Hort Innovation

Final Report

Australian Macadamia Industry Innovation and Adoption Program

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Delivery partner:

Australian Macadamia Society

Project code:

MC15004

Project:

Australian Macadamia Industry Innovation and Adoption Program (MC15004)

Disclaimer:

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Content

Summary

Project MC15004, which ran from March 2016 to February 2021, was an industry extension and capacity building project supporting growers to adopt innovative practices and research outcomes to increase production and profitability. Its target audience was macadamia levy payers, industry stakeholders such as consultants, and value chain members such as processors.

The project was designed to contribute to the strategic vision of the industry as defined in the Hort Innovation Strategic Investment Plan (SIP) plan 2017-2021, i.e. to "lift the Australian macadamia industry production while maintaining, or improving, the price received for Australian macadamias, leading to increased grower profitability".

Knowledge outputs from the macadamia levy research and development program were integral to the development and implementation of the project.

The five-year project was delivered during a time of significant industry expansion. In 2016, the industry consisted of about 650 growers and 17,000 ha planted to macadamias; in 2021 this had increased to about 800 growers and 32,500 ha, of which approximately 25,000 ha were bearing. The industry is currently experiencing the strongest growth ever seen, with new entrants establishing orchards and existing growers expanding or maximising current holdings. It is projected that by 2025 there will be 45,000 ha under macadamias in Australia.

Growth in areas planted to macadamias around the world and the focus on maintaining Australia's reputation as a supplier of premium nuts have highlighted the importance of a strategic and industry-wide approach to increasing production and profitability. This has been complicated by a feature of the industry in the last decade, which is the number of new growers who have entered the industry, many with little knowledge of macadamia culture and management.

As a result, an extension strategy that recognised the significant range of skills and background in the industry – from corporate managers with a successful history of growing macadamias, through to inexperienced new entrants establishing small and medium-sized orchards, was a priority for the project in developing extension strategies and applying research outcomes. The range of industry experience provided an opportunity for the project to use a peer learning approach where experienced growers were able to share learnings and best practices with other, less experienced, growers.

The project was organised using a logic framework at the heart of which were six project programs supported by a range of activities designed to ensure that key strategic issues were identified and managed in a way to ensure uptake of research outcomes as well as the changing needs of an expanding industry. A distinct feature of the program was to take a whole-of-industry approach that included growers, agency staff, processor grower liaison officers, industry consultants and key value chain suppliers as a way of ensuring consistency in extension messaging (see Figure 1).

The Industry Development Manager (IDM), in consultation with the project reference group implemented an annual extension operating plan (see Appendix 1) that delivered a range of activities, many of which used grower input or experience as a way of extending innovative practices, best management principles and research outcomes to the industry.

These activities were supported by a number of projects, state agencies and a range of other resources but in particular the project worked very closely with MC18000 - Australian Macadamia Industry Communications Program.

Keywords
Macadamias, industry development; innovation; adoption; capacity building; knowledge; awareness; integrated orchard management, practice change

Australian Macadamia Industry in numbers (Source: Australian Macadamia Society Yearbook 2020)

Key project deliverables met or exceeded over the term of the project included:

- 75 MacGroups were held with a total of 5665 attendances in all key growing regions three times a year covering key strategic issues identified through consultation with growers and stakeholders. A breakdown of industry segments for the 5665 MacGroup attendances were:
    - 61% of attendees were growers (about 380 individual growers representing over 90% of industry production).
    - 23% of attendees were consultants, processor grower liaison staff and supplier representatives.
    - 16% of attendees were researchers, Hort Innovation staff and other industry stakeholders.
- Additional workshops on nursery standards (three workshops), environmental monitoring (three workshops), tree water relations (five workshops), soil health (one workshop) and pollination (one workshop).
- Five targeted workshops were held for new growers (2016, 2018 and 2019).
- 113 articles as author, joint author or providing technical input in the quarterly *News Bulletin* as well as involvement in developing technical features for each edition to increase knowledge of innovative practice and research outcomes and how to apply them on farm.
- An annual two-day industry consultants group workshop held to promote consultation between service providers, identify emerging and macro issues and agree on strategic approaches to extending R&D outcomes.
- Identifying supply issues and production constraints and increasing awareness and grower knowledge of innovative approaches to orchard management. Including keeping abreast of global trends by leading a study tour for growers to China in 2018 and to South Africa in 2019, as well as attending the International Macadamia Symposiums.
- Interviews with growers and technical specialists on topical issues for the AMS YouTube channel (19 videos made from 2018 to 2020) and four for the AMS Podcast series, made in 2020. The aim of the interviews was to increase grower awareness of and capacity to apply technologies and techniques to increase production and promote sustainable practices.
- Input into, coordinating and/or writing 15 factsheets featuring new information and research outcomes about orchard management to improve grower knowledge, extend skills to implement best practice and confidence to invest in new technologies and approaches.
- Organising a total of 29 field days and workshops to increase grower knowledge and capacity by showcasing best practice and innovative techniques being applied on farm, such as pollination, soil health, environmental monitoring and integrated orchard management.
- Member of the organising committee for two AMS Conference as well as presenting papers, liaising with speakers, developing programs and coordinating special sessions.
- Organising annual Awards of Excellence to identify high performing growers and to showcase their on-farm practices to the wider industry.

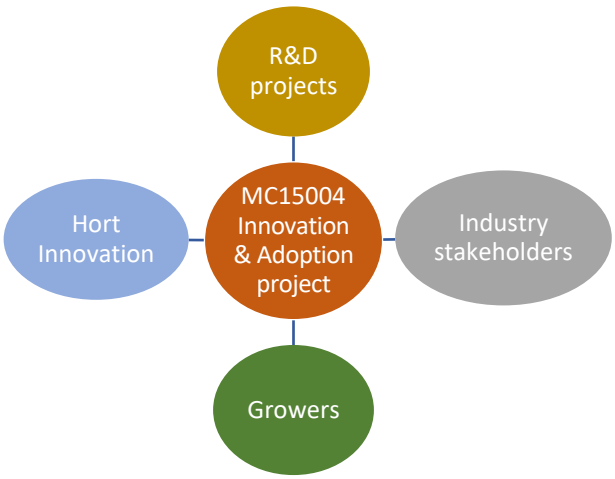


Figure 1. Relationships between MC15004, R&D program (20+ projects), Hort Innovation, industry stakeholders (85+ individuals and organisations) and growers.

The aim of the project was to enhance the adoption innovation and technology as well as facilitate capacity building in the macadamia industry. Measurement of the direct impact on macadamia grower practice as a result of the five-year Industry Innovation and Adoption project workshops/events, project best practice resources and co-learning project initiatives shows that the project engaged more than 90% of industry production. More specifically of the growers who participated in the project exit survey:

- 47 per cent of macadamia growers made significant enterprise and orchard management practice changes as a result of MC15004.
- 41 per cent of macadamia growers made several changes to enterprise and orchard management practice changes to as a result of MC15004.
- 12 per cent of macadamia growers made some changes to enterprise and orchard management practice changes to as a result of MC15004.

Main areas of practice change included the following:

- canopy management e.g. hedging and other pruning changes
- orchard floor and soil health e.g. covering roots, profiling, composting and mulching
- irrigation and drainage e.g. changing watering schedules, measuring soil moisture and installing drainage
- pest and disease management e.g. implementing integrated approaches, using beneficials, improving pollination and calibrating spray machinery
- nutrition e.g. improving soil health, soil and leaf testing and getting professional assistance with developing nutrition budgets

Introduction

Macadamias are one of Australia's most significant horticultural industries as well as being Australia's largest native export crop. In 2020 the industry's estimated farm-gate value was $293 million annually (+$700 million retail value), with three-quarters of the crop being exported.

In the last ten years, prices for nut-in-shell have steadily increased resulting in a substantial expansion in the area being planted to macadamias in Queensland and New South Wales by both new entrants and existing growers. As evidence of this expansion, in 2016 the industry consisted of about 650 growers and 17,000 ha planted to macadamias; in 2020 this had grown to about 800 growers and 33,000 ha, of which 25,000 ha are currently bearing. More plantings are planned, and it is projected that there will 48,000 ha under planting by 2025.

Most Australian macadamias are grown on the East coast with more than 80 per cent of the crop originating from two regions; Bundaberg (43 per cent) and NSW Northern Rivers (39 per cent).

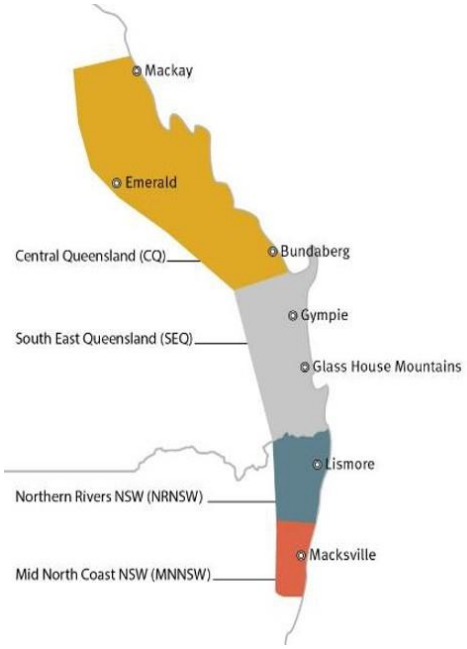


Figure 2. The main macadamia growing regions are located between Mid North NSW and Central Qld

Despite competition from established origins such as South Africa and newer entrants such as Vietnam and China, the Australian industry has maintained its role as a global leader in growing, processing and marketing macadamias, as well as its reputation as a producer of premium nut. An indicator of this is the fact that no MRL breaches were listed and there was 100 % National Residue Survey compliance during the life of the project.

The industry has done this against a backdrop of environmental challenges such as severe drought in 2016 and 2018-20 and cyclones in 2017 in Queensland and New South Wales.

The Australian Macadamia Society has historically been a key player in macadamia extension activities. It is the peak industry body representing the interests of more than 75 per cent of growers who are responsible for 85 per cent of production, as well as the processing and service sectors. It is the number one source of information for the Australian macadamia industry.

The activities of the Australian Macadamia Society through project MC15004 were focused on supporting the strategic vision of industry as defined in the Hort Innovation Strategic Investment plan (2017-2021) i.e. to lift Australian macadamia industry production while maintaining, or improving, the price received for Australian macadamias, leading to increased grower profitability.
The project was designed to take research outcomes and extend them in a way that delivered consistent key messages to growers across a range of extension platforms and activities and increased grower knowledge and skills and their confidence to invest.

Five key outcomes were identified in the Macadamia SIP, two core outcomes of which are relevant to this project:

- increased productivity and grower returns through an average increase to 5 t/ha nut-in-shell by 2021 (equivalent to about 1.6 t/ha kernel based on SKR of 32 per cent)
- improved capacity to lead and support current and future industry needs.

To support achieving these outcomes, the Australian Macadamia Society designed activities and implemented projects funded through the Hort Innovation levy fund (MC15004 and MC18000). Project MC15004 employed an IDM who worked with other Australian Macadamia Society staff members such as the industry communications manager and the industry market development manager, as well as processor, industry and agency extension advisors, to take the outputs from Hort Innovation's macadamia R&D program and apply them using extension techniques such as peer-to-peer learning.

This report the describes the implementation of MC15004, which was designed to use a whole-of-industry approach to identify key issues and develop extension activities as a way of achieving Hort Innovation SIP outcomes.

Key projects that supported achieving the SIP outcomes are shown in Figure 3.

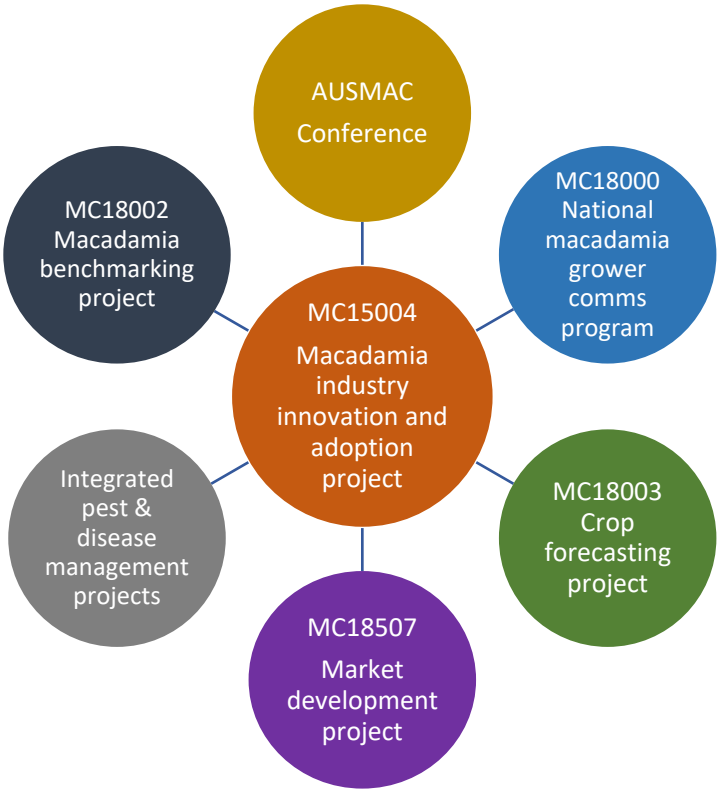


Figure 3. Linkages between macadamia industry Innovation and Adoption project and other key projects

Methodology

This report describes project MC15004, a five-year innovation and adoption program designed to consult with growers and other stakeholders to identify issues and priorities for improving production and profitability and to extend innovative practice and research outcomes to the industry.

The project was delivered between March 2016 and February 2021 by the Macadamia Industry Development Manager, who was supported by the Australian Macadamia Society CEO, Macadamia Industry Market Development Manager, the Macadamia Industry Communications Manager and financial management and administrative staff employed by the Australian Macadamia Society.

The program was designed to deliver innovation and adoption strategies to contribute to two of the five key outcomes defined in the Hort Innovation Strategic Industry Plan (2017-2021), as follows:

- increased productivity and grower returns through an average increase to 5 t/ha nut-in-shell by 2021 (equivalent to about 1.6 t/ha kernel based on SKR of 32 per cent)
- improved capacity to lead and support current and future industry needs.

MC15004 was based on an extensive industry engagement process focused around six key delivery areas, which were managed according to an annual extension operating plan. The extension approach that underpinned the project was to improve grower knowledge, attitudes, skills and aspirations (KASA) as a way of contributing to SIP outcomes. The six key delivery areas were as follows:

1. Review and understand current production constraints.
2. Assist in the development of new research outcomes.
3. Develop the agreed industry macro extension issue annually.
4. Identify and develop opportunities for new orchard and territory expansion.
5. Manage unforeseen emerging issues.
6. Deliver research outcomes and agreed industry issues.

It had a specific goal of lifting industry average production from 0.8 t SK/ha to 1.2 SK t/ha (4 t/ha nut-in-shell) as part of contributing to the goal in the SIP of 5 t/ha nut-in-shell by 2021. The industry has faced significant challenges in the period of the project, including severe drought for three years and cyclones in 2017. Despite this, the best growers are currently achieving yields of at least 5 t/ha.

1. Review and understand current production constraints by engaging with growers and stakeholders in the macadamia and other similar industries

A Project Reference Group (PRG) was established, and meetings held to help identify extension issues and provide stakeholder input and guidance on the project and its delivery by the IDM.

The project also established relationships with other, similar, tree crop industries to gain an understanding on issues and how they were being managed, e.g. the use of tree shakers for other tree nuts and orchard management to improve harvest efficiency, and completed grower study tours of tree nut industries in Australia and the US as well as of macadamia growing in other origins such as China and South Africa. Outcomes on the application of innovative practices were extended to growers and other stakeholders using a variety of methods including presentations at AUSMAC conferences (2016 and 2018), meetings, videos, podcasts, articles and in the *News Bulletin*.

Surveys of growers, consultants and R&D staff were also conducted to identify issues of concern.

2. Assist in the development of new research outcomes

The project regularly engaged with R&D service providers to help develop new research outcomes and with the end goal to extend these outcomes through channels such as MacGroups, field days, conferences, *News Bulletin* articles, videos, podcasts and fact sheets. This was an essential part of developing practical on farm outcomes and consistent best practice for macadamia and promoting innovative thinking. Examples of the development of new research outcomes include:

- Contributing member to Macadamia SIAP.
- Contributing member to research projects such as integrated pest and disease management (IPDM), crop forecasting, MacMan, Benchmarking and MIVIC.
- Organising annual consultants meeting to workshop key industry challenges, lack of research and formalise best practice messaging and strategies related to the annual macro issue, as well as any emerging issues. Attended by a range of providers including R&D organisations, consultants, pest scouts and processor grower liaison staff.
- Establishing industry advisory committees and working groups comprising growers and other stakeholders to provide advice on macro issues.
- Organising opportunities for researchers and growers to work together on innovative solutions and approaches to macro issues and other research outcomes. These opportunities included MacGroup meetings and field trips, biennial AUSMAC conferences (2016 and 2018) and regular orchard visits.
- Steering committee participation for projects such as a harvest review (MC16001), developing macadamia industry nursery standards (MC17001), digital remote monitoring to improve horticultures environmental outcomes and national tree crop mapping which involved project scope and design, industry technical advice, implementation guidance and ongoing consultation.
- Working with state agencies such as DAFQ, NSW DPI, Office of the Great Barrier Reef, Qld Dept. of Environment and Science, NSW Dept. of Environment and Planning and Local Land Services on various advisory panels and consultative forums as a representative for the macadamia industry. This included the development Reef catchment and other water quality projects, environmental monitoring and improved outcomes, erosion control and fertiliser stewardship initiatives.
- Organising experts outside the industry to stimulate practice change on specific topics, e.g. Jorg Kitt on spray application and Dr Theunis Smit on irrigation and soil moisture monitoring.
- Organising two strategic workshops to develop a 2030 vision of a productive orchard followed by the development of a 2030 vision and strategic plan, then taken to industry for comment in 2020.
- Working with research agencies and processor organisations that provide extension opportunities to develop a holistic approach to ensure consistency of messaging.
- Working on environmental management and water quality regulation with the Office of the Great Barrier Reef and Growcom in Queensland and NSW DPI and LLS in New South Wales.

Annual Consultants Meeting group touring a Glasshouse Mountains orchard during the event in 2018

3. Develop the agreed industry macro extension issue annually

A key activity of the PRG was to review and endorse an annual extension operating plan for macro extension issues and to assist with identifying emerging issues and their management (see Appendix 1). It should be noted that macro issues were developed mid-year, a result of seasonal requirements and planning and implementation from the previous project, so there was some overlap between issues each calendar year. As well, the PRG specified that while new macro issues were developed, it was important to continue to include messaging about previous ones in the annual adoption plan.

Macro issues identified for the annual extension plan were as follows:

- 2016 – Integrated orchard nutrition (ION) and integrated orchard management (IOM)
- 2017 – ION/harvest efficiency
- 2018 – Harvest efficiency/IPDM
- 2019 – IPDM/tree water relations
- 2020 – Tree water relations/ecophysiology

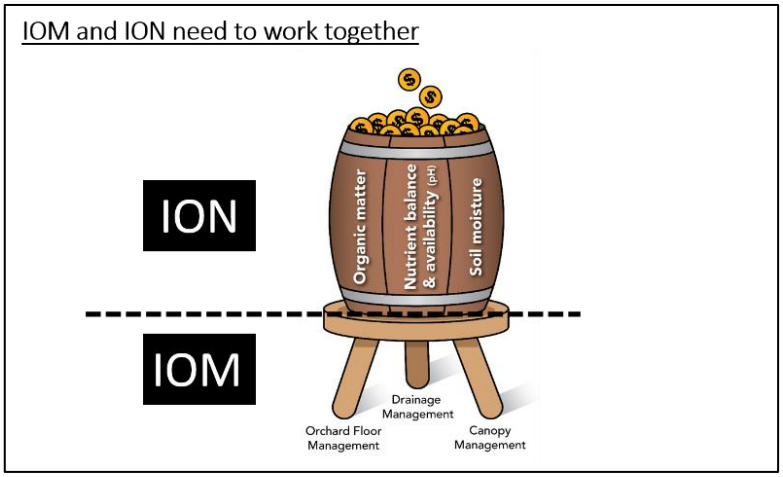


Figure 4. This graphic was developed by the investigative committee and refined after consultation with the PRG, consultants and growers. It was developed to help growers identify the key opportunities to increase production, with IOM creating the foundation and ION providing a play on Lieberg's law of minimums barrel to highlight the key limiting factors in a macadamia nutrition program. It was used extensively during the extension delivery across several platforms.

4. Identify and develop opportunities for new orchard and territory expansion

The project worked with stakeholders to identify and develop opportunities for new orchards and territory expansion on the Northern Rivers floodplains, Bundaberg to Maryborough regions, Yamba region and Mackay region.

As part of this, case studies of grower experiences were published and the first-ever MacGroup meeting at Mackay was held in 2017 and in Yamba in 2019 as an opportunity for growers to learn from each other and discuss orchard establishment and regional practices.

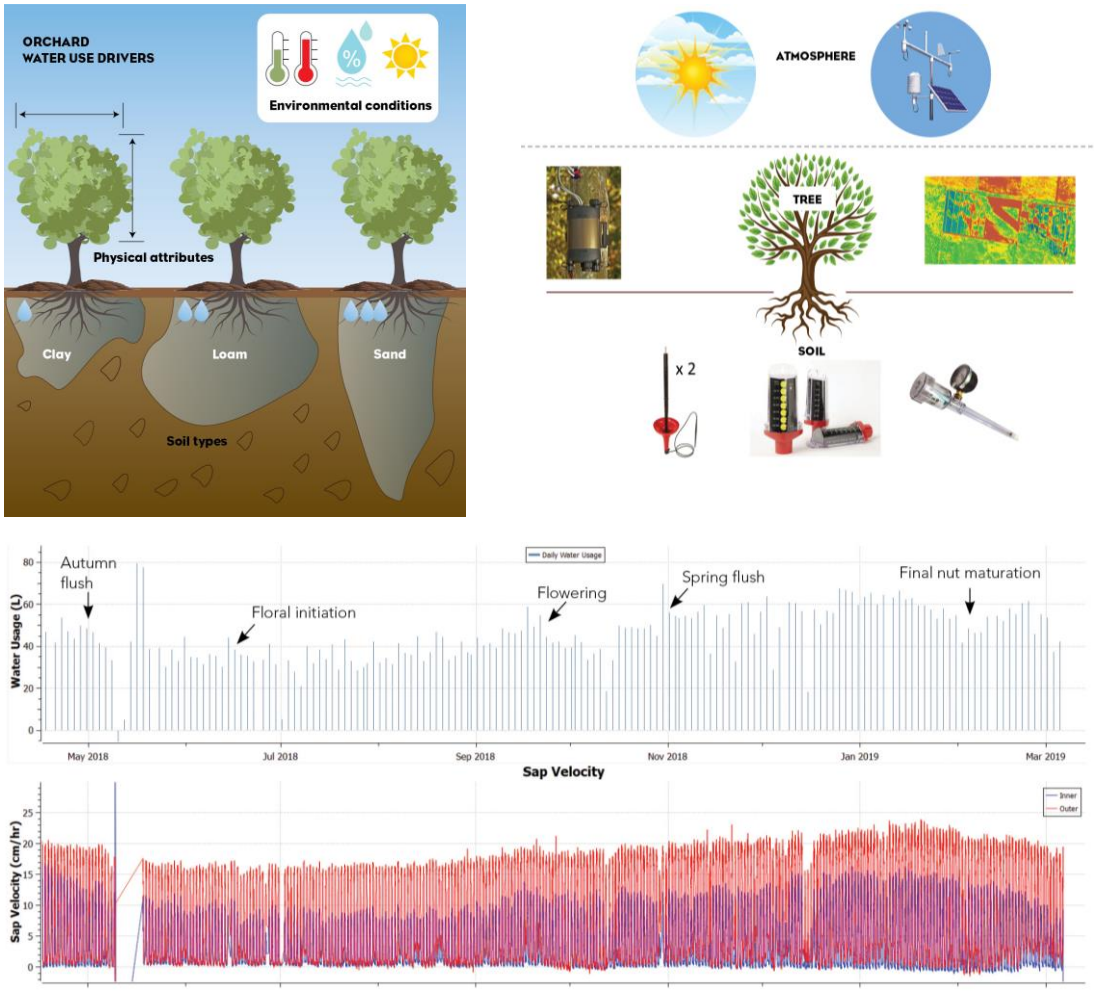
NSW Coastal MacGroup meetings were instituted during the last half of the project for NSW MacGroup rounds to cater for the specific growing information and challenges faced by growers in these unique environments.

In Queensland territory expansion into more marginal regions with less scheme or available water required an improvement in the understanding of tree water use and this particular need was a focus towards the end of the project and became timely as the region faced a significant and ongoing drought.

5. Manage new and emerging issues

The project worked with growers and stakeholders to respond to several emerging issues, such as:

- Providing information and advice on managing the rural-urban interface on issues to do with social license such as noise, pesticide practices and environmental management.
- Developing extension materials and promoting examples of growers implementing innovative techniques to recover from the impacts of variable climate and environmental events such Cyclone Debbie in Queensland, from hail and bushfire damage and drought and water stress.
- Developing extension materials and working with R&D providers to inform growers about biosecurity issues such as pesticide resistance and emerging pests/diseases.
- Improving the awareness of the importance and economic impact of quality nursery trees and extending nursery standards.
- Extending seasonal crop loss information and on farm mitigation strategies including analysing industry harvest loss and practical harvest improvement information.
- Extending best practice information in line with state specific legislative changes such as Reef catchment regulations, crop protection licences and spray application changes, record keeping requirements and workplace health and safety directives.
- Investigating and extending new technological advancements in the industry and on farm applicability/integration such as Lidar technology, tree shakers, new in tree and soil monitoring tools, water quality and nutrient monitoring.



Examples of macadamia tree water use graphics developed by the project

6. Deliver research outcomes and agreed industry issues

A range of extension activities and tools were used to deliver information to levy-paying growers and other stakeholders over the term of the project, with relevant information being prepared in consultation with growers and in partnership with R&D providers and stakeholder groups such as consultants and processors. Activities and extension methods used included:

- Communication materials such as technical articles, industry updates and case studies in the *News Bulletin*, items in the AMS e-newsletter, posters, checklists, and reports.
- MacGroups, which were held three times a year (twice in 2019) at six different locations in growing areas in Queensland and New South Wales.
- Grower field days, bus trips and workshops on topics related to macro extension issues and emerging issues.
- Technical input into, commissioning and/or writing 15 fact sheets covering topics such as best practice and innovative application of research outcomes (see Appendix 2 for an example).
- Production of videos and podcasts where growers and industry specialists were interviewed about macro extension and emerging issues (see Appendix 4).
- Workshops by invited experts from overseas and Australia on macro extension issues, e.g. Jorg Kitt (spray coverage), Alwyn Du Preez (production and profitability), Theunis Smit (irrigation and soil-water monitoring) and Dan Manson (irrigation and tree monitoring).
- Grower study tours to macadamia growing origins in South Africa and China to examine growing practices and assess their application in Australia.
- Meetings with individual growers and industry stakeholders to confirm current issues, specific regional needs or challenges, identify grower management and R&D gaps in knowledge and skills and investigate innovative practices being applied by growers.
- Annual consultants meeting to identify macro extension issues, identify production constraints, promote partnerships and ensure consistent messaging across the industry.
- Developing issue-specific materials such as an integrated orchard nutrition poster distributed by consultants and at meetings such as MacGroups, a harvest efficiency checklist and an IPDM phenological wheel (see Appendix 7).
- Member of organising committee of AUSMAC conferences in 2016 and 2018 involved in program development, presentation technical input, leading sessions and presenting papers.

MacGroup meeting orchard walk in Bundaberg in 2016 with growers and industry experts sharing their learnings with others

Outputs

Review and understand industry boundaries by engaging with growers and stakeholders to understand what was happening in similar tree crop/horticultural industries

Central to the project was regular engagement with stakeholders through industry committees such as the investigative committee, whose membership included growers and stakeholders, as well as with the project reference group and individual levy payers. The aim of these engagement activities was to identify production constraints, key issues and innovative practices in the macadamia and other industries that would contribute to achieving project outcomes. These activities included the following:

- Six-monthly meetings with the project reference group.
- An investigative committee made up of growers and consultants to identify best practice on macadamia farms as well as contributors to best practice and productivity in other, similar, industries. This committee was wound up in May 2016 and its activities taken up by the PRG.
- Industry consultation through the Australian Macadamia Society supply chain, including processors, consultants, suppliers and growers.
- Organising a study tour to China (2018) followed by attending the International Macadamia Symposium and at study tour to South Africa (2019) for 45 growers and stakeholders to examine macadamia growing and assess their application in Australia and to improve grower knowledge and increase confidence to invest in new technologies and approaches.
- Maintaining contact with other tree crop industries such as almonds, avocados, mangoes and apples to keep abreast of innovations on-farm with application to macadamias.

Growers and other industry members during the study tour to China in 2018.

Growers and industry members during the study tour to South Africa in 2019.

Deliver research outcomes and agreed industry issues

The project worked with other research and development projects to develop and deliver extension outcomes to industry, including outputs such as:

- Held 75 MacGroups to showcase innovative practices on-farm related to the annual macro issue, extend the outcomes of funded research projects and to provide opportunities for improvement in knowledge, awareness, skills and attitudes. Note that in 2020, two rounds were held and one webinar because of COVID-19 restrictions. The breakdown of industry segments for the 5665 MacGroup attendances were:
    - 61% of attendees were growers (380 individuals representing over 90% of industry production)
    - 23% of attendees were consultants, processor grower liaison staff and supplier representatives.
    - 16% of attendees were researchers, Hort Innovation staff and other industry stakeholders.
- Held 29 field days and workshops on topics dealing with strategic issues such as integrated orchard nutrition, pollination, soil health, nursery standards and practices, harvest efficiency and tree water relations to improve grower knowledge and capacity and increase confidence to invest in new technologies and approaches.
- Producing videos showcasing top performing orchards as a way of promoting awareness and uptake of practices and promoting co-learning from peers. Videos featured interviews with industry specialists and growers as a way of promoting awareness and uptake of innovative practice and research outcomes.
- Engaging Hort Innovation and the SIAP to participate in the November-December 2017 MacGroups as a way of increasing understanding and awareness of the R&D projects underway as well as how they are managed.
- Extending information about emerging issues such as crop protection changes, best practice guidelines, COVID-19 and legislative responsibilities to improve grower awareness and capacity to manage orchards in a changing regulatory and social environment.
- Aiding growers by providing information and support to develop capacity to manage issues such as drought mitigation strategies, storm recovery, bushfire prepared/recovery and environmental monitoring.

Activities to extend R&D outcomes to growers are included in Appendix 3.

Develop the agreed industry macro extension issue annually

The annual extension operating plan for managing macro issues was developed in consultation with the project reference group, growers and industry stakeholders such as consultants. The plan, which was guided by the strategic vision of the industry as defined in the SIAP 2017-21, defined activities, outputs and outcomes.

The plan included monitoring and evaluation measures to ensure the project was achieving the goal of supporting growers to adopt innovative practices and research outcomes to increase production and profitability. It should be noted that macro issues were developed mid-year, a result of seasonal orchard management requirements planning and implementation from the previous project, so there was some overlap between issues each calendar year.

Macro issues identified for the annual operating plan were as follows:

2016 - Integrated orchard nutrition (ION) and integrated orchard management (IOM)

2017 – ION/harvest efficiency

2018 – Harvest efficiency/IPDM

2019 – IPDM/tree water relations

2020 – Tree water relations/ecophysiology

Identify and develop opportunities for new orchard and territory expansion

As a result of a positive outlook for macadamia production, there has been considerable pressure on the industry to expand in the last five years, particularly on sugarcane land at Maryborough and Mackay in Queensland and on floodplain areas between Ballina and Grafton in New South Wales. Management issues in these areas differ from those in the traditional growing areas, so effort has gone into supporting growers and building their capacity to adapt and adopt practices to ensure orchard productivity. Capacity building and industry development activities have included initiatives such as:

- Delivered presentation "Where can Macadamias be Grown in Australia?" at AusMac (2018).
- Five workshops for new growers (2016,2018 and 2019).
- Working with stakeholders to identify areas for expansion including climate suitability, access to water and other infrastructure.
- Information on coastal floodplain farming practices produced (2018).
- First-ever MacGroup to support new growers in the Mackay region (2017).
- First-ever MacGroup held at Yamba to support new growers establishing orchards on the floodplains between Ballina and Maclean (2019).
- Assisting with community engagement events in new regions such as Wardell and Maryborough.
- Various articles in the Bulletin and case studies on floodplain establishment and management.
- Extending orchard establishment information and key principles.
- Developing and extending regional suitability information with regard to new cultivars.

First ever MacGroup meeting held in new growing region of Yamba in 2019.

Manage new and emerging issues

New and emerging issues included macadamia nursery standards, weather events such as cyclones in Qld and NSW. Capacity building and industry development activities have included initiatives such as:

- Instigation of a project to develop nursery standards and subsequently running workshops for nursery managers and growers (2019).
- Support for growers affected by short term damage and long term effects from events such as cyclones, hail and storms, bush fires, dry conditions including disaster assistance.
- Promoting awareness of issues regarding rural-urban interface and providing information/ support activities, e.g. information reminding growers of social responsibilities, managing spray drift, neighbour relations, trees under powerlines and protecting managed pollinators.

- Promote awareness of biosecurity issues such as resistance and on-farm mitigation strategies.
- Best practice information and innovation to promote integrated orchard management, which in the case of a pest such as Macadamia Seed Weevil has contributed significantly to the reduction of broad-spectrum chemistry use and the adoption of biological and cultural control.
- Active environmental monitoring tools for farm operations such as crop protection and harvest.
- Instigating new practices and fundamental efficient management of irrigation/water management during record droughts in key regions and growing water insecurity concerns.
- Regular updates and best management practices extended to industry regarding changes to registered and permitted crop protection products.

Deliver research outcomes and agreed industry issues

A summary of key outputs for delivering research outcomes and agreed industry macro issues is shown in Table 1 (see Appendix 3 for details).

Table 1. Key outputs and macro issue for each year (2016-2020).

2016 ION/IOM	2017 Harvest efficiency	2018 IPDM	2019 Tree water relations	2020 Ecophysiology
Investigative committee and input to harvest review project.	Annual PRG meeting to identify macro issues and review annual extension op. plan	Annual PRG meeting to identify macro issues and review annual extension op. plan	Annual PRG meeting to identify macro issues and review annual extension op. plan	Annual PRG meeting to identify macro issues and review annual extension op. plan
Annual consultants meeting and 12 grower/industry input meetings	Annual consultants meeting with IOM and ION focus and 12 grower/ industry input meetings	Annual consultants meeting with IPDM focus and 12 grower/industry input meetings	Annual consultants meeting with tree physiology focus and 12 grower/ industry meetings	Annual consultants meeting with IPDM & monitoring focus and 12 grower/ industry meetings
Poster (ION), articles, factsheets and video for growers with focus on ION and best practice	Articles, posters (phenological wheel), factsheets and videos for growers with focus on efficient harvest	Articles, factsheets and videos for growers with focus on innovation/best practice, managing storm damage	Articles, factsheets and videos for growers with focus on improving productivity, IPDM and tree water use	Articles, factsheets, videos and podcasts for growers with focus on improving productivity.
12 MacGroups and 6 field trips with ION focus. Two new grower workshops and one pollination workshop. AUSMAC presentation	19 MacGroups meetings focusing on IOM, ION, IPDM and research outcomes. 6 field trips	18 MacGroups focusing on IPDM/ orchard innovation. A nursery workshop, irrigation field trips and 2 new grower workshops. AUSMAC presentation	13 MacGroups: Groundcover and tree shaker trials. 2 workshops on nursery standards, 5 on water use, 1 on soil health; 3 on env. monitoring	13 MacGroups and webinars on sustainability and canopy management
Input into update to IOM guide and development of IOM case studies	Two surveys with industry members to gauge pest and disease pressure	Mac2030 workshops to develop future vision and grower study tour to China	Analysis/ extension of 2019 production information	Extension of compliance with COVID-19 restrictions
Engagement and collaboration with R&D providers about projects and to provide input into macro issue extension.	Engagement and collaboration with R&D providers about projects and to provide input into macro issue extension.	Extend information about R&D projects, collaborate with R&D providers, engagement with Growcom and Reef projects	Engagement and collaboration with R&D providers about projects. Extension planning meeting with state agencies	Engagement and collaboration with R&D providers using online methods to provide input into macro issue extension
Consultants 'survey on nutrition		Support new areas expansion.	Study tour of South Africa with growers	

Outcomes

The aim of the project was to enhance the adoption innovation and technology as well as facilitate capacity building in the macadamia industry to contribute to the following SIP outcomes:

- increased productivity and grower returns through an average increase to 5 t/ha nut-in-shell by 2021 (equivalent to about 1.6 t/ha kernel based on SKR of 32 per cent)
- improved capacity to lead and support current and future industry needs.

Measurement of the direct impact on macadamia grower practice as a result of the five-year Industry Innovation and Adoption project workshops/events, project best practice resources and co-learning project initiatives shows that the project engaged more than 90% of industry production and more specifically exit surveys showed that:

- 47 per cent of macadamia growers made significant enterprise and orchard management practice changes as a result of MC15004.
- 41 per cent of macadamia growers made several changes to enterprise and orchard management practice changes to as a result of MC15004.
- 12 per cent of macadamia growers made some changes to enterprise and orchard management practice changes to as a result of MC15004.

Main areas of practice change included the following:

- canopy management e.g. hedging and other pruning changes
- orchard floor and soil health e.g. covering roots, profiling, composting and mulching
- irrigation and drainage e.g. changing watering schedules, measuring soil moisture and installing drainage
- pest and disease management e.g. implementing integrated approaches, using beneficials, improving pollination and calibrating spray machinery
- nutrition e.g. improving soil health, soil and leaf testing and getting professional assistance with developing nutrition budgets

The project was designed to use a whole-of-industry approach to identify the issues that were most likely to sustainably improve orchard management (R&D) and develop strategies for encouraging uptake by growers (adoption). These focus areas that would contribute to achieving the aims of the project were identified in the Monitoring and Evaluation Plan (see Appendix 5), as follows:

- Review and understand current production constraints.
- Assist in the development of new research outcomes.
- Develop the agreed industry macro extension issue annually.
- Identify and develop opportunities for new orchard and territory expansion.
- Manage unforeseen emerging issues.
- Deliver research outcomes and agreed industry issues.

The M&E Plan also identified immediate project outcomes to be achieved in the life of the project:

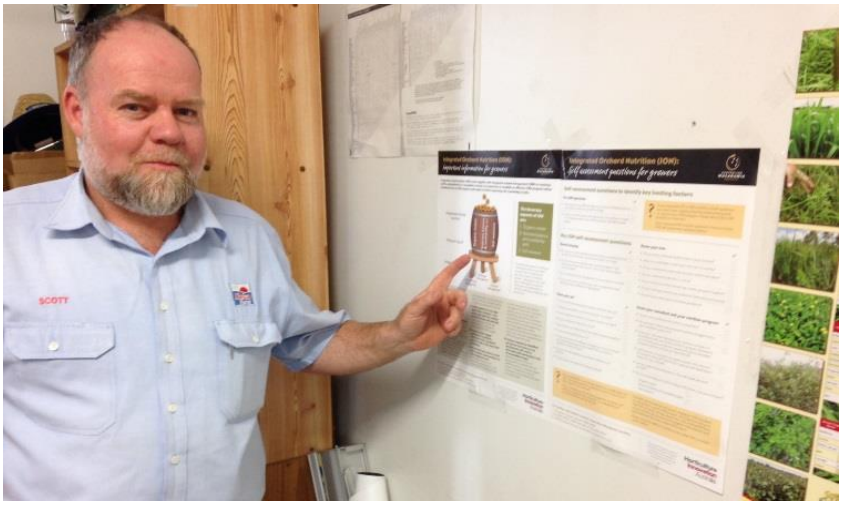
- extent of awareness
- gains in knowledge and skills
- extent of practice change
- indicative benefits
- barriers and enablers.

This following section describes outcomes applying to these focus areas and immediate project outcomes:

Review and understand current production constraints

The project collaborated with industry stakeholders and providers as well as growers to understand constraints to production and devise a whole-of-industry extension approach as a way of extending the reach of the project to deliver goals. Annual reviews of production issues using material such as benchmarking reports and crop forecasting information, growers and industry input meetings were also used to identify and quantify constraints and their impact on the industry as a way of substantiating issues identified by the PRG, consultants' meetings and other stakeholder meetings.

An outcome of this was that there was confidence in the fact that the macro and emerging issues identified were agreed to by industry and that research outcomes were designed to help growers manage important issues. The whole-of-industry approach also was important in driving change in the industry and encouraging growers to invest to obtain best value.



Scott Herd, macadamia advisor with Norco, with the integrated orchard nutrition poster produced by the project. The poster was developed based on input and feedback from advisors like Scott and distributed throughout industry and used to as a resource to improve understanding about the importance of a balanced approach to nutrition management.

Assist in the development of new research outcomes

The collaborative approach taken in the project was important in ensuring the practical application of research outcomes. This was achieved through encouraging a high level of collaboration on activities and events between stakeholders and providers, as well as through the unique role of the AMS in being able to link growers with researchers and other providers. As a result, much research was conducted on farm and with grower input, ensuring the outcomes were practical, credible and applicable. Examples of this include the research conducted by Assoc. Prof. Femi Akinsanmi et al on disease management, Dr Brad Howlett et al and Prof. Stephen Trueman/Prof. Helen Wallace et al on pollination, Prof. Andrew Robson et al on remote sensing tools and Dr Ruth Huwer et al on integrated pest management.

The project initiated research as a result of identifying emerging e.g. the development of nursery standards, which lead to three workshops being developed and held with nursery owners and with growers to ensure the adoption of standards as a way of improving orchard productivity.

Other research the project worked on in partnership with other organisations included:

- Griffith University, University of Western Sydney and Plant & Food Research: pollination and bee safety
- DAFQ: collaboration on small tree high productivity and tree physiology
- Southern Cross University: social license, integrated pest management and genetics
- University of Queensland, DAFQ: establishing breeding priorities for growers and varietal improvement.
- University of New England: yield forecasting and national mapping
- NSW DPI: IPM strategies, crop protection emerging issues and coastal flood plain establishment principles
- University of Queensland: developing integrated disease management strategies.
- Office of Great Barrier Reef and Growcom; reef regulations and improved environmental outcomes
- Griffith University: kernel quality and plant growth regulators
- Applied Horticulture Research: smart farming in macadamia for improved environmental outcomes
- NSW DPI and NSW LLS: erosion control, water quality and fertiliser stewardship

Develop the agreed industry macro extension issue annually

The project established consultative mechanisms such as the annual consultants' meetings, PRG meetings and meetings with growers as a way of identifying each year's macro issue and developing agreed, whole-of-industry approaches to improving grower and wider industry knowledge and skills.

Identify and develop opportunities for new orchard and territory expansion

Expanding macadamia growing areas into new territory was a focus area for the project, who worked with state agencies to identify suitability. With this expansion, it was recognised that many issues were different from those in traditional growing areas, e.g. the risk and regulatory requirements of establishing orchards on coastal floodplains. The project has facilitated awareness of these issues by developing extension material on floodplain orchard establishment and collaborating with NSW and Qld catchment management agencies to ensure new regulation is extended to growers.

The project also ran five successful workshops for new growers as a way of improving knowledge and skills of new industry entrants and ensuring they had access to the latest information on best practice.

The evidence is that there is confidence among growers to invest in establishing new orchards with the area planted to macadamias in Australia growing from 17,000 ha in 2016 to 33,000 ha in 2020. More plantings are planned, and it is projected that there will 48,000 ha under planting by 2025.

Orchard expansion, like this new orchard at Maryborough, is at an all-time high

Manage unforeseen emerging issues

Throughout the term of the project, a range of unforeseen issues emerged. The collaborative mechanisms set up under the project ensured that these emerging issues were identified quickly, and that extension and other responses could be efficiently implemented.

Deliver research outcomes and agreed industry issues

The project successfully established several consultative mechanisms and has engaged with and resourced a large majority of growers, as shown in increasing attendance at MacGroups and workshops and developed extension material and activities highly valued by growers and industry members. Many events have been oversubscribed, requiring a waiting list in many cases and additional days needed to be held with continual demand as evidenced during the curtailing of face to face events during COVID.

The project held activities in every major growing region to address current issues but also focussed more strategically as the industry is expanding on building the capacity of consultants and advisors who have a broad reach and promoting strategic thinking at events such as Mac2030 orchard workshops. The outcome has been increased knowledge and skills about improved orchard management practices that have seen a resilience to unprecedented climatic challenges. In addition, all growing regions see a willingness of new growers to invest in orchards and current growers increasing their holdings as demonstrated by the expansion in area planted to macadamias, demand on nurseries and specific responses recorded in surveys.

Immediate project outcomes

The M&E plan developed at the start of the project included a series of outcomes that were to be achieved during its five-year period. These outcomes were as follows:

- extent of awareness
- gains in knowledge and skills
- extent of practice change
- indicative benefits.

To assess changes in these areas, several surveys were conducted during the project as well as one at its conclusion. The results of these surveys are summarised below along with conclusions about the success of the project in meeting outcomes.

Grower survey 2021. At the completion of the project in 2021, a grower specific survey was sent to 160 growers (representing more than 50 per cent of industry production) with questions about awareness of issues, gains in knowledge and practice change.

The 40 respondents (a 25 per cent response rate) represented all growing areas and all farm sizes, from less than 5 ha to greater than 100 ha. Some key statistics were:

- 75 per cent had been in the industry for five or more years
- Almost half had been in the industry for ten years or more
- 20 per cent of respondents had orchards 50 ha or bigger
- 31 per cent had orchards between 20 and 50 ha.

This is a significant representation of the industry and it indicates that the program is reaching experienced growers, many of whom have mature, established orchards and also representing the more “professional” sector of the industry where the potential for increasing per tree production is likely to be greater than with smaller, less experienced growers.

All growers responded that they had made changes to their orchard management in the last five years as a direct result of work done by the MC15004 project, with 46 per cent responding that they had made significant changes.

The information received from project events such as MacGroups and field days and technical support from the project were nominated as playing an important role in making decisions about these changes;

- 56 per cent of respondents nominating the resources from MC15004 as essential.
- 38 per cent of respondents nominating the resources from MC15004 as valuable.
- 5 per cent of respondents nominating the resources from MC15004 as moderately important.
- No one responded that the information was not a required resource.

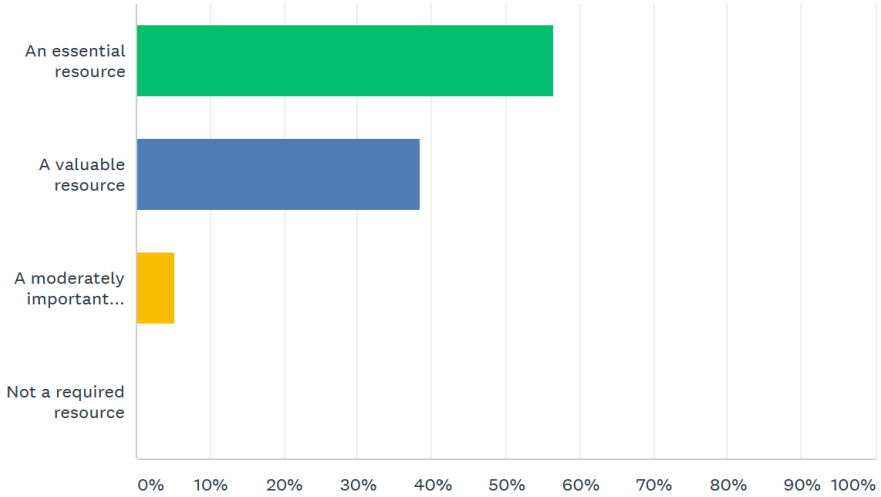


Figure 5. Grower responses to a question on the importance of information from attending MC15004 events, resources and from the IDM when making an orchard management decision.

Fundamental to these questions about awareness of information and improvement in knowledge in the last five years is action taken as a result. To identify specific practice changes, growers were asked to nominate a practice :

- they had stopped
- they had started
- and that they will continue

Table 2. Practices stopped, started and continued in the last five years (N=40).

Practices stopped	Practices started	Practices continued
Canopy management Yearly machine pruning Hedging annually Hedging trees (two respondents) Being too shy in pruning Pruning by limb removal	**Canopy management** Pruning by limb removal Row removal Limb removal Pruning Removing tops of trees Canopy management	**Canopy management** Selective limb removal External consultant and pruning Pruning and mulching Limb removal (two respondents) Removing tops Pruning hard
Orchard floor management Weed spraying (two respondents) Bare soil Grass control with herbicides Spraying entire orchard floor with herbicides	**Orchard floor management** Profiling (two respondents) Sweeping material under trees Major orchard floor management program using external consultant Mulching under tree Chipping limbs for mulch Grass control under trees	**Orchard floor management** Covering exposed roots where possible (two respondents) Profiling Mulching Brooming orchard inter row Preventing bare soil Heavy mulching
Irrigation and drainage management Stopped doing long irrigations	**Irrigation and drainage management** Targeting fertiliser closer to tree trunk in drier times to take advantage of unique shape of macadamia	**Irrigation and drainage management** Installing irrigation Shorter irrigation more often Daily scheduled watering Drip irrigation
Soil health and nutrition Applying synthetic fertiliser	**Soil health and nutrition** Making and applying compost Annual organic matter application Applying more natural fertilisers Wood chip/mulch prunings Managing our soils Using granular fertiliser Mulch/compost at larger scale Soil and leaf tests	**Soil health and nutrition** Increasing carbon in the soil Increased organic input Composting/spreading compost Fertilise small amounts often Managing our soils Foliar fertilising Soil and leaf testing
Pest and Disease management Calendar/ excessive spraying Blanket herbicide Applying Roundup Copper use Pre-flower spray	**Pest and Disease management** Native beehives	**Pest and Disease management** Integrated pest control Spray my orchard properly
Harvest and post-harvest Sending nuts off site to dehusk Harvesting in the wet Finger wheel harvesting Sorting nuts too well/ second sort Water sorting	**Harvest and post-harvest** Tree shaking Single pass harvesting	**Integrated orchard management** Replanting and respacing IOM (three respondents) Tree removal Improving timing Integrated strategies
Other hand planting Procrastinating Using hard chemicals/ herbicide Using organic principles	**Other** GPS planting IOM Block management Inter row cropping	**Other** Learning

In summary, all growers were aware of and valued information about extending research outcomes related to the program, had improved their knowledge and had applied techniques to improve their orchard management and farm productivity.

Communications survey 2020. One measure of practice change is information gained through the macadamia industry communications survey conducted by the industry communications program (MC18000) in 2020. A question in this survey asked how growers had applied information to make changes in their on-farm practices.

One hundred and forty-five growers (about 20 per cent of the industry) responded to this question. The information sources they cited included field days and MacGroups, which come under the auspices of MC15004, as well as communications materials such as articles in the News Bulletin and fact sheets produced through the industry communications program (MC18000), which the project contributes to.

The changes that were referred to most came under the following areas:

- nutrition and soil health
- irrigation and drainage management
- canopy and orchard floor management
- pest and disease management
- Spray application and chemical use.

See Table 3 for more information.

All these areas were identified in the industry innovation and adoption program as issues and were included in research and delivery strategies.

Table 3. Number of grower respondents to survey question on application of industry information, i.e. practice change (N=145).

Nutrition and soil health	Irrigation & drainage management	Orchard floor management	Canopy management	Spray application and chemical use
29	25	23	22	20
Pest and disease management	**Integrated orchard management**	**Pollinations and bees**	**Harvest and post-harvest**	
21	11	9	5	

Note: Some growers identified more than one practice change.

From their response, it can be seen that growers have implemented practice changes – some small and some significant - in their orchard as a result of their contact with the industry innovation and adoption program as well as the industry communications program.

In summary, these changes centre on issues that have been identified by industry stakeholders, who have agreed on a coordinated approach to the extension of recommended practices that growers are applying.

These practices include increased attention to nutrition, mulching and application of compost to improve soil health as well as practices recommended in orchard floor guidelines.

Irrigation is an issue that MC15004 focused on in 2019 and 2020, and the impact of information provided through publications, MacGroups and workshops can be seen in the comments by people who have implemented changes to their water schedules and soil water monitoring.

Canopy management is a practice that the program focused on from its inception in 2016, and the impact can be seen with growers identifying skirting, limb removal and thinning as priorities.

The integrated pest and disease management project has had an impact, as has the pollination project, on how growers view pest management. Growers are taking a more holistic approach, which includes timing of spray applications, encouraging beneficial insects and placing beehives to improve pollination.

A summary of quotes detailing practice changes can be found in Appendix 8.

Monitoring and evaluation

Industry development was achieved by identifying key production and capacity constraints and undertaking an extensive review and industry engagement process based on developing the knowledge and skills of growers as a way of contributing to the identified SIAP outcomes.

This was done by taking research outcomes and extending them in a way to deliver consistent key messages across a range of extension platforms and activities to improve grower knowledge and skills in applying new techniques and technologies and increase their confidence to invest.

Success of the program is shown by the following:

- Completing activities within the timeframe of the project (note that a MacGroup series was replaced with an online seminar due to COVID-19 restrictions).
- Establishing a project reference group, which met every six months and provided feedback on and develop the annual extension operating plan, including identifying the annual macro issue.
- Maintaining high levels of engagement and collaboration with growers and other stakeholders and establishing the roles of the project and the AMS as being the most important source of information for growers (confirmed through surveys and analytics) as well as providing an important function in coordinating an industry network linking growers with researchers, consultants and other stakeholders.
- Using cases studies and narratives to demonstrate real changes in understanding, skills and attitudes as a way of building grower capacity to improve production and apply innovation.
- Increasing the proportion of growers attending MacGroups to more than 60 per cent of total attendance in 2019 and maintaining a high level of grower participation in other in-person activities. These activities helped to increase grower awareness of orchard management technology and techniques and to build capacity to adapt and apply them on farm.
- Capacity development support both for new entrants to the industry, e.g. information material and four workshops in Queensland and the Northern Rivers and, for experienced growers, through leading two study tours, one to China and one to South Africa.
- Growers adopting research and development outcomes to improve orchard management (confirmed through MacGroup, workshop and communications surveys).
- Increasing engagement with other stakeholders such as a consultants and agency and processor staff leading to consistent and collaborative approaches to building grower awareness of and capacity to apply information about macro and emerging issues.

Outcomes were measured in terms of the following (from the M&E plan):

- Extent of awareness
- Gains in knowledge and skills
- Practice change
- Indicative benefits
- Barriers and enablers.

Review and understand current production constraints

Several strategies were used to understand production constraints with the aim of identifying macro and emerging issues to be included in the annual extension operating plan (Appendix 1).

Six-monthly meetings of the PRG, whose membership included growers, consultants, processor representatives, and Hort Innovation. The group played an important role in validating and providing feedback on issues constraining production, industry development and the annual operating plan.

An annual meeting with consultants, pest scouts, research and processor staff and topic specialists to identify macro and emerging issues and agree on a consistent, whole-of-industry approach to extension messaging and extending research outcomes. Surveys completed after each meeting showed that almost all attendees rated their value as high or very high (see Table 4).

Table 4. Percentage of attendees at consultants meeting rating them as high or very high value.

2016 73 attendees	2017 105 attendees	2018 89 attendees	2019 86 attendees	2020 35 attendees
90% (n=22)	100% (n=20)	Day 1: 90% (n=33) Day 2: 88% (n=35)	98% (n=34)	

Reviews of annual benchmarking information and crop forecasts were used to identify areas to focus extension activities on and to assess industry development progress. During the five-year term of the project several environmental factors, which had a significant impact on production, were incorporated into extension planning. These were Cyclone Debbie (Queensland), hail and storm events (northern New South Wales) in 2017, and drought, which resulted in 2019-20 being the driest season on record in most growing areas (see Figure 6).

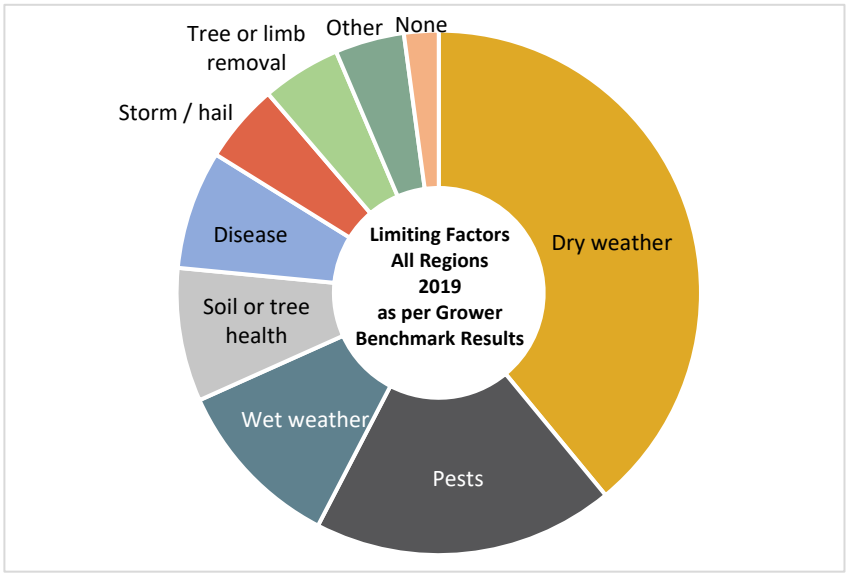


Figure 6. Limiting factors to production 2019 (Benchmarking report, 2020).

Rapidly increasing costs of production were also an issue for the industry. Benchmarking data reported an average long-term cost of production from 2013 to 2018-19 at $7500/ha; in 2019-20, this had increased to $8800/ha. These costs have been offset by the increasing farm-gate price for nuts combined with improved harvest efficiencies and the adoption of automated orchard practices, both issues that the project focused on with the aim of building capacity.

Contact has been maintained by the project with other tree crop industries such as almonds, avocados and apples as a way of identifying similar constraints on production and extension strategies. An example is an article by Stahmann Farms examining orchard floor and harvest management strategies for pecans (see Appendix 6).

Assist in the development and delivery of research outcomes

The project has established a function central to industry networking and enabling industry contact and collaboration. This is assisted by the AMS' role of representing more than 70 per cent of industry's growers, producing 85 per cent of the crop. The project has been able to link researchers and stakeholders with those willing to participate in research and provide strategic input on research investment.

Examples of this role include linking growers with researchers involved in pollination trials, disease management trials and other IPDM research, enabling many investigations to be completed on farm at commercial scale and in a representative portion of growing regions. The result of this approach to research means that results are commercially proven on farm, have credibility, are practical in focus and are directly applicable to the industry.

The annual consultants' meeting provided another forum for assisting with the development of research outcomes. Many meeting participants had close commercial relationships with growers and up-to-date knowledge of issues and constraints to production such as pest problems and managing soil and tree health. The annual meetings allowed for input "from the farm up" into research projects as a way of contributing to grower capacity building and improved orchard management.

Other strategies for achieving this delivery area were through liaison with research agencies, Hort Innovation and grower meetings. This included:

- Featuring speakers from research providers at MacGroups, field days, consultants' meetings and new grower workshops. As well, the focus of the December 2017 MacGroups was presentations by Hort Innovation and SIAP.
- Developing extension material based on research outcomes for publication through AMS channels such as the News Bulletin, e-newsletter, industry website, podcasts and videos (Appendix 3).
- Using research outcomes to develop extension information to support delivery of macro and emerging issues, e.g. harvest efficiency, spray coverage and IPDM.

Develop the agreed industry macro extension issue annually

The macro issue was identified through consultation at formal events such as MacGroups and the annual consultants' meeting, liaison with researchers, reviews of benchmarking information and annual crop projections, industry surveys and formal and informal meetings with growers. The issue was then confirmed at the annual PRG and incorporated into the annual extension operating plan for the project (Appendix 1).

This annual process of whole-of-industry consultation ensured that the most significant issues constraining production were identified and that credible, practical capacity building strategies were developed.

Identify and develop opportunities for new orchard and territory expansion

Steadily increasing prices for macadamia nuts in the last six years have resulted in considerable interest from current growers in expanding areas under tree and from new growers looking to develop orchards in greenfield sites, e.g. sugarcane land.

In 2016, the industry consisted of about 650 growers and 17,000 ha planted to macadamias; in 2020 this had grown to about 800 growers and 33,000 ha, of which 25,000 ha is currently bearing. More plantings are planned, and it is projected that there will 48,000 ha under planting by 2025.

To support the interest in expansion, the project worked with stakeholders and NSW DPI to identify and develop opportunities for new orchards in Queensland and on the Northern Rivers coastal floodplain. To support capacity development among new growers, workshops were put together by the project and held in 2016 and 2018 in Bundaberg Qld and the Northern Rivers of NSW.

The project also produced case studies detailing grower experiences and a fact sheet on floodplain macadamias and held the first-ever MacGroup meetings at Mackay in 2017 and at Yamba in 2019. These meetings provided opportunities for growers to improve their knowledge as well as learn from each other and industry experts.

Manage unforeseen emerging issues

The project was developed on the understanding that unforeseen issues representing threats to production and requiring management by growers would emerge over its five-year term.

The project responded to these threats by employing a range of extension tools and strategies to improve awareness and knowledge and build capacity in the industry to manage them. Emerging issues and examples of responses include the following:

- The emergence of pesticide resistance – collaboration with researchers such as Dr Femi Akinsanmi, extension agencies such as NSW DPI, QDPI, QAAFI and processors to develop effective extension tools to increase grower knowledge about effective and safe pesticide use and integrated pest and disease management (see Appendix 7 for an example of the phenological wheel poster).
- Recovering from storm damage – coordination of information about disaster recovery and applications for disaster support to government agencies and production of articles and a factsheet about practical tips based on grower experience for orchard management after environmental events.
- Preparing for heatwaves and bushfire – coordination of information using grower experience to show effective ways of preparing for bushfire and managing in the heat.
- Problems with nursery stock and poor survival rates after planting – initiation of a research project to develop nursery standards and the completion of three workshops (two for growers and one for nursery owners) to improve grower knowledge and practices to ensure standards are being met.
- Social license and environmental management – regulatory requirements and pressures on growers related to social license, especially in the Northern Rivers, have increased considerably. This has occurred at the same time as rising market expectations about provenance and environmental stewardship and requirements under catchment legislation. Capacity building activities were held to improve grower knowledge and practices on topics such as spray application and orchard floor management to restrict erosion and run-off into streams, e.g. in 2019, two workshops attended by 100 growers and stakeholders were held on environmental monitoring equipment and one on soil management (24 participants).
- New orchard management issues – through regular meetings with growers and stakeholders emerging issues particular to each region have been identified and strategies developed to improve skills in managing them. As an example, in 2020 a series of meetings were held with larger growers from the Bundaberg area who represent 30 per cent of the industry's production. Using benchmarking data from project MC18002 and their own experience, these growers identified that brown centres were the mostly costly factory defect in the region in 2019 and 2020 with the result that a brown centre sampling protocol will be implemented in the 2021 season.

Deliver research outcomes and agreed industry issues

Research outcomes and agreed macro issues identified as significant constraints to production were the focus for extension and influencing activities in each year's extension operating plan. The plan was developed based on a whole-of-industry approach to building grower capacity and developing knowledge and skills to improve orchard management and production.

Extension activities delivered as per the approved monitoring and evaluation plan (see Appendix 5) are as follows:

- MacGroups which are a well-known and relied upon vehicle for knowledge transfer.
- Workshops, field days and skills development activities.
- Annual consultants' meeting and six-monthly PRG meetings.
- Meetings and consultation (formal and informal) with industry stakeholders and with growers.
- Articles in the *News Bulletin* extending the practical application of research results, case studies of grower adoption, innovative technologies and important updates such as minor use permits.
- Fact sheets describing results of research and providing information to improve knowledge of on-farm practices and techniques, e.g. pollination and tank mixing of sprays.
- Grower videos and podcasts with a regular subscription in industry.

Table 5 details these activities, number to be delivered per year and actual numbers delivered over the life of the project.

Table 5. Number of activities delivered compared to those scheduled in monitoring and evaluation plan.

Extension delivery vehicle	Number scheduled (over 5 years)	Actual number delivered	Comment
MacGroups	84	75	Six cancelled because of flooding. Two extra groups run, one in Yamba and one in Mackay. In 2020, webinars replaced some face to face meetings.
Workshops, field days and training activities	20	29	Workshops developed in response to emerging and macro issues such as environmental monitoring, tree water relations, IOM and ION
Annual consultants' forum	5	5	2020 attendees reduced due to COVID
Six-monthly PRG	30	30	
Grower/stakeholder meetings & consultations	60	60	
News Bulletin articles	Not specified	95	In addition every edition had a number of extra articles with project technical input which are not included in this figure
Fact sheets	12	15	In 2020 survey of growers and stakeholders, fact sheets received the highest score for the most useful feature of the AMS industry website.
Grower videos	10	18	
Podcasts	-	4	Begun in 2020
Mac2030 workshop	2	2	

Building capacity and encouraging change to more efficient orchard practices was at the heart of extension activities and information produced. To illustrate this, the following table lists the results of surveys completed after MacGroups to demonstrate their usefulness to growers and effect in influencing the uptake of knowledge.

Table 6. Sample of MacGroup surveys with ratings and comments from growers.

NSW MacGroups July 2016 (n=61)	Queensland MacGroups July 2018 (n=66)	MacGroup February 2020 Bundaberg
Focus: ION	Focus: IPDM	Focus: Water & soil management
All respondents rated the information as interesting	97% of attendees rated the quality of the information as good or excellent	93% of attendees rated the quality of the information as good or excellent
Based on information presented, 40 growers said they would make a change to their orchard practice, 3 said they would make no change and 5 were unsure.	Based on the information presented 33 growers said they would make a change to their orchard practice, 5 said they would make no change and 15 said they were unsure.	Based on the information presented 13 growers said they would make a change to their orchard practice, 5 said they would make no change and 15 said they were unsure.
Comments from survey: "Visiting orchards that had implemented some of the changes had a positive effect." "Will change my prioritization. Plan to concentrate on drainage first then come back to canopy." "We saw the outcome of plans during the field visits."	Comments from survey: "Calibration of my spray equipment is very important." "Important issues are bees, sprayer review, implement rat strategy." "We'll pay more attention to our spray program and apply mulch." "Manage honeybees at flowering."	Comments from the survey: "Installing supplementary irrigation." "Installing taller sprinkler stakes." "More attention to soil health." "Better weed control under canopy." "Irrigation timing in relation to available soil moisture."

As a result of drought conditions in 2018-2020, access to water and efficient irrigation as a way of improving production and nut quality became hot issues, especially in Bundaberg and newly established floodplain orchards in the Northern Rivers. In response to this, the project worked with stakeholders and growers to determine key questions, information gaps and potential strategies to adopt for irrigating macadamias.

Daniel Manson, a specialist in irrigation based in Bundaberg, and Dr Theunis Smit, a specialist irrigation based in South Africa, were engaged by the IDM to present workshops in Bundaberg, Gympie/Glass House Mountains, the Northern Rivers and Yamba. From the evaluations of the workshops completed by 43 grower respondents:

- 41 rated the technical aspects of the workshop as good or excellent
- 38 rated the information as practical or very practical
- 36 rated the information as relevant or very relevant to their situation.
- 31 of the 43 growers responded that they would be implementing changes as a result of the workshop, e.g. upgrading or installing soil moisture monitoring equipment, increasing irrigation frequency, changing pruning methods and herbicide applications, how moisture stress and soil infiltration rate are monitored.

The 2020 Macadamia Industry Communications Survey, conducted under the Macadamia Industry Communication project (MC18000), provided further confirmation that information delivered under the project which is developed with the technical skill and industry engagement from this project MC15004. It showed that information is used for on-farm decision making and that:

75 per cent in 2017 and 60 per cent in 2020 of respondents say that they used industry technical information provided, most of which is initiated and developed with input from project MC15004 to change or improve on-farm practices (see Table 5).

Table 5. How growers and other stakeholders use information provided by MC18000 Macadamia Industry Communication project.

	Percentage of respondents	
	2017 (n=110)	2020 (n=275)
To obtain new ideas	81.82	70.55
To change and/or improve my on-farm practices	75.45	60.36
To talk to a consultant about a specific issue	33.64	28.36
To share with another grower or industry member	40.91	29.45
To keep up to date with what is happening in the industry	92.73	86.55
Other e.g. teaching resources, to find contractors, services and products, to be informed about issues, new products	5.00	7.27

A list of grower changes to farming practice as a result of accessing information included in Appendix 8

Recommendations

As a result of the experience and learnings from MC15004, the following key recommendations are made.

1. The innovative approach taken in the project, especially the focus on pinpointing macro and micro issues for each year and on co-learning, has provided several lessons to do with extension practice and involving growers and stakeholders in identifying issues and solutions. It is recommended that Hort Innovation identify in a structured manner the key learnings from projects to do with extension practice and then feed them into a cross-industry collaborative forum that builds capacity and stimulates fresh ideas amongst extension staff.

2. The appearance of COVID-19 in 2020 was a "black swan" event that challenged society and the macadamia industry in numerous ways. In the light of the fact that social and industry gatherings were not able to be organised for most of the year, it is recommended that Hort Innovation assist with dissemination of digital/remote contemporary engagement strategies and learnings across industries as a way of preparing for continued disruption due to COVID-19 and other, similar, disruptions. The lessons from the inevitable modifications that had to be made could serve as new extension and communication pathways, particularly to rural and remote stakeholders in horticulture.

3. When new research projects are contracted, extension and grower outcomes are built into the scope. It is recommended that research contracts have detailed requirements to collaborate with industry development projects such as Comms and Innovation and Adoption. This will aid in maintaining consistent, high standards in both research and the extension material developed.

4. Monitoring and evaluation is a critical part of investment governance, but can be a highly subjective practice depending on the modalities utilised, inquiry formulation and reporting structure. It is recommended that Hort Innovation develop an M&E rationale or model which will inform richer and more functional monitoring and evaluations plans for extension projects.

5. To provide a guide for research and extension staff as well as promoting consistency across industry programs, it is recommended that Hort Innovation establish annual benchmarks for extension.

Intellectual property, commercialisation and confidentiality

No project IP, project outputs, commercialisation or confidentiality issues to report.

Acknowledgements

The Australian Macadamia Society gratefully acknowledges the willingness of the research community in supporting the Australian macadamia industry to share their knowledge and experience in a collegiate manner with the project staff, other researchers and industry members.

The AMS also thanks the many industry members who generously assisted in providing their time, orchard space and management to field trials for projects.

The contributions of overseas researchers and industry experts who hosted study tours and travelled to Australia to share their knowledge is much appreciated.

Finally, the AMS appreciates the commitment to improvement and inclusiveness that characterises the industry, facilitates adoption of change and allows a focus on today's issues while permitting investment in production system research for the future.

Appendixes

Appendix 1. Annual extension operating plan 2019-20

2019 – 2020

Macadamia Industry Annual Extension Operating Plan (AEOP)

Leoni Kojetin

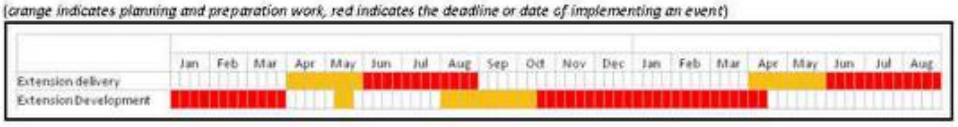
Introduction and Background

The macadamia industries extension, innovation and adoption program utilises a process of focusing on only one primary macro extension issue annually. This is to ensure that each issue obtains the required investment of time, energy and resources whilst having an ability to react to and assist to manage emerging issues. The primary macro extension issue is determined based on; potential return on investment, grower interest and industry capacity *(the industry's ability to access required resources such as information and expertise)*.

The dominant timing for delivery of the macro issue will be from June to August each year. This is due to the timing of on-farm operations, as the majority of the orchard improvements take place from August to October. Focusing the delivery in June, July and August will provide growers with information in a timely manner that will enable and empower them to adopt the improved practices. Delivering extension platforms in October or November are too late for growers to utilize and adopt that information.

The remainder of the year the industries extension, innovation and adoption program will be focused on the development phase for the following year's delivery, and introducing the upcoming issue to growers. The completion of the development phase will occur prior to the dominant extension delivery period of June to August. The illustration below summarises the two different phases and how they compliment each other.

(orange indicates planning and preparation work, red indicates the deadline or date of implementing an event)



This document summarises the industries progress of the previous years annual extension operating plan, and outlines the plan for the coming period. It encompasses both the extension development phase and the extension delivery phase of the program. These distinctly different phases are summarised below;

Extension Development Phase

A development stage within the extension program enables a macro issue to be broken down into micro issues, and consequently a greater understanding of the challenges, barriers and solutions to be understood. A specialised investigative committee will be formed annually to undertake the development of each macro issue. The development stage will include a review of knowledge to date, input from growers and stakeholders on orchard experiences, studying and viewing current practises used in the industry and identifying barriers to adoption. This will ultimately lead to agreement on the key extension messages and the most suitable methods for extension delivery *(including which platforms to utilise and the timing of those platforms)*.

Extension Delivery

Platforms -Specific extension platforms will be utilised for each issue during the extension delivery phase. Each platform utilised will be assessed in accordance to its suitability in regards to the target audience, the timing and method of communication (*to ensure a broad range of communication methods are utilised to cater for growers*). Not all platforms will be used for all extension issues, the right tool for the right job approach will be utilised. The range of extension platforms at the disposal to the macadamia industry include;

2

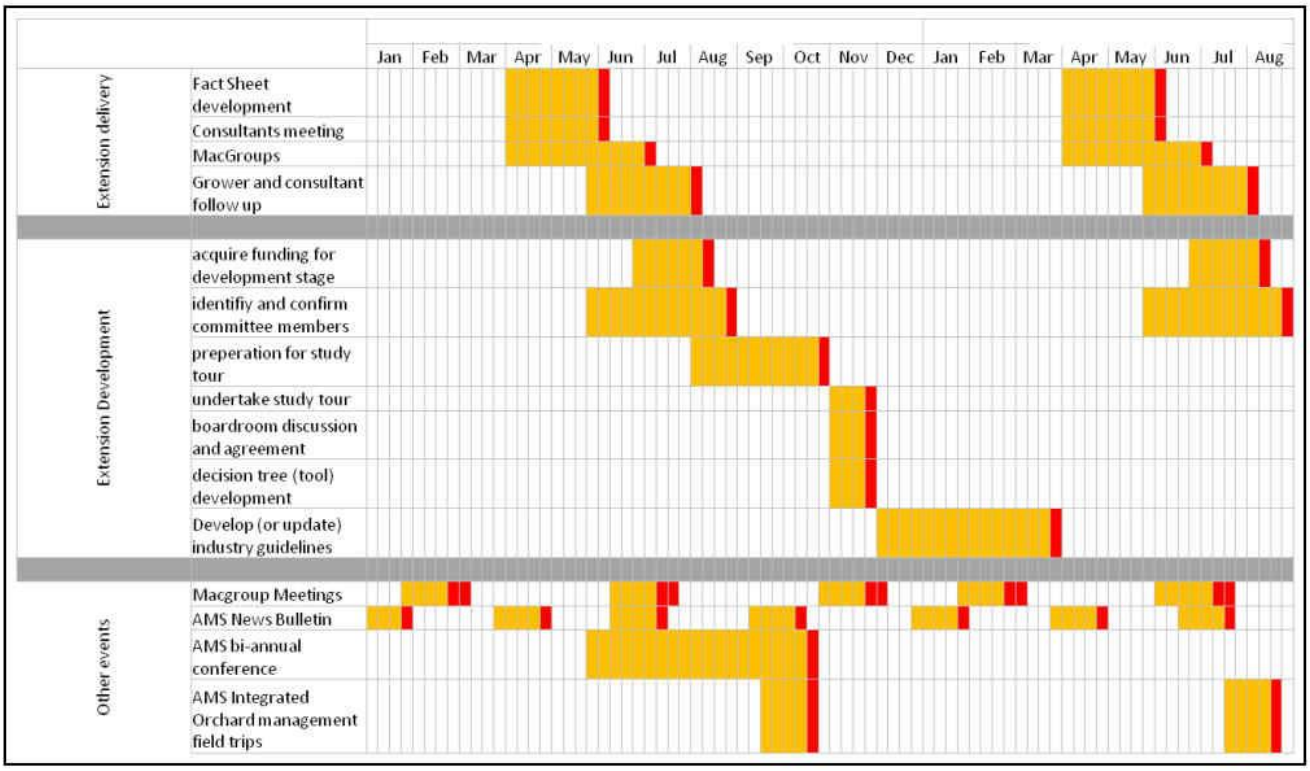
	Target Audience	Timing	Method of communication
Strategic Reference Groups	- Growers - Consultants - Stakeholders	2-3 meetings per year per group	- meetings/planning workshops - verbal presentations - summary written information
MacGroups	- Growers - Consultants	- March - July	- verbal presentations - summary written information - visual demonstration - practical demonstrations
AMS News Bulletin	- Growers - Consultants - Stakeholders	- March - June - August - December	- Written communication only
Regional Topical Courses	- Growers	October to November	- verbal presentations - summary written information - visual demonstration - practical demonstrations
Conference	- Growers - Consultants - Stakeholders	October to November	- verbal presentations - potential for written summary information
Consultants meeting	- Consultants	June	- verbal presentations - written summary information - detailed information presented
E-newsletter	- Growers - Consultants - Stakeholders	Monthly	- Written communication only
Mac2030 Workshops	- Growers - Consultants - Stakeholders	December	- planning sessions - verbal presentations
Field Days	- Growers	Flexible	- visual examples - potential for verbal presentations - grower talks - summary written information - practical demonstrations
MacSmart	- Growers	Flexible	- visual examples - verbal presentation
Field Trips	- Growers	Flexible	- visual examples - potential for verbal presentations - grower talks - summary written information - practical demonstrations
Direct contact with consultants	- Consultants	Flexible	- verbal discussion - detailed information
Fact Sheets *(summary sheets)*	- Growers - Consultants - Stakeholders	Flexible	- written summary information - visual examples
Grower Posters	- Growers - Consultants - Stakeholders	Flexible	- written summary information - visual examples - self assessment questions

**A combination of platforms that deliver visual, written, verbal and demonstration methods of communication will be utilised at each extension delivery period.*

3

Summary Gant Chart

(Orange indicates preparation and planning work, with red indicating the deadline or date of an event)



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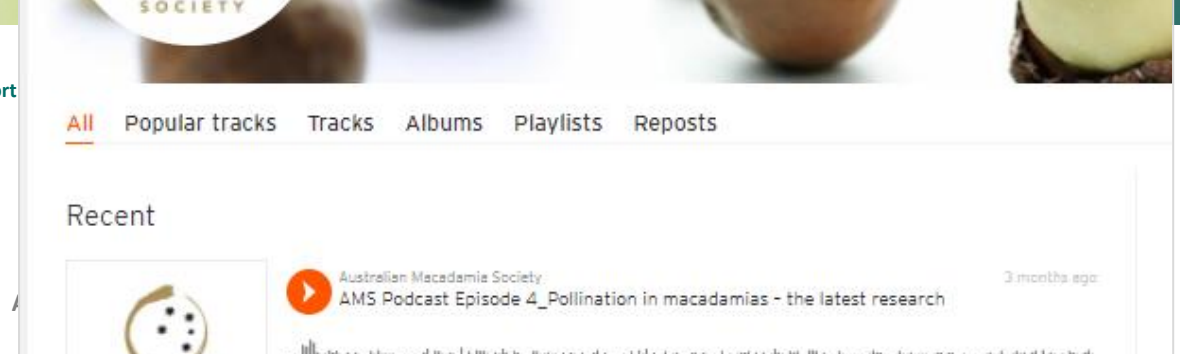

Fact sheet
POLLINATION

AUSTRALIAN MACADAMIA SOCIETY

Pollination by agents such as insects underpins production in many crops, including macadamias. Ensuring efficient and effective pollination is one way that growers can increase nut yield in orchards. This fact sheet summarises current knowledge about pollination in macadamias and suggests how this knowledge can be applied in the orchard to help improve production.

Fast facts

- Good pollination is essential to achieving good nut set and production in macadamias
- While some varieties can self-pollinate, DNA paternity testing has consistently shown that most nuts come from cross-pollination, highlighting the importance of including pollination strategies in your orchard management plan
- The most important macadamia pollinators are the honey bee followed by the native stingless bee, although a variety of other naturally occurring species have been identified as macadamia pollinators of lesser importance, including rhinid flies and lycid beetles
- It is important to monitor pollinator insects in your orchard so you can determine how pollen is being moved between trees and whether there is potential to improve opportunities for cross-pollination
- Strategies to improve cross-pollination include: distributing hives of honey bees or native stingless bees or both through the orchard, incorporating multiple varieties in each orchard block, encouraging foraging by bees by managing the flowering canopy to allow longer periods of sunlight, and testing potential increases from cross-pollination by doing your own hand pollination and comparing results with production from racemes that are naturally pollinated.

What is pollination?

Pollination involves the movement of pollen from the anthers of a flower to the stigma of the same or a different flower.

Self-pollination occurs where pollen is moved within and between racemes of the same macadamia variety by a pollinator such as a honey bee or native bee.

Cross-pollination occurs where pollen is moved by a pollinator from one macadamia variety onto the flowers of a different, compatible variety.

An important element in the process of macadamia pollination is fertility.

Self-fertile trees can pollinate themselves or trees from the same variety and produce nuts (called "selfing"). Self-sterile trees cannot pollinate themselves or trees from the same variety to produce nuts, rather they need to be cross-pollinated. **Self-incompatibility** means that there is some constraint that stops self-fertilisation.

Although macadamias are thought to be partially self-incompatible, i.e. they favour fertilisation of the ovule by pollen of another cultivar over its own pollen, research and grower experience have shown that they can produce nuts through self-pollination. Despite this ability for some varieties to self-pollinate, DNA paternity testing by three different research teams in Queensland and New South Wales has consistently shown that most nuts come from cross-pollination. DNA paternity testing has also shown that the nuts produced by self-pollination are often smaller, with lower kernel mass and lower kernel recovery, than the nuts produced by cross-pollination.

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Appendix 3. Program outputs

MacGroups

MacGroups and field days are a key tool for extending information about best practices and demonstrating the application of technology and research outcomes at a farm level. Underpinning the philosophy behind MacGroups is building capacity in the industry as growers learn from growers.

Three MacGroups were held each year (two in 2019) at locations in Queensland (Bundaberg, Gympie and Glass House Mountains) and in New South Wales (Nambucca and Northern Rivers). A MacGroup meeting was also held in 2019 in Yamba and in Mackay.

Table 1. MacGroup meetings held 2016 to 2020, number attending and meeting focus.

2016	
July (Integrated Orchard Nutrition)	438
December (Harvesting strategy, IPM project, regional pest updates)	318
Additional events	
July ION field trips (6)	438
New Grower Workshop - Northern Rivers	26
New Grower Workshop - Bundaberg	18
2017	
February/March (Market demand, production and strategy/HIA SIP)	427
July (Integrated Pest and Disease Management)	550
December (Hort Innovation presentations and SIAP)	277
Additional events	
September IOM Field Trips (5)	327
Mackay MacGroup	20
2018	
February/March (Market update, global production and demand, partner presentations)	379
July (Integrated pest and disease management)	614
December (Innovative machinery/farm tours)	180
Additional events	
Nursery workshop - Production nurseries	32
New Grower Workshop - Northern Rivers	19
New Grower Workshop - Bundaberg	16
Irrigation field trip, Bundaberg large area growers	14
2019	
February/March (Ground cover management, Grower trials, Marketing)	391
June/July (Tree physiology, Tree shakers)	448
Yamba MacGroup - September 2019	27
Additional events	
Nursery standards workshops for growers (Bundaberg and N. Rivers)	66
Nursery standards workshops for production nurseries (N. Rivers)	22
Environmental monitoring workshops (Gympie, Bundaberg, Northern Rivers)	100
Soil health your wealth workshop (Mid North Coast)	24
Tree water relations courses (Bundaberg, Gympie/Glass House Mountains, Northern Rivers and Yamba)	167
2020	
February/March	438
MacGroup webinar - August	241
December	253

Note: Levy payers averages about 60 per cent of attendance, this proportion has increased since 2016.

Annual Consultants Meeting

A 2-day annual consultants meeting is held each year with researchers, pest scouts, consultants and processor extension staff to agree on macro issues and to provide information about research outcomes. This meeting has become an important vehicle for the industry to agree on consistent messaging provided to growers.

Table 2. Consultants' Meetings 2016 to 2020, attendance and focus topics.

Year	Focus topics	Attendance
2016	IPDM, Pollination, ION, research outcomes	73
2017	IOM, ION, IPDM, research outcomes	105
2018	IPDM, research outcomes	89
2019	IPDM, tree physiology, water use	86
2020	IPDM, monitoring tools, setting industry priorities	35 (Limited due to COVID)

Bulletin articles

The project worked in partnership with industry levy communication program (MC18000) and market development program (MC14005) to plan, provide technical input into and/write articles. Articles which were authored by the IDM, alone or jointly, are indicated. Articles where IDM had input into planning or provided feedback about technical aspects are noted "input".

The *News Bulletin* is distributed to levy payers, industry stakeholders and key Hort Innovation staff. Since May 2016, distribution has increased from 696 to 953.

Table 3. News Bulletin articles with IDM as author or providing technical input.

May 2016 **Editorial focus: ION; Harvest efficiency**	
Robbie's MacAttack	IDM
Time to work on your ION program	IDM
Getting the little things right	IDM
Modifications improve harvest efficiency	IDM
Sweeper and finger wheel harvesters improve risk management	IDM
Time to work on your ION program	IDM
August 2016 **Editorial focus: ION; Drainage**	
Robbie's MacAttack	IDM
ION - What is it? Important information for growers	IDM
ION - Self assessment questions for growers	IDM
What is your most limiting ION factor?	IDM
Husk spot management: Start in September	IDM with AMS Comms
Managing water flow and drainage top priorities	IDM Input
Ground covers control erosion	IDM Input
Workshop shines a light on pollination	IDM
November 2016 **Editorial focus: Productivity; Innovation; Drainage**	
Robbie's MacAttack	IDM
State of Origin winners shine	IDM
MacGroups well regarded by growers	IDM
Controlling waterflow and orchard drainage	IDM Input
Plan helps reduce soil loss	IDM Input
Targeting erosion hotspots	IDM Input
Irrigation helps boost erosion	IDM with AMS Comms

February 2017 **Editorial focus: Harvest efficiency; Marketing**	
Robbie's MacAttack	IDM
Harvest strategy quick tips	IDM
Harvesting opportunities for 2017	IDM
Harvest 2017 - are you ready?	IDM
Improving harvest efficiency while maintaining grass on the orchard floor all year	IDM
Coordinated approach to pest control in macadamias (IPM program)	IDM Input
May 2017 **Editorial focus: Harvest efficiency; Innovation and technology**	
Robbie's MacAttack	IDM
Northern orchard highlights	IDM Input
Riverbend harvests 2-year-old crop	IDM
August 2017 **Editorial focus: IPDM; Coverage and spray application**	
Robbie's MacAttack	IDM
Monitoring, timing and coverage:get them right for effective IPDM	IDM
Timing the key with IPDM	IDM
Jorg Kitt covers coverage	IDM
November 2017 **Editorial focus: IPDM; IOM**	
IOM Plan 2016; Yield increase 2017	IDM Input
Changing canopies	IDM
February 2018 **Editorial focus: Harvest efficiency; Marketing**	
Farming together, learning together	IDM with AMS Comms
Harvesting strategy quick tips	IDM
Fortnightly harvesting achieves consistent quality	IDM with AMS Comms
May 2018 **Editorial focus: Tree water relations; IPDM**	
Meet your industry productivity development manager	IDM with AMS Comms
Staff and timing: Keys to efficiency	IDM
Investment in irrigation pays off in production and quality	IDM
August 2018 **Editorial focus: IPDM; Pollination**	
Leoni's orchard rounds	IDM
Getting the little things right pays off	IDM with AMS Comms
Macadamias in Vietnam – a snapshot	Queensland IDM
IPDM - A strategy for the future	IDM with AMS Comms
Growers embarking on the IPDM journey	IDM with AMS Comms
Pests and diseases - the future is integrated management	IDM with AMS Comms
IPDM - A view from the orchard	IDM with AMS Comms
Mythbusting fruit spotting bugs	IDM
The macadamia integrated pest & disease management program	IDM Input
November 2018 **Editorial focus: Environmental monitoring; Tree water relations**	
Leoni's orchard rounds	IDM
Taking the guesswork out of decision-making with weather monitoring tools	IDM with AMS Comms
SAP Flow monitoring - A new frontier in irrigation management	IDM with AMS Comms
Production potential or pipe dream?	Queensland IDM

February 2019 **Editorial focus: Macadamia marketing and innovation; Harvest efficiency**	
Leoni's orchard rounds	IDM
China; crouching dragon or paper tiger	IDM input
Industry welcomes new growers	IDM with AMS Comms
Mistletoe: No cause for celebration in macadamias	IDM with AMS Comms
Minor use permits	IDM
May 2019 **Editorial focus: Improving orchard productivity; Financial and business management**	
Leoni's orchard rounds	IDM
First Macgroup in Yamba responds to significant new plantings	IDM
Tree specifications for new nursery tree standard	IDM with AMS Comms
Environmental Monitoring to improve orchard management	IDM
Profile: Bruce and Liz Green	IDM with AMS Comms
Grass selection and management key to orchard productivity	IDM with AMS Comms
Weather stations: a sound business investment	IDM with AMS Comms
Mistletoe and macadamias	IDM with AMS Comms
Minor use permits	IDM
August 2019 **Editorial focus: Pest and disease management; Application technology**	
Leoni's orchard rounds	IDM
Managing macadamia seed weevil	IDM with NSW DPI
Anenometers, wind meters and weather stations	IDM
Tank mixing agricultural chemicals	IDM input
Spraying in New South Wales? You may need an EPA licence	IDM with AMS Comms
Record keeping requirements	IDM with AMS Comms
Minor use permits	IDM
November 2019 **Editorial focus: Orchard health; New technologies for the orchard**	
Leoni's orchard rounds	IDM
South African macadamia study tour, July 2019	IDM
Tree water management special feature	IDM Input
Ingenious mobile dehusking and processing plant a game changer	IDM with AMS Comms
Macadamia: the sustainable water user	IDM Input
Minor use permits	IDM
February2020 **Editorial focus: Harvest efficiency; soil/leaf monitoring; Post-harvest handling** **Distribution: 905 people per edition**	
Leoni's orchard rounds	IDM
Grower of the year award winners, Gary and Julie Davis	IDM
Grower experiences of coping with the drought	IDM with AMS Comms
Orchard floor management strategies	IDM with AMS Comms
Dealing with small nuts during harvest	IDM with AMS Comms
Canopy management adaptions during drought	IDM with AMS Comms
Water use and irrigation scheduling adaptions	IDM with AMS Comms
Investing in irrigation systems on dryland orchards	IDM with AMS Comms
Delivering crucial nutrition in dry times	IDM with AMS Comms
Pest and disease consideration in drought conditions	IDM with AMS Comms
Getting a little bit extra out of every drop of water	IDM Input

May 2020 **Editorial focus: Pollination; Spray application; Pest and disease management; ION and IOM**	
Leoni's orchard rounds	IDM
The importance of macadamia pollination: an overview	IDM input
Are you ready for the new regulatory reality?	IDM
AusMac2020 preview: Water use management by Dr Dan Manson	IDM
Tree shaker shortening the harvest season	IDM with AMS Comms
Minor use permits	IDM
August 2020 **Editorial focus: Nutrition; IOM; Crop protection and monitoring**	
Leoni's orchard rounds	IDM
2020 season review	IDM Input
Orchard preparation the key to long-term macadamia success	IDM
Macadamia nutrition and vegetative vigour: a new approach	Input
The mobility and uptake of nutrients in macadamia	IDM et al
Identifying toxicity and deficiency symptoms	IDM et al
Simple but effective fertigation system a winner	IDM with AMS Comms
Under-tree nets providing soil health benefits	IDM Input
Regenerative nut production: a case study	IDM Input
Minor use permits	IDM
November2020 **Editorial focus: Macadamia cultivars; Machinery and new technology**	
Leoni's orchard rounds	IDM
Which variety is which?	IDM
Genetic variation in macadamia cultivars	IDM Input
New Hidden Valley A-series variety release	IDM
Minor use permits	IDM

Podcasts and videos

The AMS began producing podcasts in early 2020 and videos in 2018 as channels to extend messaging on macro issues and research outcomes.

Table 4. Podcasts and videos produced by project.

2016	
AMS Video: Assessing and achieving optimal coverage in macadamia orchards (Jorg Kitt)	View at You Tube
2017	
AMS Video: Improving your harvest efficiency - focus on fingerwheels	View at You Tube
AMS Video: Macadamia harvest improvement - review (IDPM)	View at You Tube
2018	
AMS Video: Jason Klotz (Red Rock Macadamias, Bundaberg)	View at You Tube
AMS Video: Scott Allcott (Macadamia Farm Management, Bundaberg)	View at You Tube
AMS Video: Peter Fraser (Rosebank)	View at You Tube
AMS Video: Bruce and Pam Lilly (Beerwah)	View at You Tube
AMS Video: Garry Sheppard (Ozmac)	View at You Tube
AMS Video: Rodent control in macadamia orchards (David Elmouttie)	View at You Tube

AMS Video: Optimising pollination of macadamia and avocado in Australia (Dr Brad Howlett)	View at You Tube
2019	
AMS Video: MacGroup Preview: Grass Management, featuring turf consultant Matt Roche	View at YouTube
AMS Video: Harvesting out of grass, featuring macadamia grower Tony Flick	View at YouTube
AMS Video: MacGroup Preview: Tree shakers, with Dan Manson (Bundaberg)	View at YouTube
AMS Video: Understanding macadamia water transpiration – presentation at workshop by Theunis Smit	View at You Tube
AMS Video: Irrigation Scheduling – presentation at workshop by Dan Manson	View at You Tube
2020	
AMS Podcast One: Macadamia water use	Listen at Soundcloud
AMS Podcast Two: The interrelationship between nutrient management and irrigation management	Listen at Soundcloud
AMS Podcast Three: Use of ethrel in macadamias	Listen at Soundcloud
AMS Podcast Four: Pollination in macadamias, the latest research	Listen at Soundcloud
AMS Video: Macadamia quality	View at YouTube
AMS Video: Ethephon use in challenging conditions	View at YouTube
AMS Video: Tree water relations	View at YouTube
AMS Video: MacGroup seminar (August 2020)	View at YouTube

Factsheets and posters

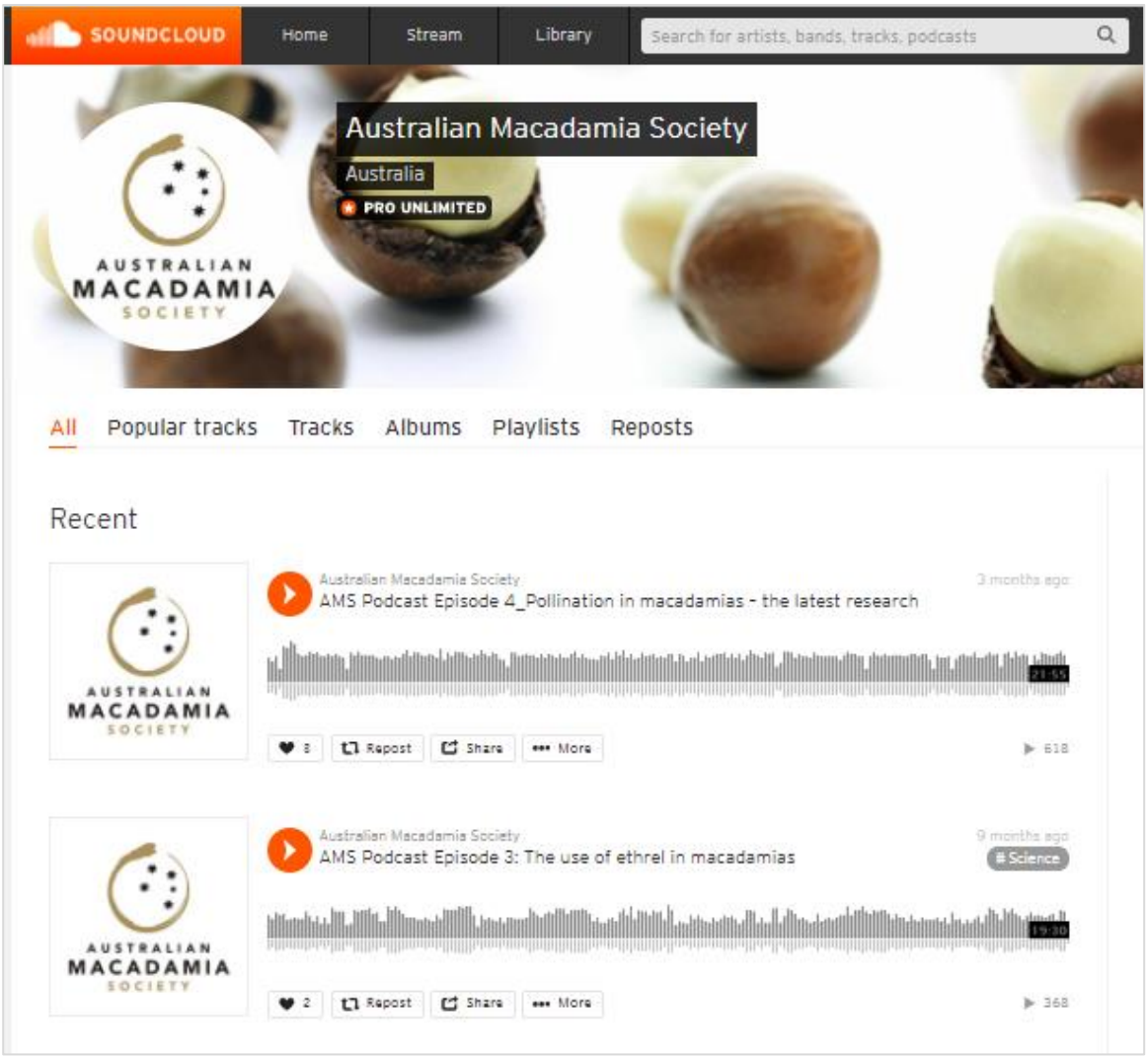
Factsheets are an important channel for extension messaging related to macro issues and research outcomes. The IDPM has written or provided technical input into the fact sheets in Table 5. Included in the table are posters, which were developed and distributed to consultants, agencies and other suppliers to reinforce extension messages.

Table 5. Fact sheets authored by the IDPM or technical input provided. Download from the industry website in the Industry Resources section.

2016	
Integrated orchard nutrition (poster)	IDM
Integrated orchard nutrition (checklist)	IDM
2017	
Harvest strategy	IDM
Harvest strategy quick tips & grower experiences	IDM
Integrated Orchard Nutrition (ION)	IDM
Sugar mill organic amendment by-products in composts and for direct application to orchards	IDM Input
2018	

Bee management during flowering	IDM
Macadamia IPM Phenological wheel posters: (NSW Northern Rivers, NSW Mid North Coast, Central Queensland, South-East Queensland)	IDM
Tips on managing storm damage	IDM with AMS Comms
2019	
Floodplain orchard development	IDM
Mistletoe and macadamias	IDM with AMS Comms
New nursery tree standards	IDM ete al
Rat control integrated regional approach	IDM with AMS Comms
Anemometers, wind meters and weather stations	IDM with NSW DPI
2020	
Using ethephon in macadamias	IDM et al
Making healthy compost on the farm	IDM et al
Buying in composts for orchards	IDM et al
Tank mixing agricultural chemicals	IDM et al

Appendix 4. Podcasts were introduced as a tool for extending information about innovations and best practice in the orchard.



Appendix 5. Monitoring and evaluation plan

Document Purpose

The purpose of this document is to provide a Monitoring and Evaluation Framework and Evaluation Operational Plan for the Australian Macadamia Industry Innovation and Adoption Program (MC15004). This will guide the data collected for review and reporting purposes of the project.

Project Purpose

The objective of the project is to enhance the adoption of innovation and technology and facilitate capacity building in the Australian macadamia industry.

The aim of this project is to contribute (20%) to raising average industry productivity by 3.75% from 2.9 tonnes NIS/ha (2015 av) to a min. 3 tonnes NIS/ha – adding 1,650 tonnes NIS, and approx. $6.6m to industry farm gate value. It also has an aspirational target of an additional 18,000 tonnes with a farm gate value of $60m

This project contributes to the following Macadamia Industry strategic Objectives:

Macadamia Industry – Strategic Investment Plan 2014-2019 (SIP)

- Objective 1: Sustainably increasing the productivity of Australian macadamia farms
- Objective 3: Improving stakeholder confidence in the Australian macadamia industry
- Strategic investment areas
  - ID opportunities to improve productivity in existing orchard base
  - ID and advocate opportunities for expansion
  - Sharing knowledge and facilitating the implementation of productivity improvements
  - Promoting industry successes to increase the confidence and investment of the industry
- Industry targets
  - SK average/ha increased form 0.8 tonnes/ha to 1.2 tonnes/ha by end 2019 (inc average NIS from 2.66 tonnes/ha to 4.0 tonnes/ha by 2019)
  - Attract 200ha greenfield plantings annually that adopt recommendations for maximising orchard productivity with 800 ha planted by 2019.

Project Approach

This project will seek to achieve its objectives through an extensive industry engagement process focused around the following key delivery areas:

1.Review and understand current production constraints (5%).

2. Assist in the development of new research outcomes (10%).

3. Develop the agreed industry macro extension issue annually (35%).

4. Identify and develop opportunities for new orchard and territory expansion (5%).

5. Manage emerging issues (15%).

6. Deliver research outcomes and agreed industry issues (30%)

Context

The Australian Macadamia industry has invested over $25 million *(matched through with HAL funding)* into research, development and extension over the past 15 years, resulting in an average annual investment of over $1.5 million. The Australian Macadamia industry has been, and still is, very well serviced by a vast range of highly capable and successful research providers, predominantly through the state governments department of primary

industries agency. These agencies often utilise appropriately qualified researchers that specialise in certain fields, tree physiology or entomology for example. These individuals are very well qualified and skilled to undertake the research and development of specific projects however they are not necessarily qualified or skilled in extension. The macadamia industry has achieved high levels of success in research and development to date, disease management and nutrition research developments are great examples. Through this success, the macadamia industry has effectively built up a bank of knowledge. A key challenge over the immediate to medium timeframe for the macadamia industry, and most Australian horticultural industries, is not within the research and development but within the extension of that research and development out to the industry.

This project/program is an industry capacity building based project that has a strong focus on this major industry opportunity, of innovation and adoption. It serves as an integral conduit and catalyst for both the development of innovation and adoption outcomes as well as the delivery of those outcomes to macadamia growers to drive the adoption of innovative practices that increase production and improve profitability. This project/program sits in between research, growers, HIA and industry stakeholders, *as illustrated in diagram 1*.

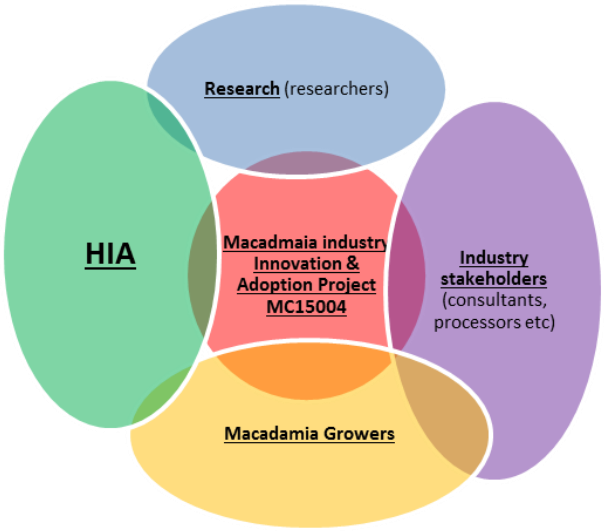


Diagram 1 – an illustration on the "fit" of the macadamia industry innovation and adoption project. With this project fitting between the entire R&D program [over 20 different specific projects], industry stakeholders [over 85 individuals], HIA [a wide range of individuals and portfolios within HIA] and Australian macadamia growers [over 750 individual orchards]).

To achieve the ambitious targets this project/program has set for itself a suite of industry activities will be undertaken in a targeted and strategic manner as outlined in the Annual Extension Operating Plans. To track the impact and level of success these targeted and strategic activities have in the industry it is important to undertake careful and regular monitoring and evaluation (M&E). This document highlights that major points of M&E that will be undertaken to track the impact the project/program is having on the strategic industry targets.

Project Log Frame

Project Name: Australian Macadamia Industry Innovation and Adoption Program **Number:** MC15004
Date Started: 1/03/2016
Completion date: 28/02/2021

Evaluation Level	Project Details	Performance Measures	Evaluation Methods

Broader Goals
Potential longer term impacts on industry productivity, profitability, environmental and/or social benefits
 	
Contribution to industry Objectives
• Horticulture Innovation Australian
	Potential Long Term Impact
	
	Macadamia Industry – Strategic Investment Plan 2014-2019 (SIP)
	• Objective 1: Sustainably increasing the productivity of Australian macadamia farms
	• Objective 3: Improving stakeholder confidence in the Australian macadamia industry
	• Strategic investment areas
	  ○ ID opportunities to improve productivity in existing orchard base
	  ○ ID and advocate opportunities for expansion
	  ○ Sharing knowledge and facilitating the implementation of productivity improvements
	  ○ Promoting industry successes to increase the confidence and investment of the industry
	• Industry targets
	  ○ SK average/ha increased form 0.8 tonnes/ha to 1.2 tonnes/ha by end 2019 (inc average NIS from 2.66 tonnes/ha to 4.0 tonnes/ha by 2019)
	  ○ Attract 200ha greenfield plantings annually that adopt recommendations for maximising orchard productivity with 800 ha planted by 2019.
	• Annual extension operating plan
		• Extent of gains in number of farms and ha, production, profitability of the industry over time.
		• Extent of gain in investment into the industry over time.
		• Extent to which industry targets are met.
			[Not the responsibility of the funded project]
			
			• ABARES survey data
			• Industry surveys/reports
			• Surveys of stakeholders
			• Collated data from regional projects
			• Industry benchmarking data
			• Regional production data
			• Consultants' meeting surveys

Evaluation Level	Project Details	Performance Measures	Evaluation Methods
Immediate Project Outcomes [expected to be achieved in the life of the project] • Extent of Awareness • Gains in Knowledge and Skills • Extent of practice change • Indicative benefits • Barriers and Enablers	By 2019: **Capacity and Practice change** High level/increased awareness, knowledge, skills and motivation across macadamia producers and their advisors about the relevant research and development outputs and improved management outcomes that could improve their enterprise. A critical number of producers, representing 30% of the production base adopts one or more new or improved practices. **Indicative Impact** The practice changes made is expected to contribute (20%) to raising average industry productivity by 3.75% from 2.9 tonnes NIS/ha (2015 av) to a min. 3 tonnes NIS/ha – adding 1,650 tonnes NIS, and approx. $6.6m to industry farm gate value. • Aspirational target – an additional 18,000 tonnes with a farm gate value of $60m.	• The extent of awareness, improvement in understanding, skills and motivation to change by macadamia producers as a result of communication and engagement activities. • The number of producers and the production base represented who have made one or more of the recommended practice changes to their enterprises influenced by the project. • The calculated and measured benefits of the changes in terms of their indicative impact on productivity and farm gate value – farm level and collated industry level. • Barriers to change and issues identified for future action.	• Feedback sheets from participants of extension activities - questions specific to impacts on understanding, skills and motivation. • Follow-up adoption surveys of producers engaged in activities. • Final adoption survey – across sample of producers and consultants. • Annual interviews with informed persons. • Narratives • Case studies • Benefit Cost Analysis based on adoption data gained
Influencing Activities [expected to be undertaken during the project] • Communication activities • Extension Activities – field days, farm walks	*6. Deliver research outcomes and agreed industry issues (30%)* **Communication** • Website • Macadamia Bulletin – 4 editions/yr • Industry e-newsletters **Extension** 60% of production base (by ha) engaged in the project. June-August focus for extension activities • MacGroups – 18/yr • Grower field days – 4/yr • Grower tours	• The number, type and topics of communication articles and posts, their effectiveness/user-friendliness and their access by producers and their advisor. • The extent to which producers (and the production based they represent) are engaged in project activities and their reaction (perceived value) of	• Project records on communication activities. • Media analysis – google stats. Newsletter circulation and opening information. • Feedback on producer surveys about the different communication and extension activities in terms of their value and use to them

Evaluation Level	Project Details	Performance Measures	Evaluation Methods
	• Annual consultants' meeting – 1/yr June • Mac 2030 Orchard Workshop (yrs 2 and 4) • Presentations to biennial industry conference	those activities – compared to 60% target. • The number, type and quality of engagement activities undertaken compared to planned – support by stakeholders, reactions, and commitment shown.	• Project records on extension activities, participation – location, numbers and production base. • Feedback sheets – questions on reactions, value, process. • Observation/reflection sheets by team members.
Outputs & Products [expected to be developed from the project] • New/adapted technology • New information products or packages • New understanding or knowledge	**Extension materials** • Macadamia Bulletin articles • Fact sheets (2/yr) • Grower videos (DAF HortSmart YouTube) 2/yr August/Dec • Papers for conferences **Project reports** • Annual Operating Plans • MER Plan • Updates to AMS Board • Updates to Hort Innovation • 6 monthly milestone status reports • Mid-term project review report • Final report	• The number and type of extension material developed, their quality, rigour and appropriateness. • The extent to which required reports and other administrative outputs are completed to the satisfaction of project management and funders.	. • Project records on extension materials and reports produced. • Feedback from stakeholders – and through producer surveys. • Peer review of conference papers and technical outputs • Response by Horticulture Innovation on outputs and reports submitted.
Development [expected to be undertaken during the project] • On-farm trials and testing activities • Development of extension or training packages	1. *Review and understand current production constraints* (5%). 2. *Assist in the development of new research outcomes* (10%). a. Research liaison b. Grower and industry input meetings – 12/yr 1/month 3. *Develop the agreed industry macro extension issue annually* (35%). a. Investigative committee workshop 1/yr (Oct-Dec) b. Assisting to update industry guidelines and manuals	• Extent to which current production restraints are identified, the rigour employed and their endorsement by industry. • Extent to which time and resources have been used to assist with development of new research outcomes, quality of input an impact on decisions. • Activities undertaken and extent to which macro extension issues have been identified and endorsed and the effectiveness of their use in planning	• Project/Milestone reports with details of activities undertaken • Informed person and researcher interviews about activities and value. • Interviews with project team members • Questions in producer survey relevant to development activities.

Evaluation Level	Project Details	Performance Measures	Evaluation Methods
	c. Researcher liaison d. Grower and consultant meetings e. Extension Planning meetings (yrs 2 and 4) May 4. *Identify and develop opportunities for new orchard and territory expansion* (5%). a. Mac 2030 orchard workshops – 1 in yr 2; 1 in yr 4 b. Working with new entrants and existing growers seeking to expand 5. *Manage emerging issues* (15%). a. Use of existing extension and communication channels to deal with issues such as pests and environmental challenges,	and undertaking extension activities and developing relevant materials. • Extent to which new opportunities have been identified for orchard and territory expansion and the extent of actions to take advantage of this development. • Extent of effective reaction to emerging issues and industry satisfaction with the actions taken.	
Foundational Activities [planned to be used to undertake and advise the project] • Project team – including producer members • Funds and in-kind	**Governance** • CEO AMS responsible for oversight of Productivity Development Manager. • Project Reference Group – 2/yr ○ HIA representative ○ AMS representative ○ Levy payer representatives	• Extent to which effective management processes are in place and in use. • Make-up, extent of meetings and effectiveness of PRG and their influence on the project. • Extent to which promised funds are received, and used as per budget	• Project records on management processes and PRG make up and meetings. • Feedback sheets to PRG at each meeting – satisfaction, issues, input and action.

M&E Action Plan

M&E Method [from Evaluation Methods column]	**Purpose/Focus**	**Details**	**Responsibility and Timing**
MacGroup Survey (X3 rounds/yr)	• Gauge impact on target audience from their attendance at MacGroups and look at how to improve them over time.	• Email sent with Survey Monkey link 1 week after each event. Example questions are included in this document.	• Shared MIPDM & AMS Comm's Mgr. • 1 week after each event
Consultants' Annual survey	• Detailed feedback on previous 12 months orchard activities/changes of practice	• Undertaken prior to consultants' annual meeting • Covers range of production issues such as: IOM, ION, pest mgt., disease mgt., production and new plantings	• MIPDM • Prior to Annual Meeting • Once per year
Production Data Analysis	• Annual impact review	• Industry benchmarking • Regional production (Crop forecast project) • ABAREs reports (if available) • Consultants' Surveys	• MIPDM • PRG members • Last quarter annually (Oct – Dec)
Annual Grower Interviews	• Track progress over time and gain feedback on what is working well and what needs to change.	• Utilise Industry benchmarking • Engage growers by production quartile • Engage growers by region • Interviews year 1 and then annually	• MIPDM • AMS Comm's Mgr.
Annual researcher & Stakeholder Interviews	• Track progress over time – and capture observations and views from stakeholders on what is working well and where impact is occurring – as well as barriers and issues.	• Update & feedback from range of industry stakeholders – phone and face to face interviews with questions about what they have observed, impacts made, issues arising and future needs.	• MIPDM • AMS Comm's Mgr.
PRG surveys and Interviews	• Detailed feedback on project's progress and methodology	• Survey PRG each meeting – short one page feedback sheet. • Interview PRG members annually	• MIPDM • Surveys at each meeting (2-3 times a year) • Interviews annually
Extension & Development Benchmark analysis	• Compare this project's progress to other similar projects	• Acquire data from APEN & HIA • Compare progress from MC15004 to other similar projects (Both ROI $ & activities)	• MIPDM • Coutts J&R

M&E Method [from Evaluation Methods column]	**Purpose/Focus**	**Details**	**Responsibility and Timing**
Annual Summary of activities and Industry "reach"	• Review industry engagement • Identify opportunities	• Review attendance% and trends • Research/review key drivers • Identify opportunities for improvements	• MIPDM • PRG

Field Day Participant Feedback Sheet
[example only – for modification and development]

Thanks for providing this feedback. It is important that we are able to understand how useful the event was and how we can improve future field days.

Date:

Location:

1. Which group best describes your role:

- □ Producer/Manager
- □ Farm employee
- □ Consultant
- □ Government employee
- □ Service provider
- □ Other (Please describe)

2. If a producer, please give an approximate idea of the size of your orchard?

Hectares: Av NIS:

3. Overall, how relevant would you rate the field day to you and your enterprise?

Not at all relevant □0 □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 Highly relevant

Comments:

4. What could have made the field day (even) more beneficial to you?

Comments:

5. At the field day what level of new knowledge or understanding did you gain about:

5.1 ……..?

No new knowledge □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 A significant amount

5.2 ……..?

No new knowledge □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 A significant amount

5.3 ……..?

No new knowledge □ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 A significant amount

6. What is a key message that you are taking away from the (event)?

7. As a result of what you have heard at the (event / forum, etc), what actions (if any) have you been prompted to take following the (workshop/meeting/forum/field day) – please tick any that are appropriate:

☐ Reassessing …….. practice
☐ Changing your approach/advice to ……
☐ Discuss possibilities with my consultant/clients
☐ Seek extra information or training ……
☐ Come back to the next field day
☐ Other actions:

7.7 Please give details of what you are planning to follow up and/or take actions on:

8. Please indicate what other information or assistance you might need to act on the information you have gained:

9. Please make any other comments or suggestions about the event or [ ] it's management:

Thankyou for your feedback

PRG Meeting Feedback sheet

Thank you for providing this quick feedback on the PRG meeting. I am keen to ensure that meetings fulfil their purpose and remain productive. Your feedback will help keep us on track. The responses will be collated to provide a short overview – individuals will not be linked to responses.

1. Overall, how useful did you find the meeting in terms of understanding the current situation of the project?

Not useful □ 0 □1 □2 □3 □4 □5 □6 □ 7 □8 □9 □10 **Very useful**
Comments/explanations:

2. How useful did you find the meeting in terms of providing input into the project direction?

Not useful □ 0 □1 □2 □3 □4 □5 □6 □ 7 □8 □9 □10 **Very useful**
Comments/explanations:

3. How satisfied are you that you (personally) had full opportunity to provide the level of input you wished at the meeting?

Not satisfied □ 0 □1 □2 □3 □4 □5 □6 □ 7 □8 □9 □10 **Very satisfied**
Comments/explanations:

4. How well did the meeting structure and process work for you?

Not very well □ 0 □1 □2 □3 □4 □5 □6 □ 7 □8 □9 □10 **Very well**

5. What could have (further) improved the meeting process for you?

6. How satisfied are you with the way the different agenda items were dealt with and the steps that were agreed?

Not satisfied □ 0 □1 □2 □3 □4 □5 □6 □ 7 □8 □9 □10 **Very satisfied**
Comments/explanations:

7. Please note any specific items that you would like to make (further) comment on:

8. What are the pressing issues that you see need to be addressed by the project in the next few months?

9. Please make any other comment about the meeting or the matters addressed (use the back of the page if more space is needed).

Thanks for this feedback. Feel free to discuss any aspect with the project team

Example MacGroup Follow-up Survey

Q1 Please select your growing region
- Mid North Coast NSW
- Northern Rivers NSW
- Glass House Mountains/SEQ
- Gympie QLD
- Bundaberg QLD
- Other

Q2 Did you attend one of the July MacGroup meetings?
- Yes
- No

Q3 Please select your orchard size
- 0-12ha
- 13-40ha
- 40-100ha
- 100ha +
- I don't own an orchard but am involved in the industry in other ways

Q4 Please outline why you did not attend
- Not interested in the topic
- Timing of meeting clashed with other events
- Don't see the value in attending MacGroup meetings
- Was not aware of the MacGroup meetings
- Too far to travel
- Other

Q5 On average how many MacGroups do you attend annually?
- 0
- 1
- 2
- 3
- 4 or more

Q6 Do you have any comments you'd like to share with us about the AMS MacGroups?

Q7 Had you heard of Integrated Orchard Nutrition (ION) prior to this MacGroup?
- Yes
- No

Q8 Was the topic Integrated Orchard Nutrition (ION) of interest and benefit to you?
- Yes
- No
- Other

Q9 Based on the information presented at this MacGroup are you likely to either (please answer A or B, not both):
- engage a professional consultant to assist with your investment into Integrated Orchard Nutrition
- increase your engagement with a professional consultant to assist with your investment into Integrated Orchard Nutrition

Q10 Had you heard of Integrated Orchard Management (IOM) prior to this MacGroup?
- Yes

□ No

Q11 Was the topic Integrated Orchard Management (IOM) of interest and benefit to you?
□ Yes
□ No

Q12 Based on the information presented at this MacGroup (including the field trip, ION poster and the IOM booklet) do you feel more confident to identify the highest investment priority for your orchard from drainage, orchard floor or canopy?
□ Yes
□ No
□ Unsure

Q13 **Based on the information presented at this MacGroup (including the field trip, ION poster and IOM booklet), are you likely to increase your investment into, or continue to increase your investment into:** [Yes, No; Unsure]

□ A drainage management program

□ A canopy management program

□ An orchard floor management program

Q14 Please explain why you will/won't increase your investment in the above areas

Q15 Will you make a positive change in yourbusiness/orchard/management practice as a result of something you learned at this MacGroup?
□ Yes
□ No
□ Unsure

Q16 Please explain why/why not you will make a change to your business/ orchard/ management practices

Q17 Please rate the quality of presentations overall
□ Excellent
□ Good
□ Average
□ Needs improvement
□ Poor

Q18 Was there a presentation that you found particularly useful?
□ Industry update, (name)
□ Soil health and disease management, (name)
□ IOM update & benchmarking, (name)
□ LLS drainage and erosion plan funding, (name)
□ NSW sugar mill mud, (name)
□ ION update, (name)
□ Barmac sponsor presentation, (name)

Q19 Please rate the AMS staff in regards to service provided
□ Excellent
□ Good
□ Average
□ Needs improvement

□ Poor

Q20 Do you have any further comments on the presentations and/or support staff at this MacGroup?

Q21 How many MacGroup meetings do you attend annually?
□ One
□ Two
□ Three
□ Four or more

Q22 How did you hear about the MacGroup meeting?
□ AMS Email
□ Processor Email
□ AMS Website
□ AMS Flyer
□ Rural Retailer
□ Other (please specify)

Q23 Is the promotion of the Macgroup meetings?
□ Excessive, too much information is sent to me
□ Just right, and helps remind me in a friendly and timely manner
□ More reminders are needed

Q24 Please rate the length of the MacGroup meeting:
□ Too short
□ Just right
□ Too long

Q25 Are there any other comments you'd like to share with us about the AMS MacGroups?

Follow up survey of General Event Participants
[example only – for modification and development]

Thanks for being willing to provide this feedback. It is important that we are able to understand how useful the information being presented at the field day was and whether you were able to apply any of it.

1. Which group best describes your role:
□ Producer/Manager
□ Farm employee
□ Consultant/Vet or Advisor
□ Government employee
□ Service provider
□ Other (Please describe)

2. If a producer, please give an approximate idea of the size of your orchard?

Hectares: Average NIS:

3. Please indicate if you have accessed other information (as well as from the event) from the project through:
□ Website
□ Fact sheets

□Videos
□E-newsletter articles
□

4. As a result of what you have heard at the event , what actions (if any) have you taken:
☐Reassessed your own ……practice
☐Changed your approach/advice to ……
☐Considered changing approach to ……
☐Discussed possibilities with your consultant/clients
☐Sought extra information or training
☐Other actions:

5. If you have made a change in practice/advice, please provide some more details:

6. How much sooner did you make this change as a result of the project information or activities than you may have done otherwise (please tick)?
☐Sooner than I would otherwise have done so
☐I don't expect to make a change:

If sooner, number of years sooner (0 if it was planned for current year anyway):

7. Overall, to what extent would you attribute your attendance at the field day or the influence of related information and/or activities to you making the change?

No influence□ 1 □ 2 □ 3 □ 4 □ 5 □ 6 □ 7 □ 8 □ 9 □ 10 A significant influence

8. If you have made a change on your orchards or (for consultants – with your advice), what benefits or impact has this had on your enterprise (or your client's) - or do you expect it to have? Please comment:

-

9. Has this triggered any other changes in the way you manage your enterprise? If so, what changes:

10. What has stopped you – or made it difficult to – make changes in this area?

11. What further information or assistance would help you in making (further) changes to your management?

12. Please make any other comments about the project, emerging issues or future needs:

Thanks for your time and insights.

Narratives and Case Studies

Purpose

To capture real situations of changes in understanding, attitudes or practice across target groups. Project staff informally become aware of changes/impacts that occur but this anecdotal data often does not find its way into the evaluation data. Narratives are not 'random samples' and do not quantify to what extent such changes have occurred across a population but they are **real** instances of change and can illustrate the types of changes that are occurring and indicate their value and impact. If enough are systematically collected they can provide data illustrating certain kinds of change. They can also be used to illustrate quantitative assessments of change. Case studies are more detailed analyses of actual situations and allow statements to be made about the broader potential impact.

Narratives and case studies are useful for capturing impacts on other researchers, technical advisors, policy people and funders – depending on the context and target of the project.

Timing

Narratives should be captured cumulatively over the life of the project and be the responsibility of all Program members interacting with target groups. A goal should be to attach a number of narratives to each milestone report.

Case studies are best captured towards the end of the project to highlight impacts that have occurred as the result of change practices. Support may be required to capture and measure the impacts using a case study approach. Technical specialists and economists could help flesh out and quantify these cases. The information should include the results of interviews, discussion, observation and analysis, and be as specific as possible, with supporting data. Photos and other evidence of changes are also useful in case studies.

Approach

The approach is to capture instances of impact in a short summary form under some structured headings – as they occur. Structured **narratives** are short stories describing the impact that has occurred as a result of a project. They follow a set structure and should be written regularly throughout a Program (which differs from case studies which are normally written towards the end of a project). The narrative (or story) describes the link between the activities in a project and the desired outcomes. These provide an illustration of the impact that has been achieved, or has the potential to be achieved. And, where enough narratives are systematically collected, collated and analysed, they start to quantify what change is happening 'on the ground'. A small selection of narratives provides the basis for more in-depth analyses of **case studies**.

Structure

Narrative headings

1. Context of 'the case' – for example, the group and specific decision-making area.
2. What actions/new approaches were taken *as a result of* project information or activities – by whom and where, and what was the situation beforehand (the benchmark)?
3. What were the aims of taking these new actions/approaches and how were they implemented?
4. What specific results were observed or recorded?

5. What does this convert to in terms of improved investment decisions, management, productivity, environmental or social outcomes?
6. What is the projected benefit/cost (qualitative and/or quantitative)?
7. What has happened with these results – who has picked up on them, how are they being applied? How is it being packaged/spread for others?
8. What are the indications for impact over the next three years plus?

Example Narrative (simulation only)

Date: 15th September 2017

Recorder: Jeff Coutts

Outcome/s: Integrated Orchard Nutrition

Actors: Mary J is a macadamia grower from Gympie, with an orchard size of 80ha.

Event: Mary is a regular participant in MacGroups, attending three meetings in the last year. At the recent meetings she was introduced to the concept and practice of Integrated Orchard management.

Reaction: The ideas being presented were very relevant to her business and she was keen to learn more and see how it could benefit her orchard.

Action: ***As a result*** she talked with her consultant about how it be implemented on her farm. After exploring the costs and benefits and practicalities, she obtained a bank loan and purchased the equipment she needed. With the aid of her consultant she fully implemented the IOM approach.

Impact: Although it is too early to see the final results of this approach, she has already been able to decrease her fertiliser cost by being more effective in nutrient management and she expects that yields will increase over the next years.

Other: Mary is sharing her experience with her neighbours who are very interested in seeing its relevance and impact for their own farms.

1. To maximize value from these narratives they should follow the same format and be systematically collected by project team members. It is suggested that a range of stories are collected on different outcomes, such as on practice changes, Date
2. Contributed by ….
3. The issues captured in the narrative. These can be linked to the KRAs:
4. The situation of the producer/stakeholder
5. The specific activities/processes etc. which triggered a change
6. The change (new understanding, attitudes, practice etc.) that occurred
7. The observed/expected impact of that change
8. Other comments/observations

Appendix 6. Article by Stahmann Farms about harvesting (example of looking at other industries)

PECANS: QUICK SHAKE AND HARVEST

Eryn Wrigley, Stahmann Farms Enterprises

Harvesting in the macadamia industry has always been an extended process that lasts for five to seven months, depending on factors such as the number of varieties to be harvested and the weather. This length of harvest is unusual in the tree nut industry in Australia, and there are efforts to compress it by using plant growth regulators such as ethephon or physical methods such as shaking.

A shorter harvesting period has a number of advantages: it's time efficient and has the potential to be cheaper in terms of labour and machinery, it could result in improved nut quality, and it allows more time for managing the orchard (more time to grow next year's crop).

With this in mind we thought it would be a good idea to have a "look over the fence" at how harvesting is managed in another tree nut crop to see if a similar amount of time is spent on harvest and whether there are any lessons for the macadamia industry. In this article, Eryn Wrigley, agronomist with Stahmann Farms at Moree, describes the key aspects of harvesting pecans.

Stahmann Farms has more than 100,000 trees (900+ ha) in their orchards in Moree. The original plantings at "Trawalla" are almost 50 years old and consist of 690 ha of Western Schley and Wichita trees. As well, on other farms, there are 22 ha of 12- to 18-year-old Cape Fear and Wichita trees and 90 ha of non-bearing Wichita and Navaho trees that will come into production over the next couple of years. Another 110 ha has been marked for planting later this year.

What is the process for preparation for harvest and harvest itself?

Eryn. Orchard floor cleanup starts in December to January, when we apply post-emergent herbicides and slash the orchard floor. Maintenance on all harvest machinery starts during this period as well.

Harvest starts when we can see a significant percentage of shuck, or husk, split across the farm. Tree shakers with side-shoot arms clamp around the tree and shake for between 3 and 5 seconds to get as many mature nuts as possible without too many green nuts that have not yet split.

A sweeper is then used to form windrows. This is done through using a rotating sweeper front and the blower on the side, which clears nuts away from the trees. A team of stick pickers remove any large sticks and branches from the windrows which could block or damage harvesters. The harvester picks up the windrows by sweeping any stray nuts back into the row with fronts similar to the sweeper, flicking them into the harvester and blowing the excess leaf, soil and grass back into the field.

Nuts are sorted in the on-farm cleaning factory to remove sticks and stones only. They are dried on farm and then transported to the processing factory in Toowoomba. Product shipped still contains between about 4 to 6% kernel moisture.

The post-harvest process is closely monitored so shaken nuts are ideally on the ground only for 12 hours to ensure quality.

Tree shakers are used to shake mature nuts from the trees. Trees are shaken for between 3 and 5 seconds and mature nuts fall to the ground.

Sweepers sweep nuts into a window using machines that have a rotating front sweeper and side blower.

A number of harvesters work the rows of pecan trees to harvest nuts as quickly as possible.

How long is the harvest season?
Eryn. We harvest in two rounds, first starting in late April which collects around 60% of the crop. There is a four-week break before we start the second round. This allows time for frosts to trigger leaf drop, and the remaining crop is collected. Each round lasts approximately three weeks, depending on weather. This means our harvest period is usually no longer than ten or twelve weeks.

What are the key issues that you have to manage during harvest?

Eryn. Machinery breakdowns are an issue as they can create bottlenecks in the harvest process quickly if one stage suffers regular breakdowns.

Weather is another issue. Rain and wet fields interfere with machinery, and small amounts of rain can hold harvest up for days if drying conditions aren't favourable, which can reduce quality. (Some initial drying occurs in the field before harvest, very different to the macadamia harvest process. This is mainly because macadamia's high oil content compared to other tree nuts makes it essential to get it off the ground quickly. Ed.)

Because harvest is condensed into a short period of time, a number of operations occur at the same time in the orchard. This creates a "production line" of sorts making coordination crucial. Machinery speed must be carefully managed to maintain an ideal gap between each process, so nuts aren't left in the field for too long or machinery doesn't bunch up.

As far as incoming nuts are concerned, we have to ensure the harvesters don't exceed the capacity of cleaning factory, drying shed and truck outs.

Safety is also important. We have to effectively manage close to 20 machines and many inexperienced workers. Related to this is a necessity to train operators, many of whom have not driven the machinery before and are new to the farm. This means training is important to allow each stage in the process to reach optimal efficiently quickly and safely.

What strategies have you implemented or thinking about to improve harvest efficiency?
Eryn. There are a number of things. We want to upgrade machinery by adding a shuttle cart to retrieve nuts from the harvesters, rather than the harvesters continually driving out to the dump points.

Shuttle carts have been introduced to make harvesting more efficient. The cart is taken to where the harvester is rather than the harvester driving out to dump points. When the shuttle cart is full it is taken back to the shipping container, and the full container is taken to the cleaning factory.

Adding a night shift has improved efficiency significantly. Harvesters now run in two shifts which reduce the average time of nuts on the ground from 24 to 12 hours, and has significantly decreased the cost of capital and requirements to buy additional harvesting equipment.

Pruning trees to reduce height is another efficiency improvement. Pecans are taller than mature macadamias and can reach heights of 20 m and above. The aim for us is to allow more sunlight into the trees, which reduces the number of sticks on the ground. This is important as sticks interfere with machinery.

We have worked on coordinating deliveries to the factory to improve efficiency along the production and processing chain. We have been working together to deliver nuts in a suitable timeframe for both parties to ensure maximum quality and shelf life. Delivering product not fully hand sorted also centralises technology and people at the plant in Toowoomba and keeps the harvest moving as quickly, further removing bottle necks from the farm.

Information
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Appendix 7. Phonological wheel. Posters were produced for each growing region with information tailored to their requirements.

Appendix 8. Practice and management changes made because of information provided through MC15004 and MC18000.

Nutrition and soil health	"I'm now using compost in the orchard." "Soil and leaf sampling information prompted us to get tests done (instead of just thinking about them. The new compost fact sheets encouraged us to get organised for on-farm composting." "I am now composting." "I have greatly increased my use of mulch to improve yield."
Irrigation and drainage management	"A recent article by the IDM about irrigation management made us review our watering practices and we subsequently reduced the amount of water we were applying after flowering and nut set." "Changed my watering program." "I found the irrigation workshops held in 2019 to be most useful. I have since installed plant dendrometers on five of our irrigation blocks to monitor plant stress and the timing of irrigation scheduling." "I have implemented irrigation scheduling." "The recent irrigation MacGroup was excellent. It was an area I had limited knowledge on and through the expert's talk and on-site visits I modified my existing irrigation trailer system." "Overland flow and erosion management. I am currently looking at contouring and ponding to manage soil, compost and mulch retention." "I updated my system to reflect more what the industry is doing."
Orchard floor management	"Profiling the orchard floor and pruning to allow light onto the floor." "We are growing sweet smother grass and are using LIDAR mapping." "Tree mulch chip applied to farm to cover roots. Tree removal in gullies." "We have implemented orchard floor management techniques prior to harvest." "We are implementing orchard floor management practices." "We use the industry guidelines on orchard floor management when we create fertiliser programs." "After the orchard floor management information was released, we formulated our approach to regenerate our orchard."
Canopy management	"I have more awareness of what I am trying to achieve when I prune my trees." "We went to a lot of field days and read AMS articles on what form of tree training and limb removal is best and we are trialling a variety of methods on our place, including removing whole rows." "We have adopted selective limb removal." "We are more aware we should be orchard thinning." "Went to YouTube to look at farm management and pruning/tree management options. Found it very useful to see the process demonstrated." "Delayed skirting in 2018 to help maintain soil moisture during drought, which helped through the dreadful 2019 spell." "Limb removal and tree thinning." "Information on hedging versus tree removal."
Spray application and chemical use	"Have had good results from Sigastus control spraying." "New chemicals and their uses." "Latest spraying information in sprays released and recommendations."
Pest and disease management	"I have used beneficial insect applications." "I have used the information about pest and disease management that has been obtained through bulletins, grower workshops and AMS newsletters and videos." "Leptocorris info so I could check for a new pest due to very dry

	conditions." "Fungicide/insecticide/BMP and rotation for resistance management strategy."
Integrated orchard management	"Practices relating to integrated farm management have been adopted and continue to be implemented." "In breeding plots we have used management ideas gleaned from AMS to help with tree management." "Implemented integrated orchard management system." "Variety selection for new planting." "Prioritising farm improvements, purchasing/upgrading/maintaining equipment, looking at productivity and how to improve it." "Changed the way I planted out trees." "Use of GPS mapping for our farm plan."
Pollinations and bees	"We have changed positioning of beehives in the orchard as well as timing of sprays."
Harvest and post-harvest	"We have made improvements to on-farm nut storage."