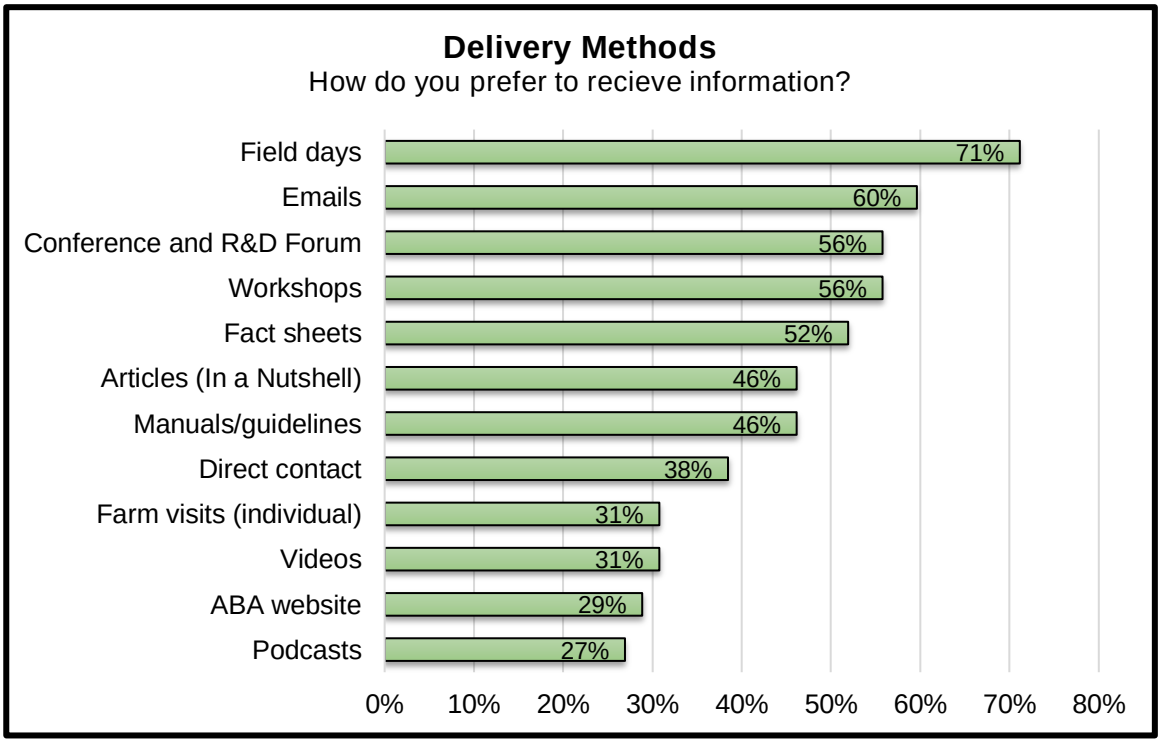

Figure 7. Response from the ABA Grower Survey, May 2023.

Feedback suggests improved knowledge and skills have been gained, and in some instances, aspirations proclaimed to make on farm changes as a result (refer to the Outputs summary). With the implementation of Almond Hort360 modules that demonstrates the progression of best management practice adoption for various production aspects demonstration of uptake will be more easily and more accurately represented from an industry-wide perspective.

- **Project outputs delivered on time; to specification and to budget**

Each year outputs were delivered in line with the annual work plan as specified in the project agreement and within

budget against with some flexibility in topics based on PRG advice to reflect the changing operating environment. While webinars, videos and publications were the media used to overcome face-to-face restrictions a program of field days and workshops quickly resumed and exceeded the original delivery target (refer Appendix 10. Project deliverables against the agreement.

A broad portfolio of publications, factsheets, videos, and tools have been published on ABA grower resources webpages for each topic area. Links are used to create awareness and promote the utilization of these resources when-ever possible in ABA publications such as Almond Bytes, In-a-Nutshell magazine, Grower notices and event promotions etc.

Website analytics suggest there is a high interest in, and utilization of, the almond growth and development webpage from passive navigation (i.e. not via a direct link) where tools produced in previous extension programs appear to be most popular: Almond Production Spreadsheet (316 unique downloads); Interactive Flowering Graph (190 unique downloads); Flowering Reporting Tool (47). Refer Appendix 11. ABA Website analytics.

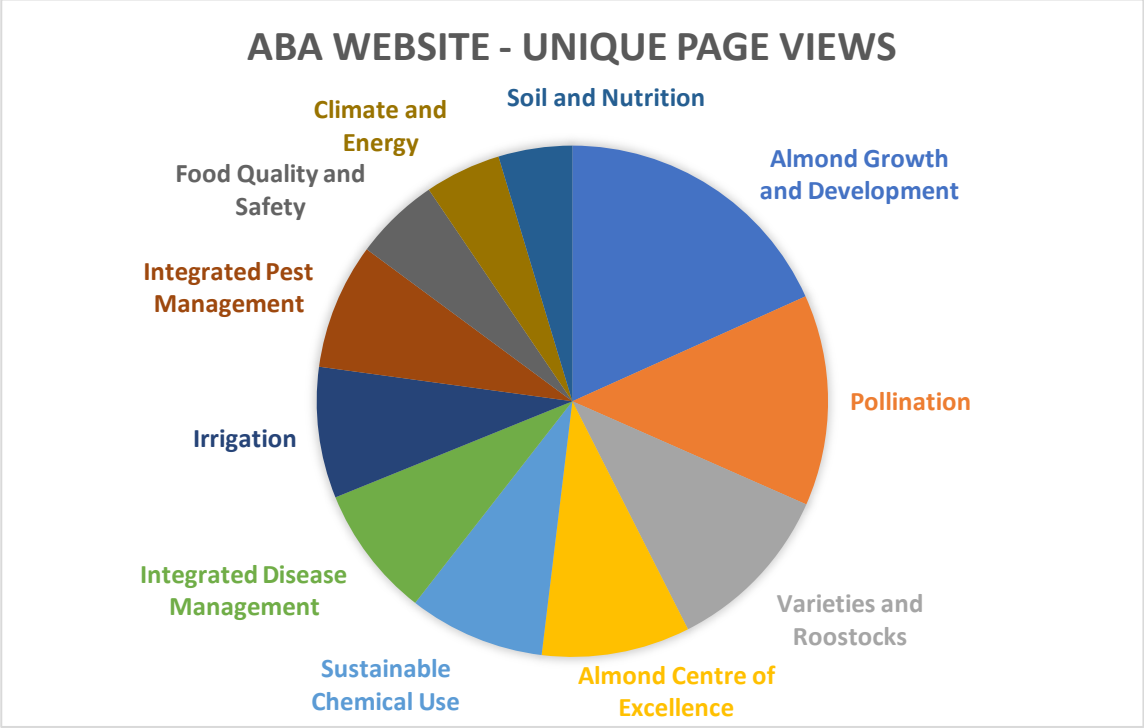

Figure 8. ABA Website analytics on the number of views for grower resource pages.

- **60% of growers participating in a segmentation study to identify preconditions fostering adoptions and key constraints preventing adoption.**

Segmentation information regarding their role in the industry, location, time in the industry and size of property together with their observation on farm and constraints preventing BMP for each topic were collected through the registration survey. This information is saved in the Event Feedback spreadsheet supplied to Hort Innovation and was used to inform events and design further extension products.

- **At least one focus group established in each region to address key industry topic/ theme.**

The second half of the project focused on face-to-face events that had been missed during COVID. Irrigation workshops and field days on fumigation and Agtech demonstrations were held in each region as they were relevant to all regions.

Formal focus groups are yet to be established in each region however there have been on-farm gatherings addressing Monterey decline in the Riverina, and Carpophilus Beetle and Carob Moth control in Sunraysia. Online workshops for the nutrient monitoring network are proposed for next year.

- **Workforce needs for the Almond industry is communicated to SA, NSW, WA and Victorian educational institutes.**

A meeting with the University of Adelaide Agricultural Science Coordinator established connections and highlighted potential areas where the almond industry could be involved to encourage students to consider a career in almonds.

- **Skilled labour available / More graduates working in almonds.**

Skilled and unskilled labour demands were challenged during COVID. The ABA provided representation in regional meetings regarding labour force issues as needed.

The ID team held information booths at University Career Days at Urrbrae High School and Deakin University – Wagga Wagga and the University of Adelaide. Flyers were produced listing the various types of jobs that students might be interested in. The ID team presented to the University of Adelaide Students at their Riverland tour. In addition to talking to high school students at the Urrbrae High School careers day the ID team was also able to connect with the National Farmers Federation Training and Career Development Coordinator to incorporate almond farms in their program.

- **At least one R&D concept submitted per year to address R&D gaps.**

During the project there have been three new project concepts developed by Hort Innovation with assistance from the ID team including cover crops, pathway to carbon neutral - whole orchard recycling and life cycle assessment.

The ID team has been a pivotal member of the core bid group in the development of the funding bid for CRC Pollination Security. Success or otherwise will be indicated in December 2023.

The ABA worked with research agencies in the development of various project concept ideas to capitalise on state and federal funding initiatives to increase the number of almond R,D& E projects to support Australian growers including:

- National Landcare Program – Round 3 October 2020 (SARDI/ABA) Demonstrating and refining grower friendly tools to improve nutrient application efficiency and almond quality across the Murray Darling Basin. Successful.
- Agrifutures Carbon Initiative Mar 21 – SARDI - Using orchard waste to improve nitrogen use efficiency and productivity of almonds. Successful.
- Future Drought Fund: Drought Resilience Innovation Grants Program Sept 21 – ABA/SARDI – Investigating soil water and plant establishment responses to whole orchard recycling in Australian soils and production systems. Unsuccessful.
- Future Drought Fund: Drought Resilience Innovation Grants Program Sept 21 – ABA/UniSA – Returning almond biomass to fragile Mallee soils improving soil health and moisture retention. Unsuccessful.
- Future Drought Fund: Resilient Soils and Landscapes Jan 22 – ABA call for project ideas for collaboration with research agencies and private companies resulted in three project concepts submitted by SARDI, CSIRO, Agriculture Victoria. They were, however, unsuccessful.
- Future Drought Fund: Extension and Adoption of Drought Resilience Farming Practices Grants Program Dec 22 – The University of Adelaide (UofA/ABA and other hort industries) - Decision making in water constrained settings (drought) – supporting productivity and longevity of perennial horticulture crops. Unsuccessful.
- PIRSA Agtech Growth Fund Grant May 2023 - Athena IR-Tech/ABA/The UofA/Wineries - Maintaining Soil Water Balance through Evapotranspiration Measured with Satellite Imagery. Successful.

Outputs

ABA Webinars

Published during COVID a five series ABA webinar on 'preparing for a wet harvest' was initiated by the ID team on PRG advice and in response to the impending LaNina. The webinar series was aimed to assist growers, especially new entrants who had not experienced the previous wet conditions in 2016. The series covered a range of topics that were thought to be influenced by wet conditions and involved researchers, growers and commercial tools (where available).

Feeback from growers about 'what other information would they like to know' identified topics for following webinars.

Topic	Content	Attendees	Unique downloads
1. Integrated Disease Management – NOV20	Industry-wide survey findings; Anthracnose - typical wet season disease; Lower Limbe Dieback & phytophthora; Grower observations and experience; Crop Protection; Trunk disease - what do we know; Almond Rust modelling tool.	47	44
2. Irrigation management – NOV20	Optimising irrigation through system maintenance; Grower observations and experiences; Taking irrigation design to the next level.	41	28
3. Integrated Pest Management – NOV20	Carpophilus beetle identification; Grower observation and experience; The functions and requirements of insecticides; Risk management of potential pest populations; Commercialisation of past research - Mummy nut mapping.	51	73
4. Food Quality and Safety – DEC20	Processing almonds in a wet season; Learnings form previous wet harvests; Understanding the food safety challenge in a wet season; Current research and moisture management options	22	33
5. Sustainable Chemical Use – DEC20	The international regulatory environment; Getting the most out of our chemical toolkit; Chemical use and market considerations; CropLife - stewardship programs; Revisiting spray efficacy research.	28	34
6. Integrated Pest Management - Carpophilus beetle and Carob moth – SEPT21	Life cycle; damage identification; monitoring; management.	53	17
7. Managing wildlife and pest animals in almonds – OCT21	Wildlife behaviour; Vic permit requirements; Bird lazer; grower experience; CSIRO mice update	37	12
8. ABA Pollination Webinar – APR21	How industries are working together to secure pollination resources; NSW DPI research update on bloom progression and removal of hives; overview of the BMP guidelines	49	152
9. Insect management using fumigation in almond stockpiles – FEB22	Results from Almond fumigation trials.	28	30
10. Almond Trunk Diseases - Project updates, field surveys and field sampling – NOV22	Project updates, field surveys and field sampling.	19	23
11. Israel Trade Commission - Pollination & Beehive Tech Companies – JUL23	Bee Hero, Bee Wise, BeeMax, Edete.	37	19

12. Irrigation Scheduling Webinar – SEPT23	Irrigation Scheduling Webinar: Growers' Experiences with Tools and Integration	24	0
Total	Refer to Appendix 12. ABA Webinar Series. for summary reports.	**466**	**472**

In general growers appreciated the webinar format during COVID and participating in events without travelling. There were mixed responses regarding the webinar content between new growers and experienced growers. New growers (<5 years in the industry) were keen to better understand the fundamentals and appreciated having access to knowledge owners. “I thought it was fantastic, very impressed and included most of what I wanted to know. Presenters were experts in their field, and they had good ideas and different approaches.” In comparison growers who had been in the industry for >10 years were looking for more detail and assumed the industry had a higher baseline of knowledge, “Webinar was good but covered pretty basic stuff. Expect that 70% of growers would be well over what was presented.” Irrigation Nov 20.

Post webinar survey indicated that growers valued learning more about the topics presented in particular:

- “Need to get out and observe what is happening in the orchard”, “Pay attention to the weather conditions and the importance of optimum timing of spray applications.”- IDM Nov20
- “Today was good. Anthracnose symptoms presented by Suzanne – that is not what we are seeing but what everyone is calling Anthracnose…we ain't got any of that!!” Service provider feedback - IDM Nov20.
- “Grower solutions to system drainage/wet areas”, and “Maintenance of irrigation system is paramount.” – Irrigation Nov20.
- “My lack of knowledge regarding Carpophilus beetle” – IPM Dec20.
- “Most interested to learn more about aflatoxins so thank you for that. Really great mix and relevant to the upcoming season with much to think about and prepare for.” - FS&Q Dec20.
- “Resistance management tool from Crop Life”, “Great Initiative and a must with the growth of the industry and the changes in chemical options.” Corteva rep – Sust Chem Dec20.
- “Life cycles, timing and location in the tree and on the ground, hygiene is the key and it starts at harvest!!!”,
- “New developments in pest management and importance of hygiene’ and ‘How tree architecture can help in reducing mummy nuts.” “Life cycle of these bugs and where to find them in the orchard and importance of growing varieties with hard shells as this seems to be a better way forward!” – IPM Sept21.
- “The specific aspects of BMP about Honeybee health”, Chemical applications during flowering plus timing of hive drops”, “Elizabeth's work with pollen collection and showing what the bee's do. Her work showing the different pollen collected during almond pollination was good and encourages the idea of planting bee forage. Trevor's presentation was helpful and showed how far the bees will fly to find what they need. Josh's running of the webinar was amazing!” – Pollination Apr21.
- Information on the sensors and tarps for stockpiles” – Fumigation Feb22.

As a result of participating in the webinar survey respondents indicated they would:

- “Start monitoring for disease earlier and time treatments better” – IDM Nov20.
- “Look out for further results from research currently underway” – IPM Dec20.
- “Revisit spray applications”, “implement chemical rotations”, and “use the rust model” – Sust Chem Dec20.
- “Better understanding of weak areas in existing irrigation systems”, “Putting maintenance into practise.” – Irrigation Nov20.
- “Certainly more aware and can apply this to the coming season - FS&Q Dec20.
- “Approach harvest and post-harvest hygiene with more effort”, “Continued training and monitoring harvest operators. Do more counting and assessing damaged nuts immediately after harvest and before processing. Employment of specific scout to carry out this work.”- IPM Sept21.
- “I will change when I spray these products and what they are mixed with.” “We always welcome more information on bees and pollination. It sure has changed from my first few years to now (>10 years), regarding spraying herbicide/fungicide/anything really. We do not go around knocking down all the flowering weeds anymore and more water is out for the bees than we previously did.” – Pollination Apr21.
- “Review current practices and look for improvements” – Fumigation Feb22.

ABA Field Days

The program of field days was delayed until the third year (mid 2022) of the project after COVID restrictions were lifted.

Topics were selected to showcase almond research and grower trials and orchard demonstration of best practice and new technologies.

Topic	Content	Attendees
1. GoTrack Autonomous tractor demonstration (AE Orchard – Feb 22)	Targeted invitation to the ABA Production Committee and ACE Orchard Committee members to inspect and see demonstration of the retrofitted tractor enabling autonomous operation.	**15**
2. Irrigation and soil health trials (SHV, Lake Powel and Carina West - May22)	Irrigation deficit trials at Select Harvests, SARDI soil water extraction and Monitoring network project, Netafim Stem Water Potential technology, Ag Victoria satellite-based soil water balance modelling to improve estimates of crop water use and root zone drainage, SHV compost trials and impact on nitrogen use efficiency and productivity. One survey response indicated they were 'satisfied' with the event with information about Solusamplers, half rate irrigation and soil pH observations of most interest. As a result, this grower intended to check their soil pH and monitor change over time.	44
3. Soil Science Australia: Riverland Soil Knowledge Day (ABA ACE Orchard – Jun22)	Understanding Organic Matter in soil, and organic amendment trials in almonds. The ABA collaborated with SSA in organising and promoting the event. Almond growers were provided a discount to attend and the SSA video is published on the ABA website.	24
4. Demonstration of new and autonomous technologies (Hattah, Tooleybuc, Griffith, ACE Orchard – Jul22)	Insight TRAC – robotic removal of mummy nuts & GOtrack - autonomous vehicle demonstrations and AWMA Fish Screens.	131
5. Almond variety and rootstock (Lindsay Point – Aug22)	A farm walk through the varietal breeding trial & rootstock trial at Lindsay Point and discussion about performance.	15
6. Agriculture Victoria – Smart Farm walk and research update (Irymple – Sept22)	Overview of the research trials being conducted at the Ag Vic Smart Farm.	43
7. ACE Orchard - Open Day (ACE Orchard – Oct22)	Following the ABA Conference in Adelaide, the ACE Open Day show-cased research trials and provided an update on trial results.	63
8. Integrated Pest Management - Carpophilus beetle and Carob moth (Aroona Farms, Liparoo – Nov22)	Pest ID; life cycles; hygiene; traps; stockpile management. Growers valued being able to hear about technical observation and research results in an orchard setting.	29
9. ABA Almond Fumigation Field Day (Century Orchards Loxton, ofi Processing Facilities Carwarp and Griffith – Apr, May and Jun23)	Pests, lifecycles, fumigants & monitoring (NSW DPI), Commercial experience and best practice (Australian Fumigation), Grains industry experience & grower experiences (Harveston Aeration Solutions). Growers were 'satisfied' to 'very satisfied' with the event finding all aspects presented useful as many growers had not yet undertaken fumigating stockpiles on farm. As a result of attending growers were considering 'changing their fumigation program', 'talking to other experienced growers to find out what has worked within their system' or 'do further research'. Refer Appendix 13. ABA Field Day – Fumigation. summary report.	60
Total		**409**

ABA Workshops

Workshops were delivered to provide a more detailed understanding of key aspects in growing almonds and input efficiency.

Topic	Content	Attendees
1. Climate change in Almonds online workshops: • Improving the almond model –Aug 21 • Results of the improved almond model – Dec 21 • Industry presentation modelled future yield impacts; growing season; water requirements; future heat events Eto, rainfall and chill portions – May 22	In collaboration with Agriculture Victoria (AV) almond growers provided input data to develop a model to predict likely production responses of almonds (and other crops) in the Mallee under likely future climate scenarios. Modelled projections were minuted and circulated to participants. Refer Appendix 14. ABA Workshop Report – climate change. AV have published a factsheet with the results of the modelling activity. Growers indicated that the modelled results were "more positive than expected and couldn't see too much impact other than shorter growing seasons, may be good in avoiding issues with late season harvests". "May need to select for early flowering in the breeding program and low chill varieties."	57
2. Carbon Footprint and Feasibility – Loxton, June 22	The ABA collaborated with Ag Excellence Alliance and invited two people from 10 almond farming businesses to participate. Each business provided data to independent consultant Integrity Agriculture and Environment (IAE), who analysed their business carbon footprint and carbon emissions which were then discussed in the workshop. 71% of participants said the workshop 'definitely' improved their knowledge about carbon footprints (29% selected 'some') with most (64%) of growers aspiring to carbon neutrality and engaging with future carbon projects, 36% were focused on maintaining market access. However, the confidence was not strong in gaining a carbon neutral target for the almond sector with only 14% 'definitely confident' most (50%) were neutral. As a result of attending the workshop 36% of participants said they would revisit their farm business plan to update their actions.	22
3. Improving nutrient application efficiency in almonds using soil water extractors – (online) July 22	In collaboration with SARDI the workshop introduced growers who were part of rootzone nutrient monitoring network (60 probes), across multiple regions and almond farms (12 farms), to the principal goals of the network - to demonstrate the value of Soil Water Extractors (SWE's) as rootzone nutrient monitoring tools, and to educate almond irrigators around potential efficiency gains in their fertigation schedules. This is part of a Department of Agriculture Water and Environment National Landcare Program (Smart Farms Small Grants Round 4). A quick guide was published to help participants maintain their SWEs. SWEs-Measuring-Soil-Fact-Sheet-LG06-23.pdf (almondboard.org.au)	14
4. ABA Almond Drip Irrigation Workshop Series - 2022: • Loxton July 22 • Robinvale Aug 22 • Griffith Aug 23	In collaboration with Agriculture Victoria and Netafim the ABA convened a two-half day training workshop covering: soils, drip systems, scheduling and data interpretation. A mix of theory and practice within field soil classification and systems checks enabled growers to test their learnings. The workshops targeted irrigation manager who are in the field and attracted a lot of new faces that don't generally attend field days or other events. "The way it was delivered kept me engaged. Mix of outdoor and theory – applied knowledge and practical use of theory." Irrigation Manager 3 Years. "The soil pits were very interesting, which gave clear insight on how different soil gets and how the root system grows." Irrigation Hand, 18 months in industry.	61

	In a Nutshell Spring 2022 Vol 23 Issue 3 (joomag.com) – Page 22 & 23.	
5. ABA Almond Drip Irrigation Workshop Series - 2023: • Loxton July 2023 • Robinvale Aug 2023 • Mildura Aug 2023 • Griffith Aug 2023 • Online workshop – irrigation scheduling tools and integration Sept 2023	Building on the success of the previous year the ABA convened a second round of drip irrigation management workshops in collaboration with Agriculture Victoria and Netafim using a similar format and topics but an additional venue in Robinvale and online workshop on integrating scheduling tools as a result of 2022 feedback. Grower response was again positive valuing all parts of the program with average satisfaction of 4.4 out of 5. Some of the changes growers nominated included 'system monitoring, checking multiple points and not individual ones', "the workshop has shed light on current practices and through maintenance and scheduling will look at improvements", and "I really enjoyed the course, and it was good to get an understanding of the challenges that others are facing." "Interesting workshop thank you, and as a result we are speaking to Swan Systemswith regards to their Eto scheduling software, in the meantime I'm using the spreadsheet from the ABA website. I'd like to modify it to reflect our different varieties..." NSW grower who attended the scheduling tools online workshop.	96
6. Lifecycle assessment workshop	Review the results of the almond industry life cycle assessment (AL20005) and greenhouse gas emissions (GHGE) and to workshop potential mitigation strategies to reduce industry hot spots.	36
Total		**286**

ABA Factsheets, Guidelines & Grower notices

Factsheets, Guidelines and Grower notices were produced by the ABA addressing gaps in information available to almond growers.

Topic	Content	Unique downloads
1. Pest-bird-control	Information covers economic and environmental benefits of bird presence in almond orchards, measuring bird damage and early forecasting, control techniques, legislation, social environmental factors affecting bird control.	35
2. Evaluation of prunus rootstocks - AL16006	Results from the rootstock evaluation trial Lindsay Point.	27
3. Adverse weather at harvest: resources	A summary of resources available to help achieve a quality harvest. Topics cover ensure your crop has a home, what previous experience tells us, knowing and promoting food safety, potential pest and diseases during adverse weather, moisture management, canopy coverage.	58
4. Harvesting in adverse weather	The harvest process, when to start harvest, back sweeping to manage windfalls, avoiding moisture, conditioning, drying within the orchard, finish drying on drying areas, mechanical drying, on-farm storage. Published May23.	-

5. Quick guide for soil water extractors	What they are; when to use them; the benefits of measuring soil water; how to install and use SWE.	-
6. Australian Honeybee Best Practice Management	Written for growers about how to look after bees while hives are in the orchard to maximise pollination. Headings include, communication, pollination agreements, independent audits, bee biosecurity code of practice, phase in and out to match flowering, hive placement, floral resources, WHS, chain of responsibility,	137
7. Honey bee best management practice - quick guide for spray operators	Summary of key points from the BMP guidelines specific to spray operators.	38
8. Honey bee best management practice – quick guide for growers	Summary of key points from the BMP guidelines based on what to do in each season.	88
9. Career options in Almonds	A flyer produced to have available at Career expo information displays listing all the different types of careers available in the industry to attract more young people to almonds.	NA
10. Fumigation 101	Basic principles, products and practices of onfarm fumigation of almond stockpiles to reduce contamination and spoilage – in production.	NA
11. Monitoring Tools - Irrigation Scheduling	Monitoring tools for irrigation scheduling and how they work along with their advantages and disadvantages – in production.	NA
12. Nursery letters - Nursery agreement template and standards	Consultation package including letters to nurseries to notify them of impending tree standards and agreement template. Refer summary report Appendix 8. ABA Nursery agreement and standards.	19
13. Grower notice - Nursery agreement template and standards	Promotion of the almond industry nursery tree standards and agreement template available from the ABA website. Refer Appendix 15. ABA Grower notices.	296
14. Grower notice – Mice update	Mice updates were circulated to all growers with updates on CSIRO monitoring and links to ABA Factsheet on mice control in almonds. Refer Appendix 15. ABA Grower notices.	
15. Grower notice – preparing for pollination	Highlighting past work done by Saul Cunningham (CSIRO) on enhancing pollination efficiency, hive stocking rates and hive placement on fruit set. Promoting grower resources on the Pollination webpage and letter templates for neighbour notification. Appendix 15. ABA Grower notices.	588
16. Grower notice – nutrients for almond pollination	How micronutrients can help with pollination efficiency. Time for action occurs throughout the season, with a shuck fall spray not far away for most regions. Appendix 15. ABA Grower notices.	602
17. ABA letter template - Notice of bees on site	Letter template providing notice to neighbours when almond pollination is due to occur and who to contact if there is an issue. Appendix 15. ABA Grower notices.	

ABA Magazine articles

Industry articles were written and published in the quarterly ABA industry newsletter 'In-a-Nutshell'.

Topic	Content	Unique views
1. Replanting considerations	What to think about when replanting an almond orchard.	502

2. Pollination 2020 season update	A summary of pollination related industry issues including the Pollination COPs, best management practices, effect of bushfires on pollination resources and importance of early communications with beekeepers.	502
3. In the orchard: the causes and different types of gumming	The different types of gumming and potential causes and how to work out which is the cause.	502
4. New Australian almond varieties	Results of interviews targeting those who are growing the new Australian almond varieties and what they are observing.	412
5. ABA webinar series	A summary of webinars held to assist growers prepare for adverse weather conditions and a link the download the webinar from the ABA website.	413
6. Irrigation management best practice	A summary of the key learnings from the Irrigation webinar.	413
7. Monterey leaf bud failure	Results from an ABA survey of Monterey growers and a literature review on all information currently available. Supplemented by the briefing paper provided to the ABA Production Committee. Refer Monterey leafing failure report Appendix @.	475
8. Onshore biosecurity levy	Highlights the issue of risk creators at entry ports into Australia.	475
9. ABA Budwood production	ABA budwood program purpose and how it works.	605
10. Setting the standards	A summary of the new industry standards and agreement template for nursery trees.	659
11. Beyond the borders – how our extension team beat lockdowns to keep engaging	Overview of the extension activity during COVID with link to grower resources page.	790
12. A seasoned harvest - coping with a wet season	Riverina management of wet conditions during harvest, drying and storage techniques.	790
13. Almond fungicide planner designed by the ABA	The purpose, functionality and where to find the ABA fungicide planner.	790
14. Where the river flows – page 10	Summary of the learnings and insights from the ABA Water System and Supply Study Tour.	811
15. The future of carbon farming – page 31	Summary of the carbon feasibility workshop.	811
16. New and autonomous technologies – page 35	Highlighting past work done by Saul Cunningham (CSIRO) on enhancing pollination efficiency, hive stocking rates and hive placement on fruit set. Promoting grower resources on the Pollination webpage and letter templates for neighbour notification. Refer Appendix @.	811
17. Growers flock to pest management field day – page 35	Summary of the IPDM field day.	737
18. Growing with the flow – Page 22	Learnings from the 2022 Drip Irrigation training courses and the key principles of irrigation management.	822
19. Rootstocks – Informing decision making using the ABA Rootstock Project resources – page 37-38	The article uses the AL16006 technical document and rootstock characteristics summary to note the considerations when choosing a rootstock for replant situations.	737

ABA Videos

Videos were produced on key topics as relevant during the season as determined by the PRG.

Topic	Content	Unique views
1. Australian almond breeding and evaluation program – May 20	A video series featuring Michelle Wirthenson (The University of Adelaide) providing an overview of the breeding program and showing the various tree, flowering and fruiting characteristics in the field for four of the new varieties: • Overview • Maxima • Carina • Mira	34 24 37 19
2. Pollination video series – Aug/Sept 20	A series of videos to promote hive quality in almond orchards supplementing the principles documented in the ABA BMP for Honey Bees in Almond orchards. • Honey bee BMP in almonds pollination series Part I: Standards for pollination efficiency • Honey bee BMP in almonds pollination series Part II: Biosecurity	68 56
3. Pollination video series – Aug 21	A series of videos to promote hive quality in almond orchards supplementing the principles documented in the ABA BMP for Honey Bees in Almond orchards. • Almond Pollination - inside the hive • Almond Pollination - biosecurity for apiarists	25 70
4. Irrigation series – Aug 20	A series of videos to convey the results from the irrigation audit project undertaken by SARDI Almond irrigation best practice management (AL17004) for almond properties and instructional video on how to undertake systems check and the importance of maintenance. • Irrigation systems audit - what the study told us • Irrigation systems monitoring and maintenance	23 23
5. Soil Science Australia: Riverland Soil Knowledge Day – Jul 22	A video recording of the Soil Science Australia field day undertaking soil pit investigations and discussions about how soil properties affect tree growth.	76
6. Crop Protection	An interview with Graeme Judd (Area Manager / Agronomist, Muir & Sons) on how chemical sprays fit into an integrated pest management program.	35
7. Coping with adverse weather at harvest – Mar 21	Adverse weather at harvest: Production Committee Recording providing grower experiences and insights in how to cope with wet weather	77
8. ACE Orchard – Aug 21	ACE Orchard Development 2017-2021	53
Total		**620**

ABA Presentations

Presentations were developed on key topics on invitation by almond industry stakeholders.

Topic	Content	Attendees
Biosecurity	1. Horticultural Industries Biosecurity Presentation to Mildura Rural City Council Forum 2. 34th Plant Industries Forum - Learnings as ILO in the control center Varroa	13 24
Agtech	3. PIRSA Agtech field day - ACE Orchard and technology used in the almond industry	50
Pollination	4. SAAA meeting - Honey Bee BMP presentation 5. SAAA Conference - The almond industry: current status and future growth 6. VFF Beekeeper Branch/CVAA Pollination forum - almond industry update 7. Uni of Sydney - Improving pollination relationships - best practice for almonds 8. SAAA seminar - How Varroa destructor has affected the almond industry 9. CMV Farms - Industry update - Varroa response 10. Israel Trade Commission - Pollination & Beehive Tech Companies 11. Jurisdiction meeting Varroa T2M - hive movement from almond perspective 12. NSW Bee Congress 2023 – Penrith – almond industry update	63 54 109 40 40 35 60 400
Production systems	13. Presentation to Macadamia masterclass graduates - Almond industry and ACE Orchard research.	25
Nutrients	14. Fertigation Calculator demonstration	
Chemicals	15. Presentation to Nufarm - ABA Industry update. 16. Chemical situation update - AlmondCo grower meetings Northern Adelaide Plains and Riverland. 17. Presentation to Nutrien Ag Services - Southern Agronomy Conference - on the Almond industry's approach to dealing with the changing export environment and product residues. 18. AL22002 Disease Masterclass – sustainable chemical use	35 67 50 30

ABA Tool

ABA fungicide planner	Planning tool allowing growers to plan their spray program in advance with chemical rotation using CropLife recommendations to avoid chemical resistance. The tool also provides link to further resources. Unique views from the ABA website 128.

ABA Study tours

Tour	Purpose	Description
Domestic: Water System and Supply Study Tour – June 2022.	The purpose of the 3-day tour was to provide opportunity to industry representatives (25) to gain a better understanding of the Murray-Darling and Goulburn water systems and supply issues.	The three-day tour included 25 members from the ABA Board and ABA staff; ABA Water, Sustainability and Production Committee as well as one citrus industry and one irrigation agency representative. A program of presentations from Victorian and NSW state government agencies and private irrigation companies at 9 locations describing various aspects and features of water management on-route. Grower feedback (72% of participants) indicated they were extremely satisfied that the event met its objectives and were highly impressed by the program of presentations. The presentation on the Barmah Choke (NSW DPI) was most valued (100%) by the group. "It was really valuable to look at water management from an environmental perspective." The participants provided insights into what can be done to assist the almond industry, "Highlighting the issues, and what is needed to fix it. The Story is not that Almonds are destroying the river, this is a problem of bureaucratic

		non-decision making." "ABA to work with government departments on a communication strategy to highlight challenges around water use and delivery security. Reinforcing this message within our industry to curb unsustainable future almond plantings that haven't secured water/ haven't secured a supply agreement with a processor/ marketer. Being proactive in this manner will make our growth more sustainable and help combat against a future backlash as far as negative public relations on water use/ other resources is concerned." "Largely an education process for our growers regarding the future water environment and what can be expected. It is also important we put measures in place to protect our 'social license to farm'. As the conditions get dryer, we can't be seen to be putting other industries out of business." Refer Appendix 16. ABA Study Tour – Murray-Darling water system and supply.and In a Nutshell Winter 2022 Vol 23 Issue 2 – Page 10-13.
Overseas: Californian Study Tour Report – Dec 2022.	Accessing research findings and new technologies Establish and improve relationships with Californian industry. Improved awareness of issues & opportunities faced by California.	The ID team (2) accompanied the party of 11 ABA Board members and ABA staff during a 4-day Californian study tour followed by attending the 50th Annual Californian Almond Conference in Sacramento December 2022 (AL22006). The program included commercial companies e.g. OMC and Flory to inspect orchard equipment and OMC's newly developed shake and catch machine and Corigin Solutions to discuss organic solutions from farm waste. Visits to Duarte Nursery to hear about new varieties. The group met with the ABC (Modesto) to hear about industry drivers and strategies in adjusting to water regulation, carbon footprint and sustainability. A day with UC Davis researchers with presentations on various production aspects. As well as hearing the lasted research and networking with US counterparts and service providers the Conference provided the opportunity to attain various publications and handouts providing examples of grower resources that might be produced in Australia. The ID team produced summary reports on various aspects e.g. new varieties and rootstocks (refer Appendix 17. ABA Report – Californian study tour new varieties. and mechanical pollination (Refer Appendix 3. ABA Report - Pollination technologies. In a Nutshell Autumn 2023 – ABA board and staff benefit from US California study tour.
Overseas: VIII International Society for Horticultural Science (ISHS) Almonds and Pistachio Symposium & Study Tour – May 2023	Presentation on the success of the ACE Orchard as a research facility and demonstration orchard. Accessing new research findings and technologies. Establish and improve relationships with Californian researchers. Improved awareness of issues & opportunities faced by California.	The IDM attended the International Symposium on Almonds and Pistachios held by the International Society for Horticultural Science for the first time in 3 years due to covid19. A paper was written, and presentation made on the establishment and success of the ACE Orchard as a research facility and demonstration orchard. The IDM organized a 4-day study tour followed the Symposium providing insight into changes in Californian water regulations, remote ET_0 modeling to measure water use, whole orchard recycling, replanting considerations, beehive technology monitoring hive health, urban gardens to improve pollinator diversity and engage with community. Learnings from the 4-day Symposium and study tour is provided. Refer Appendix 6. ABA Study Tour – ISHS Almond and Pistachio Symposium California.

ABA Regional Forums

Regional forums	Providing update on industry priorities and project status.	Regional forums were disrupted by Covid preventing travel and face-to-face interaction. In 2020 the regional forum was presented on-line. In subsequent years field days were held in various regions and two regional meetings convened in the Riverina at the same time as Board meetings.

ABA Mid-term review

Mid-term review report – July 2022	An external project review was undertaken to identify the impact of the project and uncover any areas for improvement via interviews with 18 industry stakeholders.	Geoff Kuehne from Meaningful Social Research was engaged to undertake a series of interviews of 18 stakeholders who had existing relationships with the ABA, including growers, ABA committee and board members, Research agency, and Australian Honey Bee Industry Council. The mid-term review report was tabled at the PRG meeting 27th July 2022 (refer Appendix 18. ABA Mid-term review report.) and has been used by the ID team in the development of the Extension Strategic Plan 2023-28 and identifying content for specific activities in work programs post the review. Growers were generally happy with ABA activities. The ABA staff were well-regarded by growers, as were the Board and Committees. There was a growing expectation that field days and activities that enable face-to-face contact among growers and with staff resumed after COVID-related travel restrictions were lifted.

ABA Extension strategy 2023-2028

Extension survey	A grower survey was undertaken in May 2023 to inform the extension strategy	Questions were asked to determine grower concerns, key aspirations and how they like to receive information. Feedback from over 50 growers was incorporated into the Strategic Framework. Refer Appendix 9. ABA Extension survey.
Almond Extension strategy 2023-2028	Hort Innovation extension strategy template	The extension strategy was designed to address the gaps in current R&D knowledge to support almond businesses in their efforts to improve efficiencies, yield, quality and competitiveness, while managing new and emerging risks and looking for opportunities to enhance the growing environment and supporting local communities. It was co-designed in partnership with Hort Innovation. The Hort Innovation: Guide for co-designing extension and industry development programs template guided the strategic planning process and an Extension Strategy Framework was established under the guidance of the ABA Production Committee. The strategy was provided to Hort Innovation to inform continue service delivery of extension activities to the almond industry.

ABA Project Plans

Project Plans	Develop and review plans in consultation with the PRG	At the project start the following project plans were developed MS102 and reviewed annually in consultation with the PRG and forwarded to Hort Innovation: • Program logic and M&E • Risk Register • Stakeholder engagement & communications – including segmentation study • Annual work plans

Outcomes

The almond industry is recognized for its willingness to share learnings and with mantra ‘rising tides lift all boats’. This is reflected in the high level of participation by growers in extension activities in particular face to face activities. The challenge is to translate engagement and participation into practice change on ground.

Progress toward each outcome is described below:

Integrated Pest & Disease Management

IP&DM strategies, and benefits/ costs are documented with a focus on Hull Rot, Carpophilus Beetle and Carob Moth.	2022-2026 Outcome 1. Strategy 5. IDPM.	A portfolio of grower resources was maintained on the ABA website documenting IPDM management strategies and research findings from the IPDM program (AL16005 & AL16009) with a focus on Hull Rot; Carpophilus Beetle and Carob Moth. The economic impacts of commercially important P&D were documented with ABA assistance and grower involvement – yet to be published by AV.	Integrated disease management - Australian Almonds (almondboard.org.au) Integrated pest management - Australian Almonds (almondboard.org.au) Sustainable chemical use - Australian Almonds (almondboard.org.au)
90% of growers know and understand integrated Pest & Disease management principles and strategies with a focus on: Hull Rot; Carpophilus Beetle and Carob Moth.		Growers have been actively involved in IPDM activities to improve their awareness and knowledge about IPDM strategies and have actively sought information generated from the IPDM program available from the ABA website.	148 unique attendees at 14 ABA of IPDM events (field days, webinars, and workshops) providing representation from 56 almond enterprises covering 53,416 hectares or 86% of production area. 1,205 unique downloads from the ABA website of IPDM publications (factsheets) developed during the project period with a further 460 unique downloads from the ABA website of IPDM factsheets produced prior to AL19001. 128 downloads of the ABA fungicide planner tool.
IP&DM adopted by 90% of production area with a focus on: Hull Rot; Carpophilus Beetle and Carob Moth.		Anecdotal reports from growers suggest strong aspirations to undertake IPDM activities however extended wet conditions over the last three years have prevented timely access and effective control with reports of elevated pest and disease pressures reported.	ABA Production Committee meeting – round table discussion summaries.

Biosecurity

Industry's biosecurity plans developed/reviewed and updated.	2022-2026 Outcome 1. Strategy 7. Biosecurity preparedness.		

Emergency response systems in place and industry representatives trained.			
90% of growers are aware of exotic P&D.			
60% of growers have adopted on-farm biosecurity measures.			

Pollination efficiency

Technologies to measure hive health investigated/ documented.	2022-2026 Outcome 1. Strategy 4. Pollination.	Existing hive health technologies documented and shared with the ABA Pollination Committee. Meetings were convened with three companies operating in California using technologies to measure hive health, artificial pollination and robotics to assist with apiary husbandry.	Appendix 3. ABA Report - Pollination technologies.
Honey bee BMP for Australian almonds documented		A portfolio of grower resources was generated by the ABA and maintained on the ABA website documenting Honey Bee BMP for Australian almonds.	Pollination - Australian Almonds (almondboard.org.au)
90% of growers are aware of honey bee BMP for Australian almonds		Growers have been actively involved in pollination activities to improve their awareness and knowledge about BMP strategies including ABA webinars, R&D Forum and downloaded information from the ABA website suggest good use of these materials. Note. Analytics do not include grower representation at the R&D Forum Aug23 with over 260 participants.	53 unique attendees at 2 ABA pollination events (webinars) providing representation from 28 almond enterprises covering 46,100 hectares or 74% of production area. 506 unique downloads from the ABA website of pollination publications developed during the project period with a further 385 unique plays of videos held on the ABA website.

60% of production area is covered by pollination agreement		Anecdotal reports from growers indicate pollination agreements are in use including on-farm audits to ensure hive health.	Grower discussions and ABA Pollination Committee.
Maintain support for incursion response for honey bee P&D		Hive delivery across state borders was facilitate through participation in 2021, 2022 & 2023 pollination season stakeholder meetings navigating border closures due to COVID and Varroa incursions. Almond EPPRD levy growers continues to be collected to support incursion response activities. Almond pollination needs incorporated into response plans for honeybee related incursions.	Extension register – PRG issue based, Biosecurity meetings. ABA IDM served as ILO Horticulture Industries for 7 days in the Control Room in Orange during the *Varroa destructor* response.

Irrigation efficiency

Irrigation demands for new varieties and densities investigated/documented.	2022-2026 Outcome 1. Strategy 3. Soil management.	Learnings from ACE Orchard and AV Smart Farm trials were have been document via In-a-Nutshell articles, R&D Forum presentations and ABA website – ACE Orchard and conveyed to growers at orchard open days and tours.	Almond Centre of Excellence - Australian Almonds (almondboard.org.au)
90% of growers are aware of BMP for irrigation		Growers have readily used the portfolio of resources generated by the ABA in collaboration with researchers and service providers, documenting Irrigation BMP for Australian almonds using a range of media maintained on the ABA website.	Irrigation - Australian Almonds (almondboard.org.au) 188 unique attendees at 13 ABA irrigation events (field days, workshops and webinars) providing representation from 53 almond enterprises covering 50,911 hectares or 82% of production area. 314 unique downloads from the ABA website of irrigation publications (factsheets and videos) developed produced prior to AL19001. 1 water study tour up to Dartmouth Dam and 9 stops along the way with 25 industry participants.
90% of growers use irrigation scheduling equipment		Most irrigators attending irrigation field days indicated that they used a variety of scheduling equipment.	Refer Irrigation efficiency.

80% of growers have participated in the SARDI irrigation tool and demonstrate improved WUE		Website analytics indicate continued use of the irrigation tool during each season however individual data is unable to be extracted or WUE measured.	Refer Results and Discussion - Irrigation efficiency.

Production Systems

Cost:benefits associated with renewing and recycling orchards documented.	2022-2026 Outcome 1. Strategy 2. Support further efficiencies in H1 orchards and intensification of H2/ H3 orchards.	Cost comparisons between WOR trial in Merbein Victoria against WOR in California has illustrated the importance of government assistance needed, like the USA, for this approach to be commercially viable.	Refer Appendix 5.ABA Report – Whole orchard recycling. and Appendix 6. ABA Study Tour – ISHS Almond and Pistachio Symposium California..
Management practices that improve soil health investigated/ documented.		Early results of trials established at the ACE Orchard have been communicated with growers via field days and R&D Forums. While impacts on yield or quality are yet to be realized improved soil health parameters are evident. Super-soil treatments have proven impractical creating weed control issues that interfere with harvest operations and lower yields.	Almond Centre of Excellence - Australian Almonds (almondboard.org.au) Almond growth and development - Australian Almonds (almondboard.org.au)
90% of growers are aware of new production systems.		Early results have been promoted via ABA ACE Orchard open days, ABE tours, R&D Forums and website and publications via the ABA grower resources webpage – ACE Orchard and Growth and Development. Note. Analytics do not include grower representation at the R&D Forum Aug23 with over 260 participants.	47 unique attendees at 2 ABA (field days – ACE Orchard and AV Smart Farm) providing representation from 31 almond enterprises covering 46,447 hectares or 74% of production. 1,205 unique downloads from the ABA website of IPDM publications (factsheets) developed during the project period with a further 460 unique downloads from the ABA website of IPDM factsheets produced prior to AL19001. 128 downloads of the ABA fungicide planner tool.

Varieties and Rootstocks

Characteristics of new varietals and rootstocks investigated and cost: benefits of production systems documented.	2022-2026 Outcome 1. Strategy 1. New varieties.	A portfolio of resources has been generated by the ABA in collaboration with researchers and service providers and maintained on the ABA website documenting the Australian almonds breeding trials using a range of media.	15 unique attendees at 1 ABA (field days) providing representation from 12 almond enterprises covering 20,453 hectares or 8% of production area.
Evaluating almond rootstocks under Australian conditions.		Results from AL16006 rootstock evaluation trial at Lindsay Point were published on the ABA website and discussed at the Variety and Rootstock Field Day.	15 unique attendees at 1 ABA (field days) providing representation from 12 almond enterprises covering 20,453 hectares or 8% of production area.
Maintaining disease free and diverse genetic material.		Budwood site have been maintained disease free through development and implementation of budwood program standard operating procedures including hygiene and virus testing.	

Plant Improvement

Nursery tree standards developed into agreement template.	2022-2026 Outcome 1. Strategy 1. New varieties.	'Nursery Tree Supply Agreement' template and 'Nursery Tree Classification Standard' have been documented.	Varieties and rootstocks - Australian Almonds (almondboard.org.au)
60% of growers are using nursery trees standards and agreement.		Grower feedback has welcomed the agreement and standards however there is some pushback from the nurseries.	"while there is still a way to go to get everyone onboard I think what you are doing is a good step forward and that the templates were a useful starting point."
95% of budwood material supplied from 2021 to 2022 is virus tested.		100% of mother trees were virus tested annually.	Reports retained on ABA files.
All ABA budwood orders filled inline with customer requirements.		All ABA budwood orders filled in line with customer requirements.	

Food safety and product integrity

Best Management Practice (BMP) for harvest and post-harvest handling techniques updated.	2022-2026 Outcome 1. Strategy 6. Emerging technology. Strategy 9. Agrochemicals. Strategy 10. Regulatory support. Strategy 11. Crop safety data.	A portfolio of resources has been generated by the ABA in collaboration with researchers and service providers and maintained on the ABA website documenting what is known about BMP for post-harvest handling. On-farm drying, stockpile management and fumigation practices are in their infancy and require more research to determine protcols, specifications and monitoring thresholds.	110 unique attendees at 3 ABA events (webinars and field days) providing representation from 12 almond enterprises covering 20,453 hectares or 8% of production area.
90% of growers are aware of food safety BMPs.		While aware of BMP the weather has made it difficult to time appropriate controls and grower reports indicate high levels of pest and disease after 3 successively wet years.	Refer results and discussion.
90% of growers have adopted food safety BMPs.		As above.	
Sustainable chemical use and resistance management principles are documented.		A fungicide planning tool reenforcing Crop Life principles of sustainable chemical use was developed to help growers plan their spray programs.	Almond-Fungicide-Planner-2022-V.2-1.xlsx (live.com)
90% of growers know and understand principles of sustainable chemical use and resistance management.		Feedback from chemical retailers suggest further information is required on spray methods, timing, adjuvants and wetters. This will be addressed in future extension program.	Feedback via ABA Chemical Committee.
90% of growers are aware of the 'chemical tool kit' for almonds.		Updates have been provided to the ABA Chemical Committee.	
Gaps in available chemicals are addressed with new registrations or permits.		3 emergency use permit applications submitted (2 successful, 1 awaiting outcome). 4 new fungicide registrations providing greater option for chemical rotation.	APVMA website – permits. ABA Fungicide Planner updated.

Industry development and intelligence

90% of growers have participated in the extension program, of which 90% have increased their knowledge and skills and 60% have adopted onfarm.	2022-2026 Outcome 3. Strategy 1. Extension capability.	There was strong participation of growers in the extension program with 86% of the production area represented overall. Feedback suggests improved knowledge and skills have been gained however on-farm adoption of BMP is yet to be measured and, in some situations, still in development e.g. intensive farming.	Over 40 events were delivered (field days, webinars, workshops, regional meetings and study tours) by the ID team with 146 unique participants representing 53,834 hectares or 86% of the production area.
Project outputs delivered on time; to specification and to budget.		Each year outputs were delivered in line with the annual work plan as specified in the project agreement and within budget	A broad portfolio of publications, factsheets, videos and tools have been published on ABA grower resources websites for each topic area.
60% of growers participating in a segmentations study to identify preconditions fostering adoptions and key constraints preventing adoption.		Segmentation information regarding their role in the industry, location, time in the industry and size of property together with their observations on farm and constraints preventing BMP for each topic were collected through the registration surveys.	Outputs.
At least one focus group established in each region to address key industry topic/theme.	2022-2026 Outcome 3. Strategy 2. Trusted relationships.	Extension events have been held in each region with topics relevant to all. Specific meetings have been convened in the Riverina and Sunraysia to address Monterey and CB and CM control respectively.	ABA Extension register.
Workforce needs for the Almond industry is communicated to SA, NSW, WA and Victorian educational institutes.	2022-2026 Outcome 3. Strategy 3. Leadership initiatives.	Discussions with the University of Adelaide highlighted potential areas where the almond industry could be involved. ID staff presenting to third and fourth years during the Riverland tour.	ABA Extension register.
Skilled labour available / More graduates working in almonds.		Four Career Days attended at Universities and Secondary Ag Schools.	ABA Extension register.
At least one R&D concept submitted per year to address R&D gaps.		Three project concepts developed through Hort Innovation. Multiple other project concepts through state and federal initiatives.	

Monitoring and evaluation

Key Evaluation Questions (KEQs) on project performance were identified within the project's M&E Plan. Areas for continuous improvement have been identified and discussed below.

Key Evaluation Question	Project performance	Continuous improvement opportunities
To what extent has the project achieved its expected outcomes?	More outputs were delivered than proposed providing a portfolio of grower resources available on the ABA Website using different medium and addressing priority topics as advised by the PRG.	Re-design of the ABA website will improve grower navigation in accessing publications.
	The project has improved knowledge and awareness of R&D outputs, technologies and innovation with learnings from past and current research projects, and grower innovations included in all events and publications on the ABA website.	
	Adoption rates were difficult to determine industry wide, some areas of research are still in development and other areas were challenged by three consecutive years of wet conditions making uptake difficult.	Future grower follow-up of extension participants may assist in evaluating adoption of research outcomes.
How relevant was the project to the needs of intended beneficiaries?	Grower feedback indicated that they valued the extension efforts with information considered useful to commercial almond business. Grower feedback has been utilised in the design of extension events and products.	Engagement strategy to directly contact every grower over a three year period for one-on-one discussions will present an opportunity to seek personalized feedback and feed into a value assessment.
	Over 40 events were delivered (field days, webinars, workshops, regional meetings and study tours) with 146 unique participants representing 53,834 hectares or 86% of the production area. Unique downloads from the ABA website indicate good use of extension materials.	Continued use of grower feedback and Q&A within extension activities to inform new products and events.
	Feedback loops between growers and researchers facilitated new ideas for R&D projects and extension activities - to address knowledge gaps through ABA value chain committees, PRG meetings and extension activities.	Establish working groups to develop BMP guidelines including growers, researchers and service providers.
Were engagement processes appropriate to the target audience/s of the project?	Growers and stakeholders were included in event programs and engaged during event planning to design and deliver information.	

	Stakeholder meetings were convened weekly during pollination in 2020, 2021 and 2022 to navigate border closures.	
	Hort Innovation was involved in PRG meetings and informal progress updates regarding industry risks and opportunities for each new extension manager.	Continuity in staff will assist with improved understanding of the project objective, scope and achievements.
	Risk management plans, monitoring and evaluation plans and communication and engagement plans were used and reviewed annually to deliver extension products and activities.	
What efforts were made to improve efficiency?	Event planning templates were developed and have assisted in planning and co-ordinating stakeholder involvement. Event registration surveys were utilised to gain insights into production constraints, current practice and knowledge gaps associated with segmentation data.	Exploring options to improve interaction with growers and aggregating feedback without relying on formal surveys.
	Other ABA initiatives were utilised during delivery including machinery demonstrations and trial updates at the ACE Orchard (ST16000 & AL19000), grower resources were published and further promoted via Almond bytes, In-a-Nutshell and ABA website via the communications project (AL18001), analysing production area trends (AL19005 statistics and data collection) and showcasing research findings via ABA Conferences and Field days (AL16700).	

Recommendations

- Explore options to capture stakeholders feedback in various forms and from various avenues all the while safeguarding IP, confidentiality and issues of a sensitive nature. This will be used for gap analysis and monitoring of activities and providing a broader representation of feedback reducing the need for on-line surveys.
- Develop educational opportunities for Hort Innovation staff to better understand the almond industry and the threats and opportunities.
- Given the small number of growers in the industry, there is a commitment to interact with as many as possible to remain relevant and as informed as possible across the various growing regions.
- Continue to build contacts within the industry that reach beyond management to assist in tailoring extension products that help in-field issues and reach of communication and extension to a tailored audience.

Refereed scientific publications

Journal article

Paper submitted for publication:

Jaensch, D., 2023. Almond Centre of Excellence: Australia's Experimental and Demonstration Orchard. *Acta Horticulturae*.

Intellectual property

'No project IP or commercialisation to report'.

Acknowledgements

The ID team would like to acknowledge and thank the many growers who have provided their orchards and time to support and participate in the program of extension activities delivered. In particular the ABA Production Committee members and their contribution towards to the design and delivery of this project.

Appendices

1. Project Plans – Communication and engagement, Monitoring and Evaluation.
2. Monthly rainfall – Eastern states 2020-2023.
3. ABA Report - Pollination technologies.
4. ABA Drip Irrigation Workshops 2022 and 2023.
5. ABA Report – Whole orchard recycling.
6. ABA Study Tour – ISHS Almond and Pistachio Symposium California.
7. ABA Report – Monterey Leaf failure.
8. ABA Nursery agreement and standards.
9. ABA Extension survey.
10. Project deliverables against the agreement.
11. ABA Website analytics.
12. ABA Webinar Series.
13. ABA Field Day – Fumigation.
14. ABA Workshop Report – climate change.
15. ABA Grower notices.
16. ABA Study Tour – Murray-Darling water system and supply.
17. ABA Report – Californian study tour new varieties.
18. ABA Mid-term review report.
19. Enquires summary.