AUSTRALIAN MACADAMIA SOCIETY

News Bulletin

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Summer 2024



AusMac2024: Conference highlights and photos

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Craig Maddox wins Norm Greber Award

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Using drop sheets for real-time insect monitoring

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AUSTRALIAN MACADAMIA SOCIETY

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Australian Macadamia Society
Level 1, 888 Brunswick Street
New Farm QLD 4005
T: 1800 262 426 (Australia only)
T: +61 2 6622 4933
E: office@macadamias.org
W: www.australianmacadamias.org
ABN: 19 010 689 415

Editorial Committee
Nyree Epplett, Leoni Kojetin

Editorial Contributions
Nyree Epplett
M: 0434 261 070 E: nyree.epplett@macadamias.org

Advertising Sales
Emma Long
E: advertising@macadamias.org
T: 1800 262 426 (Australia only)
T: +61 2 6622 4933

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Hort Innovation MACADAMIA FUND

Front cover image. *Congratulations to Craig Maddox from NSW Department of Primary Industries and Regional Development, winner of the prestigious 2024 Norm Greber Award. Craig is a committed researcher who has made a significant contribution to our understanding of insect pest behaviour, life cycles and management during his career.*

AUSTRALIAN MACADAMIA SOCIETY

AMS staff



Clare Hamilton-Bate
Chief Executive Officer
T: 0407 930 586
E: clare.hamiltonbate@macadamias.org



Emma Long
Project & Administration Support Officer
T: 1800 262 426
E: emma.long@macadamias.org

Macadamia Conservation Trust



Denise Bond
Executive Officer
T: 0488 432 226
E: denise.bond@macadamias.org

Project staff



Jacqui Price
Market Development Manager
T: 0424 107 731
E: jacqui.price@macadamias.org



Leoni Kojetin
Industry Development Manager
T: 0433 007 925
E: leoni.kojetin@macadamias.org



Emily Grieve
Industry Development Officer
T: 0438 772 757
E: emily. grieve@macadamias.org



Nyree Epplett
Communications Manager (part-time)
T: 0434 261 070
E: nyree.epplett@macadamias.org

Board of Directors

Mark Napper | Chair
T: 0413 007 197 E: mark@marknapper.com.au

Michael McMahon | Deputy Chair
T: 0419 637 721 E: michael@nutbushfarms.com.au

Andrew Leslie | Treasurer
T: 0434 191 644 E: gindifarm@bigpond.com

Henrik Christiansen
T: 0447 022 384 | E: henrik@mffarms.com.au

Robbie Commens
T: 0429 553 659 E: robbie@2te.com.au

Andrew Waddell
T: 0488 401 501 | E Andrew.Waddell@stahmannwebster.com.au



CEO's Report

With the end of the year fast approaching, we can reflect on 2024 as a much-improved season compared to 2023, although not without its own diverse range of challenges from extremes of weather, to changed supply dynamics impacting product availability in the market.

For the AMS, 2024 saw further change for and within the team as we refocused on delivering for industry based on the 2024-29 strategic plan. This has confirmed that the five key pillars of activity (representation and advocacy, communication and engagement, market development, industry development and entrusted services) are areas that can and will continue to make a difference.

Detailed updates on market and industry development activities are included in the pages that follow, and we can see how busy the industry communications program has been in the last 12 months on communication and engagement, with the delivery of a hugely successful AusMac conference. The exceptional content delivered at this event will be further extended through articles in this and subsequent editions of the News Bulletin.

In the representation and advocacy space, we continue to actively engage across many forums both in Australia and overseas.

The challenges of operating a commercial orchard in increasingly peri-urban locations or with non-agricultural neighbours have been encountered across several regions in recent months. Careful and considered responses to concerns have resulted in all these situations being largely diffused, and I commend those involved for their patience and attention to detail. Important in this process have been clear and complete farm records.

In August, I was fortunate to have the opportunity to present at the CFNA Conference in Lin'an, China, where I provided an update on the Australian macadamia industry and on our marketing activities in China. I also met with representatives of the Chinese macadamia industry in Yunnan, building on long-established relationships and reinforcing the importance of China's engagement as a key production origin contributing to the rapidly growing world crop.

In building our profile in India, the Australian Macadamias marketing program was very honoured to receive the Excellence in Trade and Investment award at the 2024 India-Australia Business Awards. This recognises three years of market development work, which has established strong foundations for the levy-funded marketing investment into India, which began in July 2024.

Several issues requiring a mix of quiet diplomacy and 'squeaky wheel' persistence remain advocacy priorities for 2025. These include the long-awaited approval of protocols for export of raw kernel to India; the establishment of a more practical, safer and more cost-efficient product sampling regime for export NIS; and working with regulators to ensure advances in technology in areas such as drone use are adequately recognised through legislative change.

The long-awaited AusMac2024 delivered delegates from across all industry sectors an innovative and engaging mix of presentations, innovation insights and research updates, as well as an extensive trade exhibition and networking opportunities. My thanks to everyone who contributed to making AusMac such a success.

The gala dinner that formally concluded the conference was themed 'A Touch of Gold', a reflection on the fact that 2024 is the 50th anniversary of the founding of the AMS in July 1974. As we acknowledge the vision and contribution of those founding members, we can also reflect on the significant changes and developments over those first 50 years and look forward to the likely changes, challenges and opportunities of the next fifty.

Looking forward, 2025 will see the launch of several new AMS systems to enable improved and more targeted industry engagement on regional and sector-specific topics. The AMS website is also undergoing a rebuild with the aim of improving access to information and resources, with a launch planned for the first half of 2025.

At the recent AGM, longstanding directors Andrew Leslie (Northern Rivers) and Michael McMahon (Bundaberg) were re-elected unopposed. Thanks to both for their time and commitment as they embark on their third term in office. My thanks to all the AMS Board and team for their commitment and support in delivering for industry in 2024,

On behalf of the AMS Board and team, I wish you all a very peaceful and safe holiday period, and we look forward to working with you in 2025.

Clare Hamilton-Bate
CEO

Global supply steady as demand across Asia and Europe strengthens



Jacqui Price, Market Development Manager AMS
M: 0424 107 731 | E: jacqui.price@macadamias.org

Global supply

The 2024 global forecast is currently reported to be 322,530 t in-shell @ 3.5% moisture, up 2% on the 2023 season. At the time of writing, the Australian forecast remains unchanged from the previous review in July at 50,830 t in-shell at 3.5% moisture (54,500 t in-shell at 10% moisture), a 5% increase on the prior year.

SAMAC reissued South Africa's crop forecast at 85,461 t in-shell at 3.5%, up 7% on last year, albeit well below their initial 2024 forecast of 92,000 t in-shell. China's 2024 forecast is marginally up on 2023 at 69,500 t in-shell. Kenya is forecasting a crop at 46,000 t in-shell at 3.5%, up 8% on last year. All other producing origins are forecasting reductions on prior year except for Vietnam (+11%).

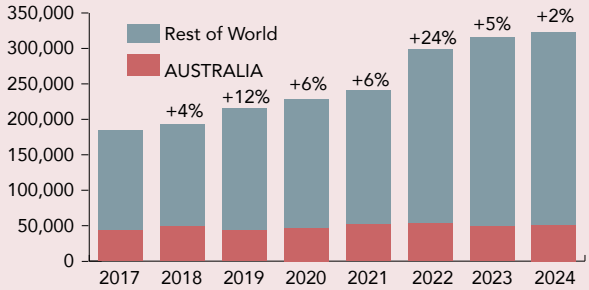


Figure 1. *Global macadamia crop volumes 2017-2024 (tonnes)*
Source: AMHA, WMO, INC. All volumes are at 3.5% MC.

Global demand

In the 12 months to September 2024, global macadamia kernel imports to the top five markets improved significantly except for the USA market. All other key markets enjoyed an upward trend with China/Hong Kong (+34%), Europe (+23%) and domestic markets (+18%) experiencing solid growth and Japan returning to growth (+11%).

The volume of nut-in-shell entering the China market has continued at a high level for the second year. Macadamia nut-in-shell imports reported by China Customs for the period September 2023 to August 2024 were up 42% versus the prior year, increasing from 69,997 to 99,451 t.

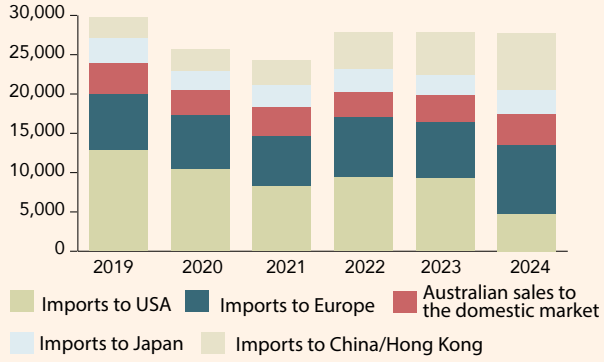


Figure 2. *Global macadamia kernel imports from all origins to top 5 markets (tonnes) MAT September to August.*
Sources: USDA, Eurostat, Japan Customs, China Customs, Hong Kong Census & Statistics Department via IHS Markit Inc, AMHA

Australian sales

The domestic kernel market continues to perform strongly, up 18% versus the prior MAT period. However, the change in the sales mix of nut-in-shell and kernel continues to impact Australian kernel availability in our export markets. Of concern are the significant market share losses being experienced in South Korea (from 99% to 75.3%), China (from 62% to 26%), Taiwan (from 60% to 31%) and Japan (from 67% to 54%). These markets are in growth, but Australian kernel sales have declined in all except South Korea.

Australian in-shell sales are down 13% in the 12 months to August 2024, after a record year in the same period last year. In-shell sales are forecast to be 36% of the crop, down from the highs of 2023 but still well above the long-term average of 25%. For the MAT period to August 2024, Australia and Kenya each hold just under 20% market share of in-shell imports to China, with South Africa accounting for 50% of imported nut-in-shell volume.

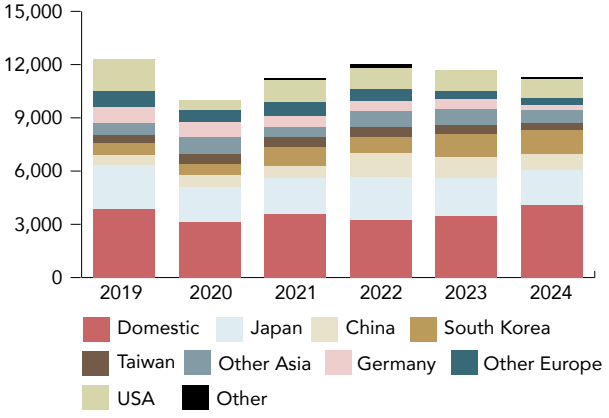


Figure 3. *Australian macadamia kernel sales (tonnes) MAT (September to August)*
Source: AMHA. Represents 95% production, sales are adjusted to represent non-AMHA members.

Global product innovation

In the 12 months to September 2024, new products launched with macadamias as an ingredient ticked up slightly to 616 from 596 in the prior period. The Australian market continued to see a significant increase in ingredient product launches in the last year, moving well ahead of traditional innovators USA and China.

Line extensions and improvements to existing product ranges continue to increase (from 243 to 309), while "true" new product launches decreased to 134 in the last 12 months from 156 the year before. The bulk of new product development using macadamias as an ingredient is still coming from the snacking category, followed by the chocolate confectionery and bakery categories.

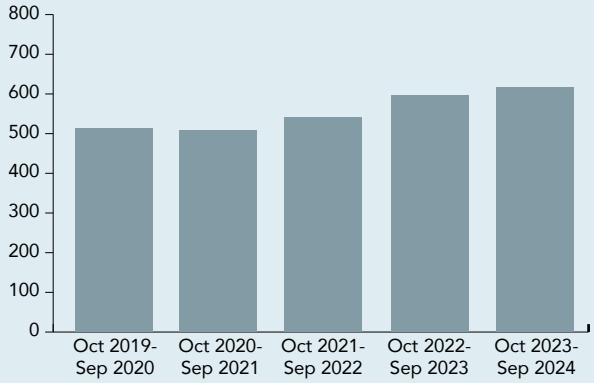


Figure 4. *New product launches using macadamias as an ingredient*
Source: Mintel GNPD, October 2019-September 2024

Make everyday moments special with Australian macadamias

The new domestic consumer campaign launched in October in spectacular style. Building on the success of last year's recipe-based *Macadamias make it special* campaign, the new activity is designed to encourage consumers to consider macadamias when they next go shopping by demonstrating how macadamias make everyday moments in life a little more special.

Whether it's a simple snack on the go, a casual family gathering, or a quiet Sunday afternoon at home, the creamy, crunchy texture and rich, buttery flavour of Australian macadamias add a little indulgence to any occasion.

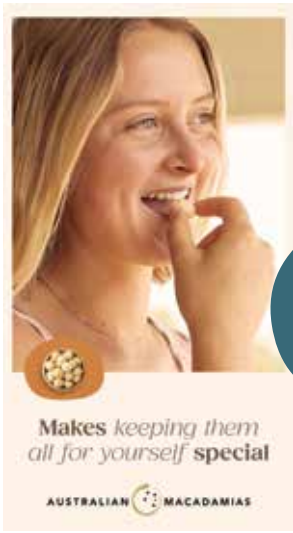
The campaign includes advertising across multiple channels including retail outdoor, print and digital advertising and editorial, social media, influencer content and gold sponsorship of the Australian *Women's Weekly* Christmas TV special and magazine.



Full page print ad in Australian Womens Weekly.



Advertising on Woolworths online shopping website



An example of social media content used in the campaign.

Next phase of promotion in India gets underway

The **2nd Australian Macadamia Festival** was held in Delhi in September, and we're pleased to report it was a huge success.

Proudly supported by the Australian Trade and Investment Commission (Austrade), the Festival spanned nine days, 11 venues, two workshops and one trade meet, with the dynamic program bringing India's food and beverage trade, media and food influencers to experience the taste and versatility of Australian grown macadamias.

The macadamia menus created by our top-tier partner venues were absolutely spectacular. Highlights included:

- A baking demo workshop at Miam Pâtisserie, featuring renowned Chef Bani Nanda, where guests were guided through the creation of an exquisite Australian macadamia bundt cake.
- A macadamia cocktail-making workshop at Sidecar India, one of India's top bars. Founder Yangdup Lama led the session, highlighting innovative cocktails infused with macadamias, including a Macadamia Sour and the Roasty Toasty Highball.
- Launch event menu at Dos restaurant, featuring chicken tacos with Australian macadamia nut romesco for entree, and chicken breast with sage and Australian macadamia nut yoghurt sauce for main course.
- Australian macadamia nut butter chicken served with Australian macadamia nut butter naan at Whisky Samba.



Workshop attendee putting the finishing touches to their Australian macadamia bundt cake.



Australian Macadamia Festival launch venue, Dos.

- Australian 'Mac-Cube' - buttery laminated pastry, Australian macadamia ganache filling, salted caramel cream, macadamia praline and caramelised Australian macadamias at Lavonne café.

The **Australian Macadamias Trade Meet** took place on 5 September and featured keynote speaker Mahendra Barve, Vice President, Product Development for Chocolates and Confectionery, ITC Limited, who shared insights on global trends and the diverse uses of Australian macadamias. This exclusive gathering, tailored for industry stakeholders, purchase managers, executive chefs and R&D heads from leading FMCG companies, explored the commercial potential of Australian macadamias in India's food industry.

THE LIL CHEF promotion ran for a month in collaboration with Reliance Retail's Freshpik stores in Mumbai and Bengaluru and Fresh Signature stores in Mumbai, Bengaluru and Pune. Created to drive awareness and trial of Australian macadamia nuts, the activity engaged popular 'mumfluencers' in India known for their healthy parenting and lifestyle content. The mums were invited to bring their children in store for a 'healthy playdate', where the kids created their own delicious lunchbox snacks using Australian-grown macadamias. An expert chef was on hand to guide them safely through the cooking process, while educating them about macadamias.



Launch event for Australian Macadamia Festival
L to R John Southwell (Austrade) High Commissioner Philip Green OAM (DFAT), Jacqui Price (AMS) and Kiran Karamil (DFAT)



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Native ingredients like macadamias can deliver a memorable food experience

Jacqui Price, Market Development Manager, AMS M: 0424 107 731 | E : jacqui.price@macadamias.org



Matt Golinski is a celebrated chef who made his mark on the Australian culinary scene as executive chef at leading restaurants on the Sunshine Coast, and as a much-loved original team member on the popular TV series Ready Steady Cook.

His work now takes him to food festivals and events across the country, where he consistently showcases the versatility of native ingredients, with the macadamia frequently featuring on his menus.

We recently caught up with Matt to learn about how he is currently using macadamias, the way he is combining them with other native Australian ingredients, and the shift he's observing on supermarket shelves.

An advocate for native Australian ingredients

Matt has long been a fan of native Australian ingredients, particularly the macadamia, and his interest has now extended beyond the kitchen as he embarks on a quest to create a personal fruit forest.

"I have always used lots of native Australian ingredients. As an Australian chef, I love using macadamias because they grow here naturally and that's something that's unique to Australia," he said.

"I now have 900 native trees planted on my own property which will all start producing in the next five years, so eventually I'll have a native fruit forest that's producing sandpaper figs, Davidson plums and macadamias."

Exploring the potential of macadamias

Matt believes that one of the most compelling reasons to use macadamias in cooking is their superior flavour and texture, and he often uses them to reinvent well-known favourites.

He replaces pine nuts with macadamias in pesto, and often incorporates them into both sweet and savoury dishes. "As an Australian chef, it makes sense to me to show off our native nut. The macadamia grows here, and it tastes great. Why wouldn't you use it?"

Matt's confidence in macadamias is obvious, and he continues to find new and creative ways to incorporate them into his cooking.

"I'm always experimenting with them," he says.

"I really like using the smaller pieces. They're convenient—there's no chopping or messing around needed, and you don't need a lot to make an impact in a dish."

Closing the knowledge and experience gap

Matt regularly meets new people who are eager for memorable food experiences, and he says native ingredients are an effective way to deliver on this.

"There are still a lot of people who have not tried a finger lime or a Davidson plum. It's great to be able to share that with people. While a lot of people do know what a macadamia is, many don't know that they come from Australia. And a lot of consumers are still learning how to use them as a premium product that can be enjoyed every day."

He has also observed the rising use of native ingredients in mainstream food products.

"Brands are realising that using native Australian ingredients can create a real point of difference, and as a result they're starting to be used more," he said.

"We're seeing it in the ice cream category in particular, with some big mainstream brands embracing ingredients like Davidson plum and lemon myrtle, as well as macadamias, of course."

For Matt Golinski, macadamias are more than just an ingredient—they are a symbol of Australia's natural bounty and a testament to the unique flavours that native ingredients can bring to the table.

His passion for showcasing macadamias in his cooking not only highlights their versatility but also encourages others in the food and beverage industry to embrace Australia's exceptional native nut.



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Megan Boote 0484 099 462 | **Paul Hibbert** 0419 209 466 | **Miles Gillespie (NSW)** 0412 030 084

SCAN QR CODE FOR MORE INFORMATION

Suncoast Gold Macadamias // 21 Drummond Drive, Gympie QLD 4570

info@suncoastgold.com.au // suncoastgold.com.au

Industry Insights



Leoni Kojetin, Industry Development Manager, AMS
M: 0433 007 925 | E: leoni.kojetin@macadamias.org

As of the end of November, the industry hadn't settled on a final crop for 2024, with the last figure forecast, in July this year, being 54,500 t in-shell at 10% moisture. There was a familiar, frustrating, sense of déjà vu with the 2024 season in that we grew a greater crop volume than we were able to harvest and send off to market. In more positive news, kernel recovery is higher this season – indicatively above 38% industry average – making up for some of the impact from lower than average yields for many growers.

Wet conditions over the first months of 2024 delayed harvest for many, and reject levels were above average as a consequence. The rainy conditions, which started late in 2023, meant that many growers weren't able to protect against late season insect damage, with the result that we saw unusually high insect damage on consignment reports. December was a challenging month to spray, and there is conjecture that the overcast, wet conditions also led to greater immaturity seen in early harvest rounds.

Effective spray coverage crucial

At pest consultant meetings, concern has been expressed about an age-old issue, i.e. inadequate spray coverage. Growers from all regions are reporting shorter ideal weather windows for completing spraying, along with greater social licence pressure. A common response has been faster sprayer travel speeds, with less focus on getting excellent coverage, and mistimed sprays.

While we are well into the spray season, there is a critical period ahead. If you haven't already, take some time to do a coverage test. It's not too late and it will give you invaluable information about whether your December and January activities are going to be effective. The table is a handy summary of the mechanics of good spray management.

In 2025 the AMS plans to conduct spray management field days to demonstrate key aspects of good spray management and help growers get the most out of this important orchard practice.

Accounting for canopy and correct dilute volumes

- Trees are 3D targets unlike broadacre crops, which use L/ha.
- Tree spraying uses mL of active/100 L multiplied by canopy volume (m^3) to guide how many 100 L increments are needed.
- Average canopy volume/ha is 25,000 to 45,000 m^3 and accounts for orchard spacing/density.
- Research shows dilute volume for mature macadamia starts from 6 L/100 m^3.
- Using 6 L/100 m^3, baseline dilute volume is then 1,500 to 2,700 L. Adjustment from 6 L upwards must be made for density and cultivar differences. We use this baseline dilute volume to calculate concentrate spray rates.

Adequate air volume and slower travel speed

- Spraying should aim to displace the air in the tree with spray-laden air.
- The fan output is critical to achieving this goal. The sprayer's specs are a starting point and should take operating pressures into account.
- Spray volumes shouldn't exceed 75% of fan output.
- Travel speed is where it goes wrong; speed should be dictated by fan output. Faster speeds reduce spray penetration, alter droplet delivery and limit coverage.
- Travel speed shouldn't exceed 2 to 3 km/hr.

Sprayer setup and droplet delivery

- Droplet delivery and dispersion are crucial for chemical efficacy and pest control. The greater the distance travelled, the more droplets lose speed and veer off target.
- Low volume/concentrate spraying hampers dispersion. Additionally, not all sprayers can apply concentrate rates.
- Sprayers that deliver spray to the middle and top of trees are more effective than those that deliver from the bottom only.
- Spraying too close to the tree canopy won't allow spray dispersal. With tall trees and/or narrow spacing, one-sided spraying to get the correct angle is often the only option.
- Nozzle selection is critical for correct droplet size and effective coverage.
- A common, costly mistake is not replacing old, blocked nozzles, which are relatively cheap.

Checking coverage

- Coverage is king! If you don't check coverage you are likely wasting time and money, and won't be getting effective pest/disease control as well as suffering crop loss.
- Whether you use a contractor or do your own spraying, coverage tests must be done annually in different blocks.
- Coverage testing throughout the canopy (top to bottom) reveals any elements that need adjusting, e.g. calibration, output, volumes, speed, sprayer setup and nozzle issues.
- You can test using kaolin clay or dye, but water-sensitive paper is the easiest, with simple apps available to help.
- It's not too late if you haven't done a coverage test. It's a small investment in cost and time to get spraying right.

Table. *The mechanics of good spray management*

What happened over flowering?

Indicative Macadamia Cultivar Main Flowering Guide

Early	Mid	Late
246	344	816
741	Daddow	849
842	660	814
G	A268	Beaumont
P	MCT1	A4
A203	R	J
A16		
A38		

Another topic of hot debate at the moment is what happened with pollination during flowering. The 2024 flowering was prolific to say the least and we all had high hopes. Instead, in a flash, pollination was over with many cultivars flowering in a short period. This was very different to 2023, where flowering was far more staged and protracted.

As well as the short time window, there seems to have been a perplexing lack of pollinators. In most seasons you hear the buzz of pollinators at work, but that wasn't the case this season. Beekeepers and growers are reporting that hives were not as strong, with fewer bees and less activity, potentially from the nationwide shortage following varroa mite. More than just a lack of managed honey bees, however, is the fact that the naturally occurring pollinators that we rely on so heavily also were seemingly absent this season.

This has meant a patchy cultivar set across growing regions and farms. Even more perplexing is that it's not early, mid or late cultivars that had good pollination, rather it's a mixed bag. Some cultivars seem to have had a great set, as is the case with many 816s, A4s and A38s, while other cultivars seem to have many empty racemes, such as with 741, 344 and A16. It also appears that macadamia isn't the only crop affected by lack of pollination this season, with many others having suffered the same fate.

There is so much we don't know about macadamia, and pollination is just one factor among many. As part of a levy investment, the industry is undertaking new pollination research led by the Australian National University. They would like to hear grower's views on pollination and will be assessing what factors impact pollination success. Scan the QR to take part and we will be publishing the results of the survey as well as their pollination gap analysis once complete.

Look forward to seeing you out in the orchard.

Leoni



Your input on pollination needed

Scan this QR code to participate in a survey by ANU about pollination. This is a part of a project to identify factors that affect successful pollination.

AusMac2024 roundup

Six hundred representatives from the Australian macadamia industry gathered on the Gold Coast in October for our industry's premier event – AusMac2024. The event brought together the entire supply chain, from growers and farm managers, agronomists, handlers and processors to marketers, researchers and commercial suppliers, for a jam-packed two-and-a-half-day program. A big thank you to all attendees, and to the many sponsors and exhibitors who helped make the event such a success.



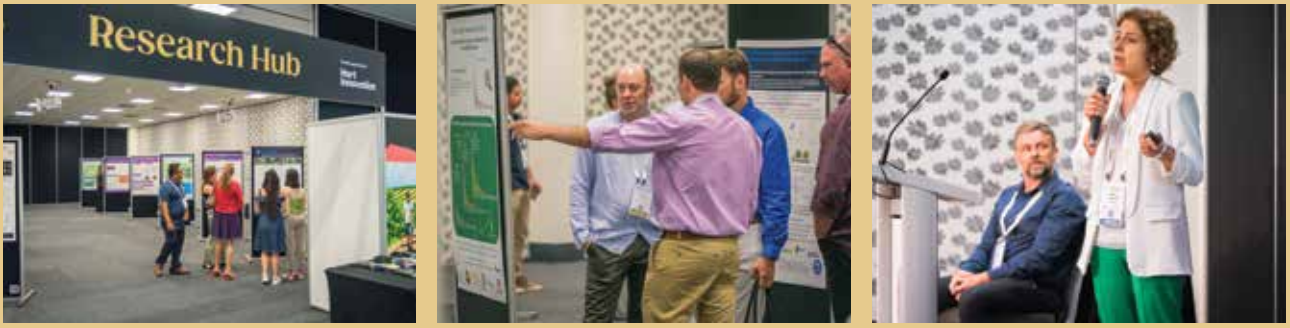
AusMac kicked off with a golf day at Lakelands Golf Course. Pictured right are Simon Anderson (L) and Henrik Christiansen.



At the AusMac welcome reception, Ian McConachie AM launched his highly anticipated book, The Macadamia - Australia's Gift To The World.
L to R: Brice Kaddatz, Jolyon Burnett, Jan and Ian McConachie, Denise Bond and Paul Chapman.



A diverse mix of plenary and concurrent sessions covered production insights and best practice, on-farm innovation, agritech, key and emerging issues, macadamia research, marketing and market insights, global trends and much more. L to R: Dr Miriam Villen King (Stahmann Webster), Jillian Laing (WMO), Growers Michael McMahon (Bundaberg) and Paul Chapman (Northern Rivers) and Stefan Vogel (Rabobank).



New this year, the Research Hub, supported by Hort Innovation, and the Innovation Lounge, sponsored by Inform Ag, provided more opportunities to learn about the latest scientific research, and all the latest ideas, technologies and cutting-edge innovations.



With 60 trade and machinery exhibitors, there was always lots to do and see, and people to meet, in the AusMac Trade Expo.



A huge thanks go to our many sponsors, whose combined support helped make AusMac2024 a big success. Pictured L to R are representatives from just a few of our sponsors - WFI, SunCoast Gold Macadamias, Nutrien Ag Solutions and Anysort.



Attendees enjoyed the welcome reception, sponsored by Marquis Macadamias and Happy Hour, sponsored by Australian Premium Macadamias.



The celebrity chef breakfast with Alice Zaslavsky was another popular event. Pictured are breakfast MC Giaan Rooney (L) with Alice and the BASF (sponsors) team – Serge Usatov, Bianca Cornelio and Greg Haslam.



The AusMac gala awards dinner, sponsored by Stahmann Webster capped off a successful event. Bottom L: Young Achiever of the Year Scott Hill with AMS Chair Mark Napper; bottom R: best dressed male Scott Ranson (with Lisa Ranson), and top R: Jacqui Price (AMS) with Stahman Webster's Michelle Herbert.

AMS Awards of Excellence

The AMS Awards of Excellence were announced at the AusMac2024 gala awards dinner. Congratulations to our winners.

Norman R Greber OAM Memorial Trophy – Craig Maddox



Craig Maddox, winner of the 2024 Norm Greber Award, with AMS chairman Mark Napper.

The Norm Greber OAM Memorial Trophy honours our industry's founding father Norman Greber and his life-long ambition to establish the Australian macadamia industry on a commercial basis.

This year's winner, Craig Maddox, from NSW DPIRD, is one of our industry's most passionate and highly respected members who has made an outstanding contribution over the last three decades. An entomologist, he began working at the NSW DPI in 1982 and moved into macadamias in 1996. He has given tirelessly to our industry ever since.

With a keen eye for detail and remarkable understanding of pest ecology, Craig's focus has been on the future of macadamia pest management and providing taxonomic help for often unknown native and potential exotic threats. His role in NSW DPI has been to develop effective pest management strategies, check varietal susceptibility to pests for the macadamia breeding team, and provide independent assessment of the potential new chemistries for each new problem.

Craig was an integral part of the team that developed the biological control for nut borer *(Trichogrammatoidea cryptophlebiae)* and has helped the industry find better monitoring techniques and treatments for a range of other pests including fruit spotting bug, macadamia seed weevil and trunk boring beetles. To support research trials, he developed rearing systems for numerous pest and beneficial insects and pathogenic fungi, and even flesh-eating mites during the height of the seed weevil problem.

For Craig, an enjoyable part of his work has been his involvement in NSW DPI taste testing of new macadamia cultivars as each new series of selections was offered to the industry. It highlighted what a special product macadamia is for Australia and how young the industry is, and he was able to hear everyone's' opinion when it counts - after the final product hit the plate.

An exceptional advocate for our industry, Craig has graciously shared an enormous amount of his time with growers on farm and at industry events and collaborated with many industry partners.

We say thanks to this remarkable man for everything he has done for our industry.

Young Achiever of the Year – Scott Hill



Scott Hill (right) is this year's AMS Young Achiever of the Year.

Scott is a passionate horticulturalist who heads up Healthy Hills Horticulture, an independent consultancy providing agronomy services for macadamias from Macksville in NSW to Rockhampton in Queensland.

With 27 years experience in horticulture production and 12 years in agronomy and research, Scott is passionate about providing cost-effective solutions to help growers achieve optimal orchard health.

His commitment to our industry started early on. As a teenager, he worked on a macadamia farm before studying at TAFE under the tutelage of industry experts Paul Moosberger, Alan Coates and Dave Forrest. He then attained a Bachelor of Ag Science (with Hons) from UQ and went on to train under the careful guidance of two of our industry's prominent consultants, Ian Vimpany and Steve McLean.

With a keen interest in research and data, he has played an integral role in several macadamia research projects including the nutrient replacement and soil amendments projects and presented his macadamia plant tissue sampling project to the International Macadamia Research Symposium in Hawaii in 2017.

Working with small family farms through to large corporate operations, Scott's considered advice has consistently resulted in significant yield increases, environmental preservation and operational efficiency. Diligent, quiet and unassuming, he's also been described as 'one of the nicest blokes you'll ever meet.'

Life Member – Larry McHugh



Larry McHugh with Mark Napper, who presented him with his AMS Life Membership.

Larry McHugh is a well-known and respected figure throughout the macadamia industry.

He joined Macadamia Processing Company (MPC) in 1992, working in various roles including factory management, factory design and engineering, process design, systems development, quality management and operations management. He became General Manager of MPC in 2005 and in 2011 was appointed as the first General Manager of the start-up company Macadamia Marketing International (MMI), which grew to be the largest macadamia sales and marketing company in the world, sourcing product from various origins and selling the product to customers all around the world.

In 2017 Larry was appointed as CEO of both MPC and MMI where he was responsible for sourcing raw material, processing, sales, marketing and logistics operations. In 2020, these companies rebranded to Marquis Macadamias and Marquis Marketing and Larry continued as CEO of both companies until his retirement in 2023.

A visionary and strategist, he has been integral to the development of the Australian and international industry and has held various positions, including AMS board member, research and development steering committee member, and committee member/Chair of the AMS marketing committee. He played a key role in driving the establishment of the Australian Macadamia Handlers Association (AMHA), which has been instrumental in collecting data that is essential in the industry.

Perhaps one of his biggest (and also most recent) accomplishments has been the driving role he played in the establishment of the World Macadamia Organisation (WMO), of which he is currently Chair. Through his work with the WMO, he has helped bring the industry together in Australia and around the world, effecting positive change and imparting direction and strategy where it has been needed.

In December 2011 he received the Norm Greber Award from the AMS for his outstanding contributions to industry.

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Award-winning growers

Congratulations to our national and regional Grower of the Year award winners



This year's winners of the AMS Awards of Excellence are Michael Cooper (left) for the large farm category and Gary and Julie Davis for the small farm category.

The national winners of the 2024 Grower of the Year awards (large and small farm), Michael Cooper and Gary and Julie Davis, were announced at AusMac2024. In the following pages, we detail regional winners. Congratulations to all for achieving these impressive results.

2024 Grower of the year

National winners

Large farm
Michael Cooper (Mr Macadamia), 1.67 t/ha SKR in 2023 and average of 1.48 t/ha SKR over five years (2019-2023).

Small farm
Gary and Julie Davis (Glendamia Park) 2.93 t/ha SKR in 2023 and average of 1.96 t/ha SKR over five years (2019-2023).

Selection criteria

Must **win** one of the regional productivity categories.

Has the highest long-term saleable kernel productivity per bearing hectare (over last five years, minimum of four years participating in benchmarking).

Regional winners (includes production details SKR/RKR)

Finalists in the regional awards were shortlisted by the QDPI benchmarking team using yield and quality data collected from the 2023 season. The awards are separated into small and large farms. Regional winners are listed below.

Farm names, where applicable, are listed in brackets.

Central Queensland

Best productivity

Large farms – Hinkler Park Plantations (Oakwood C and South Bundaberg), 1.47 t/ha SKR
Small farms – Macadamia Farm Management (Quamby), 1.24 t/ha SKR

Best quality

Large farms – Macadamia Farm Management (MFH), 0.53% RKR
Small farms – Macadamia Farm Management (Riverbend), 0.53% RKR

Gympie Queensland

Best productivity
Large farms – (Aleena Plantations), 1.4 t/ha SKR
Small farms – Paul and Deanne Ryan (Parchied PL), 1.7 t/ha SKR

Best quality
Large farms – Ian and Candy Johnson (Downsfield), 1.16% RKR
Small farms – Mitchell, Gary and Julie Davis (Kilfenora South), 0.44% RKR

Glass House Mountains Queensland

Best productivity
Large farms – Michael Cooper (Mr Macadamia), 1.67 t/ha SKR
Small farms – Gary and Julie Davis (Glendamia Park), 2.93 t/ha SKR

Best quality
Large farms – Michael Cooper (Mr Macadamia), 0.8% RKR
Small farms – Joy and Daniel Greensill (Qld Farming), 0.41% RKR

Northern Rivers NSW

Best productivity
Large farms – Callan Harding (Highgate), 1.33 t/ha SKR
Small farms – Steve and Brooke McLean (Macadamia Allsorts) and Amanda and Andrew Keller (Foxtail Farm), 1.83 t/ha

Best quality
Large farms – CL Macs (Teven), 1.58% RKR
Small farms – Bruce and Liz Green (Green), 0.98% RKR

Mid North Coast NSW

Best productivity
Large farms – Arapala Macadamia Farm (Thurgoods), 1.09 t/ha SKR
Small farms – Glen Barnes (Patagonia Macadamia Orchard), 1.55 t/ha SKR

Best quality
Large farms – Victoria Thynne (Elanora), 0.7% RKR
Small farms – Aman Singh (AS and RK Lehl), 1.2% RKR

Selection criteria

Best productivity: highest saleable kernel tonnes per bearing hectare and best quality: lowest reject kernel recovery and achieving or exceeding 2023 mature farm (10+ years) industry average saleable kernel productivity.

Gympie, Glass House Mountains, NRNSW and MNNSW
Small farms = >5 ha to <30 ha
Large farms = >30 ha

Bundaberg and Central Queensland
Small farms = >10 ha to <50 ha
Large farms = >50 ha



Regional finalists (names only)

In some smaller regions with less participating farms, fewer or no finalists are nominated.

Central Queensland

Best productivity
Large farms – Hinkler Park Plantations (Oakwood C)
Hinkler Park Plantations (South Bundaberg)
Hinkler Park Plantations (Childers B)

Small farms – Macadamia Farm Management (Quamby)
Bundaberg Sugar (Mount Pleasant)
Kurt Henke (KR Henke)

Best quality
Large farms – Macadamia Farm Management (MFH)
Hinkler Park Plantations (Childers B)
Hinkler Park Plantations (Childers A)

Small farms – Macadamia Farm Management (Riverbend)
Kurt Henke (KR Henke)

Gympie Queensland

Best productivity
Large farms – Aleena Plantations
Simon and Kate Goodhew (Jondell)

Small farms – Paul and Deanne Ryan (Parchied PL)
Mitchell, Gary and Julie Davis (Kilfenora South)
Matthew and Nicola Fea (Brae Moray)

Best quality
Large farms – Ian and Candy Johnson (Downsfield)
CL Macs (Koriella Park)
Garry and Andrea Sheppard Management (Ozmac)

Small farms – Mitchell, Gary and Julie Davis (Kilfenora South)
Paul and Deanne Ryan (Parchied PL)
Andrew Carey (Orbelle Farms)

Glass House Mountains Queensland

Best productivity
Large farms – Michael Cooper (Mr Macadamia)
Small farms – Garry and Julie Davis (Glendamia Park)
Jarod Agostinelli (Coastal Produce QLD)
Vince and Dianne Vere (VP and DC Vere)

Best quality
Large farms – Michael Cooper (Mr Macadamia)

Small farms – Joy and Daniel Greensill (Qld Farming)
Jarod Agostinelli (Coastal Produce QLD)
Garry and Julie Davis (Glendamia Park)

Northern Rivers NSW

Best productivity
Large farms – Callan Harding (Highgate)
CL Macs (Teven)
CL Macs (Newrybar)

Small farms – Steve McLean (Macadamia Allsorts)
Amanda and Andrew Keller (Foxtail Farm)
Trevor and Barbara Martin (Bunya-Bunya)
Greg and Joanne James (Deenford Plantation)

Best quality
Large farms – CL Macs (Teven)
Callan Harding (Highgate)
CL Macs (Newrybar)

Small farms – Bruce and Elizabeth Green (Julene)
Steven and Julie Starkey (SW and JL Starkey)
Trevor and Barbara Martin (Bunya-Bunya)

Mid North Coast NSW

Best productivity
Large farms – Arapala Macadamia Farm (Thurgoods)

Small farms – Glen Barnes (Patagonia Macadamia Orchard)
Aman Singh (AS and RK Lehl)
Tim Zeck and Dru Marshall (Wirrimbi)

Best quality
Large farms – Victoria Thynne (Elanora)
Arapala Macadamia Farm (Thurgoods)

Small farms – Aman Singh (AS and RK Lehl)
Tim Zeck and Dru Marshall (Wirrimbi)

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Macadamia Agrichemical Review

Leoni Kojetin, Industry Development Manager

Keeping a close eye on the agrichemicals available for use in macadamia is critical for continued sustainable production and market access. In addition to the considerable work done by the AMS in the area of agrichemical use and best practice, e.g. chemical use patterns, identifying export restrictions and aerial application, the industry recently conducted the Strategic Agrichemical Review Process (SARP) – a review of macadamia agrichemicals. This involved industry surveys to assess the perceived priority of diseases and invertebrate pests and identify gaps in pest control. The results from the surveys were combined with an analysis of the availability and continued access to agrichemicals in relation to Australian regulatory standards, integrated pest management credentials and global market acceptance trends.

It is important to note that the SARP is not a comprehensive assessment of all pests or controls used in macadamias but attempts to prioritise the majority.

The information from this work by the AMS has been combined with the outcome of the SARP, and is summarised below in two parts. First is an outline of the identified insect and disease priorities. This is followed by lists of chemicals available for insect, disease and weed management and plant growth regulation. These include use considerations that the AMS is bringing to the attention of growers, processors and consultants.

Insect pest and disease priorities

Insect pests. Macadamias are impacted by a wide variety of insect pests, with fruit and banana spotting bug, lace bug, nut borer, and seed weevil identified as high priorities through industry consultation. Pests were ranked based on prevalence, economic impact, available control options and management challenges.

It is important to take an integrated pest management (IPM) approach to pest control.

Insect		Insect	
Fruit spotting bug *(Amblypelta nitida)*, banana spotting bug *(Amblypelta lutescens)*		Bark beetle/Scolytid beetles *(Hypothenemus* spp., *Cryphalus* spp.*)*	
Macadamia lace bug *(Ulonemia* spp.*)*		Macadamia kernel grub *(Assara seminivale)*	
Macadamia seed weevil *(Kuschelorhynchus macadamiae)*		Red-shouldered leaf beetle *(Monolepta australis)*	
Macadamia nut borer *(Cryptophlebia ombrodelta)*		Macadamia felted coccid *(Eriococcus ironsidei)*	
Macadamia flower caterpillar *(Homoeosoma vagella, Xanthodes congenita)*		Macadamia twig girdler *(Xylorycta luteotactella)*	
Thrips *(Scirtothrips* spp.*)*		Macadamia leafminer *(Acrocercops chionosema)*	
Banana fruit caterpillar *(Tiracola plagiata)*		Broad mites (*Brevipalpus spp.)*, flat mites *(Polyphagotarsonemus* spp.*)*	
Green vegetable bug *(Nezara viridula)*		Pinhole borer *(Xyleborus perforans)*	
Leptocoris bug *(Leptocoris* spp.*)*		Latania scale *(Hemiberlesia lataniae)*, white scale *(Pseudaulacaspis brimblecombei)*	

Table 1. *Insect priorities (according to 2024 Macadamia SARP)*

The diversity of insects that attack macadamia require a planned, strategic approach, using a range of control measures, including cultural, biological and chemical controls. Beneficial insects such as predators, parasitoids and pollinators should be encouraged and can be introduced artificially. When selecting insecticides, it is important to consider their potential impact on beneficial insects that play a crucial role in pest management. Also, the diverse range of insect pests in macadamias requires careful attention to resistance management strategies.

Disease priorities. Husk spot and dry flower were identified as the highest priority diseases after industry consultation. Disease control relies on an integrated management strategy, including a range of cultural practices to support fungicides, and potentially reduce the reliance on fungicides.

Disease management cultural controls include:

- biosecurity measures to prevent importing infections
- promoting good drainage and avoid waterlogging
- canopy management to promote airflow and ensure effective coverage
- orchard hygiene, removing dead plant material including sticktights and unharvested nuts
- avoiding tree stress through good nutrition and water management.

In controlling diseases, the industry should be mindful of resistance management. Rotation of chemical groups will ensure effective disease control and long-term access to products.

Disease	
Husk spot *(Pseudocercospora macadamiae)*	
Dry flower *(Pestalotiopsis* spp., *Neopestalotiopsis* spp.)	
Phytophthora root rot *(Phytophthora cinnamomi)*	
Trunk canker *(Phytophthora cinnamomi)*	
Husk rot *(Phomopsis* spp.)	
Botryosphaeria dieback *(Botryosphaeria* spp.)	
Grey mould/Botrytis *(Botrytis cinerea)*	
Green mould/Cladosporium blight *(Cladosporium gloeosporioides)*	
Husk rot/Anthracnose *(Colletotrichum gloeosporioides)*	

Table 2. *Disease priorities (according to 2024 Macadamia SARP)*

Priority

= high = moderate = low



Overview of available agrichemicals, regulatory risk and product usage considerations

Combining the outcomes of the SARP and AMS analysis, the tables below list available registered or permitted chemicals for insect pests, diseases, weeds and plant growth regulation for suitability in terms of IPM, resistance, efficacy, trade, human safety and environmental issues.

Table Key: This key applies to tables 3, 4, 5 and 6.

Regulatory risk

- R1 Short term: Critical concern over retaining access
- R2 Medium term: Maintaining access of significant concern
- R3 Long term: Potential issues associated with use – monitoring required

IPM profile – indicative overall impact on beneficials

- Very low
- Low
- Moderate
- High
- Very high
- Not specified

Withholding Period (WHP) - number of days from last treatment to harvest (H) or grazing (G)

H = Harvest
NR = Not required when used as directed
NG = No grazing permitted
G = Grazing

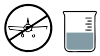
Usage Cautions/Considerations

Market access caution - not permitted in key export markets
Market access caution - only permitted with specific use pattern
Hectare volume limits
Dilute spray only, no concentrate permitted
No aerial application (including drone) is allowed

Table 3. Chemicals available for insect management

Active ingredient (trade name)	Chemical group	Usage consider-ations	WHP days	States	Label comments	Impact on beneficials	Regulatory risk
Fruit/banana spotting bug. Priority: high							
Acephate (Orthene)	1B		NR	QLD, NT, WA & NSW	Contact activity. Foliar spray at early flowering. Interval for retreatment: 14-21 days.	H Bee: H	**R3** AUS: Review planned CAN: Use restrictions EU/UK: Not permitted
Acetamiprid + Pyriproxyfen (Trivor)	4A+7C		14 NG	ALL	Contact and ingestion activity. Foliar spray post-flowering. Interval for retreatment: 14 days. Maximum 3 treatments/season.	M Bee: H	**R2** Acetamiprid: AUS & EU: Under review
Betacyfluthrin (Bulldock)	3A		7	QLD, NSW, ACT & WA	Contact activity. Foliar spray when monitoring indicates. Interval for retreatment: 14-21 days.	VH Bee: H	EU/UK: Not permitted
Betacyfluthrin + Piperonyl Butoxide (Cyborg)	3A		7				
Flupyradifurone (Sivanto Prime)	4D		20 NG	ALL	Contact and ingestion activity. Foliar spray early nut set onwards, when pests exceed threshold. Maximum 1 treatment/season.	L Bee: L	EU: Under review
Sulfoxaflor (Transform)	4C		NR	ALL	Contact and ingestion activity. Foliar spray when pest is active. Interval for retreatment: 7 days. Maximum 2 treatments/season.	M Bee: H	USA: Pollinator concerns EU: Highly restricted use
Trichlorfon	1B		2	QLD, NT, & NSW	Contact activity. Foliar spray when premature nut fall is evident. Interval of retreatment: 14 days. Maximum 4 treatments/season. Do not use at flowering/bees foraging.	H Bee: H	**R2** AUS: Listed for review CODEX & USA: No MRLs EU/UK: Not permitted
Trichlorfon PER13689	1B		2	QLD & NSW			
Macadamia lace bug. Priority: high							
Diazinon PER14276	1B		14 G:14	NSW, QLD & WA	Contact activity. Foliar spray prior to main flower. Retreatment if required prior to second flowering. Maximum 2 treatments/season.	H Bee: H	**R1** AUS: Proposed deletion EU/UK: Not permitted CODEX: MRLs deleted

Active ingredient (trade name)	Chemical group	Usage consider-ations	WHP days	States	Label comments	Impact on beneficials	Regulatory risk
Macadamia lace bug. Priority: high (cont)							
Flupyradifurone (Sivanto Prime)	4D		20 NG	ALL	Contact and ingestion activity. Foliar spray from early flowering when pest exceeds threshold. Maximum 1 treatment/season.	L Bee: L	EU: Under review
Sulfoxaflor (Transform)	4C		NR	ALL	Contact and ingestion activity. Foliar spray when pest is active. Maximum 2 treatments/season.	M Bee: H	USA: Pollinator concerns EU: Highly restricted use
Trichlorfon PER13689	1B		2	NSW & QLD	Contact activity. Foliar spray when thresholds reached. Interval of retreatment: 14 days. Maximum 4 treatments/season. Do not use at flowering/bees foraging.	H Bee: H	**R2** AUS: Listed for review CODEX & USA: No MRLs EU/UK: Not permitted
Macadamia seed weevil. Priority: high							
Indoxacarb (Avatar eVo)	22A		14	ALL	Ingestion activity that ceases egg laying. Foliar spray at pea size. Interval for retreatment: 10-14 days. Maximum 2 treatments/ season.	M Bee: H	CAN: Not permitted EU/UK: Not permitted
Indoxacarb (Avatar/Steward) PER86827	22A		42 NG	NSW & QLD			
Tetraniliprole (Vayego 200SC)	28		10 NG	ALL	Ingestion activity. Foliar spray when pest is active after petal fall. Interval for retreatment: 14-28 days. Maximum 3 treatments/ season.	L-M Bee: H	CODEX: MRL lowered EU/UK: Not permitted
Macadamia nut borer. Priority: high							
Acephate (Orthene)	1B		NR	WA & NSW	Contact activity. Foliar spray when pests is fisrt observed. Interval for retreatment: 14-21 days.	H Bee: H	**R3** AUS: Review planned CAN: Use restrictions EU/UK: Not permitted
Betacyfluthrin (Bulldock)	3A		7	QLD, WA, ACT & NSW	Contact activity. Foliar spray when pest numbers indicate. Interval for retreatment: 14-21 days.	VH Bee: H	EU/UK: Not permitted
Betacyfluthrin + Piperonyl Butoxide (Cyborg)	3A		7				
Carbaryl	1A		NR	ALL	Contact activity. Foliar spray on nut clusters late November to February. Interval for retreatment: 14-21 days.	H Bee: H	**R2** CAN: Restricted use CODEX: Review scheduled EU/UK: Not permitted USA: Under review
Methoxyfenozide (Prodigy)	18		28 NG	ALL	Ingestion/growth regulation activity. Foliar spray targeting eggs and early instar larvae. Maximum 3 treatments/season.	VL Bee: VL	EU: Restrictions likely
Spinetoram (Success Neo)	5		7	ALL	Ingestion activity. Foliar spray when pest exceeds threshold. Interval for retreatment: of 10-14 days if pests still active. Maximum 4 treatments/season.	M Bee: VH	CODEX: MRL lowered EU: Not permitted
Tebufenozide (Mimic)	18		28	ALL	Ingestion/growth regulation activity. Foliar spray when pest exceeds threshold.	L Bee: L	
Macadamia flower caterpillar. Priority: moderate							
Acephate (Orthene)	1B		NR	QLD, NT, WA & NSW	Contact activity. Foliar spray at early flowering if pest is evident.	H Bee: H	**R3** AUS: Review planned CAN: Use restrictions EU/UK: Not permitted
Methoxyfenozide (Prodigy)	18		28 NG	ALL	Ingestion/growth regulation activity. Foliar spray when 50-80% of racemes infested. Maximum 3 treatments/season.	VL Bee: VL	EU: Restrictions proposed
Spinetoram (Success Neo)	5		7	ALL	Ingestion activity. Foliar spray when pest is evident. Interval for retreatment: 10-14 days. Maximum 4 treatments/season.	M Bee: VH	CODEX: MRL lowered EU: Not permitted
Tebufenozide (Mimic)	18		28	ALL	Ingestion/growth regulation activity. Foliar spray when pest exceeds threshold.	L Bee: L	

Active ingredient (trade name)	Chemical group	Usage consider-ations	WHP days	States	Label comments	Impact on beneficials	Regulatory risk
Macadamia flower caterpillar. Priority: moderate (cont)							
Trichlorfon	1B		2	QLD, NT, & NSW	Contact activity. Foliar spray when damage levels from pests occur.	H Bee: H	**R2** AUS: Listed for review CODEX & USA: No MRLs EU/UK: Not permitted
Thrips. Priority: moderate							
Abamectin PER87510	6		28 G:14	ALL (excl. VIC)	Contact and ingestion activity. Foliar spray to protect flush in July or December. Maximum 1 treatment/ season. Do not use in 2 consecutive seasons without alternating groups.	M Bee: H	EU: Restricted use
Acephate (Orthene)	1B		NR	QLD, NT, WA & NSW	Contact activity. Foliar spray early flowering if pest evident. Interval for retreatment: 14-21 days.	H Bee: H	**R3** AUS: Review planned CAN: Use restrictions EU/UK: Not permitted
Flupyradifurone (Sivanto Prime)	4D		20 NG	ALL	Contact and ingestion activity. Foliar spray after flowering when pest is evident. Maximum 1 treatment/season.	L Bee: L	EU: Under review
Potassium Salts (Natrasoap)	-		NR	ALL	Contact activity. Foliar spray when pest is evident.	L Bee: L	
Spinetoram (Success Neo)	5		7	ALL	Ingestion activity. Foliar spray when pest is evident. Interval for retreatment: 10-14 days. Maximum 4 treatments/ season.	M Bee: VH	CODEX: MRL lowered EU: Not permitted
Banana fruit caterpillar. Priority: moderate							
Methomyl PER90592	1A		NR	QLD	Contact activity. Ground spray during late flowering or early nut development. Maximum 1 treatment/season.	M Bee: H	AUS: Listed for review CAN: Restricted use EU/UK: Not permitted USA: Under review
Green vegetable bug. Priority: moderate							
Trichlorfon PER13689	1B		2	NSW & QLD	Contact activity. Foliar spray when pest is evident. Interval of retreatment: 14 days. Maximum 4 treatments/season. Do not apply at flowering with bees foraging.	H Bee: H	**R2** AUS: Listed for review CODEX & USA: No MRLs EU/UK: Not permitted
Leptocoris bug. Priority: moderate							
No registered chemical controls in macadamia.							
Bark beetle/Scolytid beetles. Priority: moderate							
No registered chemical controls in macadamia.							
Macadamia kernel grub. Priority: moderate							
No registered chemical controls in macadamia.							
Red-shouldered leaf beetle. Priority: low							
Acephate (Orthene)	1B		NR	QLD, NT & WA	Contact activity. Foliar spray when pest is evident. Interval of retreatment: 14-21 days.	H Bee: H	**R3** AUS: Review planned CAN: Use restrictions EU/UK: Not permitted
Carbaryl	1A		NR	ALL	Contact activity. Foliar spray when pest is evident. Apply 2 applications in spring/autumn. Do not apply to flowers.	H Bee: H	**R2** CAN: Restricted use CODEX: Review scheduled EU/UK: Not permitted USA: Under review
Macadamia felted coccid. Priority: low							
Diazinon	1B		14 G:14	NSW, WA, ACT & QLD	Contact activity. Foliar spray when pest is evident. Retreatment monthly if required.	H Bee: H	**R1** AUS: Proposed deletion EU/UK: Not permitted CODEX: MRLs deleted
Petroleum Oil PER87510	-		NR	QLD & NSW	Contact activity. Foliar spray when pest is evident.	L Bee: L	
Sulfoxaflor (Transform)	4C		NR	ALL	Contact and ingestion activity. Foliar spray when pest detected. Maximum 2 treatments/season.	M Bee: H	USA: Pollinator concerns EU: Highly restricted use

Active ingredient (trade name)	Chemical group	Usage consider-ations	WHP days	States	Label comments	Impact on beneficials	Regulatory risk
Macadamia twig girdler. Priority: low							
Carbaryl	1A		NR	ALL	Contact activity. Foliar spray when pest is evident. Apply 2 applications in spring/autumn. Do not apply to flowers.	H Bee: H	**R2** CAN: Restricted use CODEX: Review scheduled EU/UK: Not permitted USA: Under review
Spinetoram (Success Neo)	5		7	ALL	Ingestion activity. Foliar spray when pest is evident. Interval for retreatment: 10-14 days. Maximum 4 treatments/season.	M Bee: VH	CODEX: MRL lowered EU: Not permitted
Macadamia leaf miner. Priority: low							
Acephate (Orthene)	1B		NR	QLD, NT, WA & NSW	Contact activity. Foliar spray when pest is evident. Interval of retreatment: 14-21 days.	H Bee: H	**R3** AUS: Review planned CAN: Use restrictions EU/UK: Not permitted
Broad mites/flat mites. Priority: low							
Abamectin PER87510	6		28 G:14	ALL (exc. VIC)	Contact and ingestion activity. Foliar spray to protect flush in July or December. Maximum 1 treatment/ season. Do not use in 2 consecutive seasons without alternating groups.	M Bee: H	EU: Highly restricted use
Pinhole borer. Priority: low							
No registered chemical controls in macadamia.							
Latania scale/white scale. Priority: low.							
No registered chemical controls in macadamia.							



Table 4. Chemicals available for disease management

Active ingredient (trade name)	Chemical group	Usage consider-ations	WHP days	States	Label comments	Regulatory risk/comments
Husk spot. Priority: high						
Azoxystrobin + Tebuconazole (Custodia Forte)	11+3		15	ALL	Match head foliar spray. Interval for retreatment: of 14-28 days. Maximum 2 treatments/season.	**R3** Azoxystrobin: CAN: Review proposed Tebuconazole: AUS: Listed for review CAN/USA: Under review EU: To be substituted
Carbendazim	1		14 G:28	ALL	Foliar spray 5 and 8 weeks after main flowering. Remove nuts under trees before spraying. Maximum 2 treatments/season.	**R2** CODEX: Withdrawal likely EU/UK: Not permitted
Copper Hydroxide/ Copper Oxychloride/ Cuprous Oxide	M1		1	QLD, NT & NSW	Foliar spray from nut set to December. Apply 3 treatments at an interval of 21-28 days.	EU: To be substituted
Copper Ammonium Acetate Complex				QLD, NSW	Foliar spray from nut set to December. Apply 3 treatments at an interval of 21-28 days.	
Difenoconazole (Score)	3		NR	& NT	Foliar spray at nut set until December, no later than 12 weeks after nut set. Interval for retreatment: 21-28 days. Maximum 2 treatments/season.	**R3** AUS: Listed for review EU: To be substituted USA: Under review
Fluopyram + Tebuconazole (Luna Experience)	7+3		NR NG	ALL	Foliar spray at match head stage. Interval for retreatment: 21-28 days. Maximum 2 treatments/season.	**R3** Tebuconazole: AUS: Listed for review CAN/USA: Under review EU: To be substituted
Fluxapyroxad + Pyraclostrobin (Merivon)	7+11		21	ALL	Foliar spray at match head. Interval for retreatment: 21 days. Maximum 3 treatments/season, only 2 consecutive.	Pyraclostrobin: CAN: Listed for review
Mefentrifluconazole (Belanty)	3		14 NG	ALL	Foliar spray at match head. Interval for retreatment: 21 days. Maximum 3 treatments/season, only 2 consecutive.	
Penthiopyrad (Fontelis)	7		14 NG	ALL	Foliar spray at match head. Interval for retreatment: 14-28 days. Maximum 3 treatments/season, only 2 consecutive.	
Pyraclostrobin (Cabrio)	11		NR	ALL	Foliar spray at match head. Interval for retreatment: 14-28 days. Maximum 2 treatments/season.	Pyraclostrobin: CAN: Listed for review
Dry flower. Priority: high						
Penthiopyrad (Fontelis)	7		14 NG	ALL	Foliar spray at bud break and 14-21 days later if required. Maximum 3 treatments/season, only 2 consecutive.	
Fluxapyroxad + Pyraclostrobin (Merivon)	7+11		21	ALL	Foliar spray prior to flowering stage 1. Retreat under high pressure at stage 3 (open flower). Maximum 3 treatments/ season, only 2 consecutive.	Pyraclostrobin: CAN: Listed for review
Phytophthora root rot and trunk canker. Priority: moderate						
Tribasic Copper Sulfate/Cuprous Oxide	M1		1	ALL	Apply with water or water-based paint to stems of trees where cankers appear, after removing dead tissue. Maximum 5 treatments/season. Take note of water pH requirements.	EU: To be substituted
Copper Ammonium Acetate Complex				QLD & WA		
Metalaxyl-M (Ridomil Gold 25G)	4		28	QLD & NSW	Preventative: Soil treatment at the start of summer wet season and at 3-6 month intervals. Apply in alternate years only. Curative: Soil treatment under tree canopy. Apply at the start of summer wet season and 8-12 weeks later, then 6 monthly.	Metalaxyl-M: EU: Restricted use
Metalaxyl-M + Copper (Ridomil Gold Plus)	4+M1		28	QLD & NSW	Apply to affected trunk/limbs and as a soil drench around tree base. Apply at the start of summer wet season and 8-12 weeks later.	Metalaxyl-M: EU: Restricted use

Active ingredient (trade name)	Chemical group	Usage consider-ations	WHP days	States	Label comments	Regulatory risk/comments
Phosphorous Acid	33		14	NSW, QLD & WA	Foliar application: Apply to affected trees at mature flush in spring and autumn. Do not apply to young flush. Trunk application: Apply at root flush to affected trees and 28 days after. Maximum 2 treatments/season.	
Husk rot/Phomopsis. Priority: moderate No registered chemical controls in macadamia. Control registered for husk rot/anthracnose.						
Botryosphaeria dieback. Priority: moderate No registered chemical controls in macadamia						
Grey mould/Botrytis. Priority: moderate						
Penthiopyrad (Fontelis)	7		14 NG	ALL	Foliar spray at bud break and again 14-21 days later. Maximum 3 treatments/season, only 2 consecutive.	
Fluxapyroxad + Pyraclostrobin (Merivon)	7+11		21	ALL	Foliar spray prior to flowering stage 1. Under high pressure apply again at stage 3 (full open flower). Maximum 3 treatments/season, only 2 consecutive.	Pyraclostrobin: CAN: Listed for review
Fluopyram + Tebuconazole (Luna Experience)	7+3		NR NG	ALL	Foliar application at flowering and prior to disease development. Interval for retreatment: 20-22 days. Maximum 2 treatments/season.	**R3** Tebuconazole: AUS: Listed for review CAN/USA: Under review EU: To be substituted
Iprodione (Rovral)	2		NR	ALL	Foliar spray open flower. If wet conditions persist retreatment in 7 days. Remove nuts under trees before spraying. Take note of water pH requirements.	**R2** CAN: Highly restricted use CODEX: Review scheduled EU/UK: Not permitted USA: Proposed deletion
Green mould/Cladosporium blight. Priority: low						
Penthiopyrad (Fontelis)	7		14	ALL	Foliar spray at bud break and 14-21 days later. Maximum 3 treatments/ season, only 2 consecutive.	
Fluxapyroxad + Pyraclostrobin (Merivon)	7+11		NG 21	ALL	Foliar spray before flowering stage 1. Retreatment if required at stage 3 (full open flower). Maximum 3 treatments/ season, only 2 consecutive.	Pyraclostrobin: CAN: Listed for review
Husk rot/anthracnose. Priority: low						
Copper Hydroxide/ Copper Oxychloride/ Cuprous Oxide	M1		1	QLD, NT & NSW	Registered for husk spot, anthracnose and pink limb blight. Foliar spray early summer to May at monthly intervals.	EU: To be substituted

Table 5. Chemicals available for weed management.

Active ingredient (trade name)	Chemical group	WHP days	States	Usage comments	Use	Regulatory risk/comments
Carfentrazone	14	NR G:14	ALL		Broadleaf weeds	
Carfentrazone-Ethyl + Glufosinate (Hellcat)	14+10	NR G:56	ALL	Directed or shielded spray	Grass and broadleaf weeds	**R3** Glufosinate: CAN: Listed for review EU/UK: Not permitted
Carfentrazone-Ethyl + Glyphosate (Broadway)	14+9	NR G:14	ALL	Directed or shielded spray	Broadleaf weeds	**R3** Glyphosate: International concerns EU: Under review
Flumioxazin (Chateau)	14	98 G:28	ALL	Directed spray/residual weed control	Grass and broadleaf weeds	EU: To be substituted
Glufosinate (Basta)	10	NR G:56	ALL	Directed or shielded spray	Grass and broadleaf weeds	**R3** CAN: Listed for review EU/UK: Not permitted
Glyphosate (Roundup)	9	NR	ALL	Directed or shielded spray and wick wiper	Grass and broadleaf weeds	**R3** International concerns EU: Under review
Haloxyfop (Verdict)	1	NR	ALL	Directed or spot spray	Grass weeds	EU/UK: Not permitted
Isoxaben (Gallery)	29	NR	ALL	Residual weed control	Broadleaf weeds	

Active ingredient (trade name)	Chemical group	WHP days	States	Usage comments	Use	Regulatory risk/comments
Oryzalin	3	NR	ALL	Directed spray	Grass and broadleaf weeds	EU/UK: Not permitted
Oxyfluorfen (Goal)	14	NR NG	ALL	Directed spray	Grass and broadleaf weeds	EU: To be substituted USA: Under review
Paraquat (Gramoxone)	22	NR G:1	ALL	Directed spray	Grass and broadleaf weeds	**R3** AUS/CAN: Under review EU/UK: Not permitted
Paraquat + Diquat (SpraySeed)	22	NR G:7	ALL	Directed or spot spray	Grass and broadleaf weeds	**R3** AUS/CAN: Under review EU/UK: Not permitted
Pendimethalin (Stomp)	3	NR	ALL	Directed spray that requires incorporation	Grass and broadleaf weeds	EU: To be substituted
Trifluralin	3	NR	ALL (excl. NSW)	Residual weed control	Johnson grass Liverseed grass	

Table 6. Chemicals available for plant growth regulation.

Active ingredient (trade name)	Chemical group	WHP days	States	Situation/comments	Use	Regulatory risk
Ethephon	PGR	7	NSW & WA	Macadamia. Do not use on Teddington variety.	Aids harvest by promoting nut fall after maturity	
Ethephon PER11462	PGR	7	NSW, NT, WA & QLD			

Key considerations

Although many products are registered or permitted for use in Australian macadamia production, some cannot be used due to restrictions imposed by export markets. With around 75% of Australian macadamias being exported, it is essential to consult your processor before using any products listed as having export constraints. Product labels often contain mandatory statements and restrictions that may not be immediately visible, especially in subclauses. This is particularly the case with restrictions such as maximum rates per hectare and whether concentrate spraying is effective or allowable. It is important that all staff thoroughly read the chemical label or permit at the planning stage of crop protection.

One crucial consideration is how the product can legally be applied. The use of drones is an efficient, potentially cost-saving solution for spraying that could be a game changer for orchards that have access limitations within the spray season. Unfortunately, regulation hasn't caught up with advances in technology. Drone spraying is categorised by Australian Pesticides and Veterinary Medicines Authority (APVMA) as aerial application and many macadamia labels and permits do not allow this use. The AMS has been strongly advocating to the APVMA to recategorise drones and to enable a sensible pathway for use in horticulture. We will continue to put the case for more sensible regulation to the APVMA in 2025.

Practices to ensure chemical efficacy

- Always read the label or permit thoroughly.
- Any decision on control of pests relies on good monitoring.
- A pest consultant can help you with pest identification and critical timing of control.
- Ensure you comply with dosage rates, hectare volumes, applications per season and methods.
- Follow tank mixing protocols and pH limits to avoid incompatibility and/or product failure.
- Coverage tests are essential to ensure you aren't spraying ineffectively.
- Always comply with mandatory buffer zones and use spray drift mitigation practices.

Integrating management tools for successful biological control of macadamia pests

Mark Duncan, BioResources

Integrated pest management (IPM) is a priority for many macadamia growers and consultants in Australia. The success of these programs relies on thorough field observations, understanding key pests and their predators, and implementing both long-term and short-term management strategies. Effective IPM requires the careful integration of cultural, biological and chemical controls, all of which should be guided by solid field data and knowledge of the biology and ecology of key pests and the local weather and natural systems. While it is important to consider the full suite of pests, identifying and prioritising the key pests is crucial, as managing them effectively will significantly impact the success of your IPM program.

Cultural management

Cultural management tools are often overlooked in IPM programs. In Australia, the fruit-spotting bug (FSB) is a key pest of macadamia, and cultural management should take into account its biology, ecology, and how damage occurs throughout the growing season. Key considerations include orchard location and layout, cultivar selection and long-term management approaches such as pruning and intercropping. Orchards located near potential FSB hotspots should consider thicker shelled cultivars that are less susceptible to late-season attacks. Closed-canopy orchards with limited airflow and narrow rows can enhance conditions for FSB breeding, while wider tree rows can support interrow cover crops that provide resources and refuges for pollinators and beneficial insects.

Biological control

Effective integration of biological controls in macadamia IPM programs requires a thorough understanding of both pests and their predators. The Anastatus wasp, an egg parasitoid of spotting bugs, can reduce the intensity of spotting bug incursions by targeting breeding areas around the orchard leading up to and during the bug breeding season. However, once adult bugs enter the orchard, other predators, such spiders and assassin bugs, play a crucial role in pest control. Trichogramma, also known as MacTrix wasps, on the other hand, can directly impact and prevent larval damage in the crop from macadamia nut borer by parasitising eggs laid on nut husks, preventing larval damage. Protecting these natural enemies and encouraging diversity is key in maintaining a resilient agroecological system.



Anastatus female inspecting fruit-spotting bug egg before parasitising it.



Spider attacking banana-spotting bug nymph.

Chemical intervention

When pest levels or damage reach economic thresholds, judicious chemical intervention is necessary. Newer chemical control options tend to be more targeted to specific groups of pests in their mode of action, and many crop consultants are now reporting the return of spiders, assassin bugs, lacewings and parasitic wasps in the orchards. In contrast, the practice of "calendar spraying" with broad-spectrum insecticides often results in undesirable side effects, such as secondary pests like thrips, mites and scales, leading to additional spray applications. Monitoring is the key in determining the best course of action, as all chemical applications will disrupt beneficial insect populations, many of which provide important agroecological services.

Many horticultural producers are facing the multiple challenges of climate change, environmental stewardship and market volatility. With further restrictions on chemical use expected, it is vital that producers continue to move towards a more regenerative production system that has resilience at its core. Getting out into the orchard and observing is vital in adapting to changes in agroecology and establishing an effective integrated pest management program.



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"Farmers are a very good, honest, genuine, and helpful bunch, but we're also quite isolated. Nutworks gives us the opportunity to meet, discuss, and compare notes with a group of like-minded individuals who share a common purpose and goal.

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Using drop sheets for real-time insect monitoring in macadamia orchards

Chris Fuller, Nutworks

Insect damage and brown centres are the two biggest contributors to macadamia factory reject levels year in, year out. Most insect damage reported by processors and independent labs is caused by fruit spotting bugs (FSB), either Amblypelta nitida *(the true fruit spotting bug) or* Amblypelta lutescens *(banana spotting bug) or a combination of both, depending on the grower's location. Green vegetable bug (GVB) damage and, of late, damage from Leptocoris, also resemble FSB damage and are often grouped into the same category during lab assessments.*

In this article, Chris Fuller describes how he experimented with using drop sheets to monitor fruit spotting bug populations as a way of more quickly identifying their presence and allowing more timely management.

Challenges of traditional monitoring

I initially started looking at drop sheeting as a monitoring tool to better understand the dynamics of FSB and other bugs causing similar damage throughout the nut growing season. The method had been used successfully in other crops, and I thought it could be adapted for macadamias.

I had been monitoring insects in macadamias for many years using existing methods. For spotting bugs, this involved walking tree rows, looking for fallen nut and cutting them open to determine if FSB was responsible. The goal was to determine the cause of them being shed from the tree and then, if they were stung, whether the damage was at an economically harmful level. At the time, we only had an economic threshold level (ETL) of 3% and if this level was exceeded, it meant you should spray.

The problem with this method is that it monitored damage after the fact. The damage had already been done and the FSB numbers could go from low to very high while we were waiting for the damaged nut to fall. We also learnt that during drier years, damaged nut remained in the trees longer before falling which further demonstrated we needed a different method for searching for spotting bugs.

We then began sampling and cutting nuts directly from the trees, so we didn't have to wait for the trees to shed the damaged nut. This took us a little closer to finding the damaging level of bugs earlier, but it still was essentially monitoring damage after the fact.

Spray decisions based on real-time data

We found that by placing drop sheets under sample trees and spraying individual trees, we could determine the real-time level of FSB within the tree. Most FSB sprays have little to no residual activity, making timing critical for effective control. Drop sheeting allows us to detect FSB activity and time



By placing drop sheets under sample trees and spraying individual trees, it is possible to determine the real-time level of FSB within the tree

commercial spray rounds to coincide with the first and subsequent flights of FSB into the orchard, preventing a rapid pest buildup.

This drop sheet method also helps us determine how late in the season we need to spray. One early adopter of this method would spray a few trees in February to check if a full late-season spray was necessary. In the first year, only assassin bugs were found on the 10 or so sheets scattered throughout the orchard, so the grower opted not to spray – and his insect results from the factory were good.

Testing new products with drop sheets

More recently we have been using the drop sheet method for other purposes. When Trivor entered the market, we wanted to test its efficacy against FSB. Sometimes growers are hesitant to try new products until they've been tested by others. What we also wanted to see with this trial was which other secondary pests Trivor would help control and which beneficial insects it would not kill and leave alive in the trees. To test it, we placed sheets under several trees, sprayed them at the recommended rate and returned the following day to collect the insects that had been killed and fallen onto the sheets. We found several dead FSB along with minor pests and other insects. We waited a few days for any potential residual activity of the Trivor to pass then sprayed the same trees with a broad spectrum pyrethroid. This allowed us to see what Trivor had left alive in the trees. We found no further FSB on the sheets after the pyrethroid spray but we did find a large number of beneficial insects like spiders. Since spiders help control FSB, we aim to keep them in orchards as long as possible during the growing season to suppress pest levels.



A spider preys on a fruit spotting bug (FSB) – highlighting the role of beneficial insects in helping suppress pest populations in macadamia orchards.

Evaluating commercial spray rounds

A further use of the drop sheeting method is to determine if a grower is achieving effective insect control during commercial spray rounds. Similar to how we used the method in the Trivor trial, we return to the orchard a few days after a spray round and place several sheets throughout the orchard. Then we hand spray the trees using a backpack sprayer. If we find any target pest on the sheets, it indicates the grower may need to recalibrate their sprayer to improve coverage and avoid leaving a residual pest population, which can build up and cause damage. We've noticed that some growers drive too fast while spraying, resulting in poor coverage, and this is reflected in the results from the factory.

Equipment needed

I use a Solo 433 20 L backpack sprayer along with the recommended PPE, including disposable overalls, a respirator, goggles, gloves and boots. The drop sheets I use are 5 x 5 m with a keyhole cut to easily fit around the tree and catch anything falling from the canopy. The total cost for a sprayer, PPE and six drop sheets is around $1800.

For a quick knockdown of pests, you can use natural pyrethrum in the backpack sprayer. You can also use the same drop sheet technique when using the orchard's spray rig with regular pesticides as long as re-entry, safety and label requirements are followed.

Disclaimer. Crestnut Products Pty Ltd (trading as Nutworks) and their representatives only recommend the use of registered crop protectant products at label rates as allowed by the APVMA. Always read and follow the chemical label directions and adhere to legal requirements for the use and storage of agricultural chemicals. This advice is general only and does not constitute a full pest management service. Advice is to be used in conjunction with all relevant chemical labels, APVMA permits and relevant industry requirements. As so many aspects of orchard pest control are out of our control (including, but not limited to, adverse weather during spraying, grower's spray overage and calibration, climatic effects on pests etc), Nutworks and their representatives accept no liability for any loss of productivity or crop damage based on this advice.

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Macadamia conservation features at conference

Denise Bond, MCT Executive Officer M: 0488 432 226 | E: denise.bond@macadamias.org

Challenges to macadamia conservation featured in a paper and poster at the 14th Australasian Plant Conservation Conference (APCC14) held in Toowoomba by the Australian Network for Plant Conservation (ANPC) from the 13–17 October. The event brought together Traditional Owners, plant conservation scientists, researchers, practitioners and land managers, government agency staff, community groups, students and volunteers, to discuss recent advances and issues in plant conservation, and how best to manage the key threats.

Previous APCC conferences tended to focus on Australia's southern states; this was the first to be held in Queensland, despite Queensland being the most biodiverse state in Australia with over 14,000 species of native plants, algae, fungi and lichens and 1424 regional ecosystems.

The conference program included the excruciatingly specific *(Molecular ecology of endemic shrubs in isolated old climatically buffered infertile landscape populations)* to bigger picture topics (Costa Georgiadis on *How to get more people interested in native plants and their conservation, including more kids studying botany*).



"The Menangle Tree" at Camden Park showing multi-stemmed growth of a macadamia tree that may date back to the 1840s.

Topics relevant to macadamia conservation

Several speakers presented work that holds relevance for macadamia conservation, including:

Bob Makinson and Brandan Espe on *Ex-situ conservation through meta-collections.*

Maurizio Rossetto on Conservation genetics - *an indispensable tool providing multiple practical solutions across multiple scenarios.*

Dr Marlien van der Merwe on *Representative genetic diversity in quality conservation germplasm collections.*

Paul Dawson and Adrian Bauwens on *Holistic health of Bunya Mountains' rainforests:* Phytophthora multivora *and the dynamics of cultural connections to place.*

Presentations by the Macadamia Conservation Trust

The MCT presented at the plenary session and in the poster session.

In the plenary session, I presented a paper on savings Queensland's rarest plant species. Queensland's four macadamia species are sparsely distributed in small areas of remnant sub-tropical forests from Bulburin National Park in Queensland to the Richmond River in NSW. Not only are they all threatened, but their seeds are recalcitrant and cannot be stored conventionally. Living trees are currently the only way to preserve genetic diversity.

Diversity tends to be highest in larger populations and at least one species has evolved into clades along a latitudinal axis. Members of the Macadamia genus have been shown to cross-pollinate both within and between species over distances of nearly 3 km. Orchard trees with a narrow genetic range now grow within pollination distance of many wild trees, potentially diluting wild genetics. The conservation

Factors relating to macadamia growth habit	Implications for determining tree age
Rate of growth is highly dependent on access to sunlight - shaded seedlings may remain small for decades	During periods of slower growth, annual bands may not be visible
Trunks are seldom circular and can have pronounced wedging	Wedging results in expansion and contraction of bands making them difficult to count accurately
Trees may grow multiple stems in response to disturbance and can resprout after damage to the main trunk resulting in stems of multiple ages	The living trunk may not be the first stem grown by the tree
Trees can continue to grow with quite extensive damage to trunk	Older tree trunks may include decay and stress fractures

Table 1. *Characteristics of macadamia growth and their implications for determining tree age.*

challenge is to protect all remnant habitat, restore habitat where possible, and plant a genetically diverse selection of trees strategically throughout the landscape to mitigate the impact of pollen from cultivated trees.

This is a clear case for translocation in its broadest sense, including reinforcement, reintroduction, introduction and assisted migration. However, under Queensland's current permitting framework, propagative materials from threatened plants in protected areas cannot be collected for conservation purposes. For macadamias, much of the remaining genetic diversity – those few larger populations in protected areas – are out of bounds for translocation purposes. This is in marked contrast to NSW which allows collection of threatened species in support of approved translocation plans. This aspect of Queensland's Nature Conservation Act needs revision, particularly to support adaptive strategies in the face of climate change.

Our poster reported findings from our macadamia longevity project. In this project, discs were cut from the base of three trees, finely sanded and the growth bands counted by dendrology expert Dr Kathryn Allen from The University of Tasmania (UTAS). Samples from the discs were then sent to Dr Vladimir Levchenko and Dr Quan Hua at the Australian Nuclear Science and Technology Organisation (ANSTO) for radiocarbon dating to see if band counts provide a consistent approximation of years.

The results illustrate some of the challenges to using either band counting or radiocarbon dating to determine the age of macadamia trees.

Tree dating techniques such as AMS 14C dating are expensive and, unless the tree is already dead, involve extracting living tissue. However, these results show that growth-band counting is not consistently reliable for macadamias, so radiocarbon dating of a series of 14C dates from a sequence or bomb 14C dating may be the only technique currently available for dating old macadamia trees. Locating the oldest tissue of an individual macadamia tree for radiocarbon dating may be a challenge if there are multiple stems and fungal or insect damage at the base of the tree.

Building conservation networks

The conference was a great opportunity not only for knowledge sharing but also to build and strengthen plant conservation networks, including the new Queensland Threatened Plant Network (QTPN), and to raise the profile of plant conservation in Queensland.

Conservation partnerships

The MCT is a founding member of the Queensland Threatened Plant Network (QTPN) – a new partnership between the Australian Network for Plant Conservation (ANPC) and the Queensland Department of Environment, Science and Innovation.

Since 1991, the ANPC has coordinated plant conservation in Australia. A major aim is to integrate approaches to plant conservation across all players – government, industry and community. Network members include botanic gardens, conservation agencies, mining companies, community groups, researchers, local government, power authorities and farmers. The ANPC exists to:

- provide a knowledge network with long-term continuity
- facilitate information flow
- disseminate scientific knowledge and practical skills and insights.

Acknowledgments. Thanks to the following for contributing to the macadamia longevity project: DAF for extracting and transporting tree disc samples; private landholders for allowing access to trees and extraction of samples; ANSTO Portal grant AP14574 for AMS 14C analysis.

New technology for growers: Innovations from AusMac2024

Technology in agriculture is evolving rapidly, with innovations in AI, remote sensing, and automation transforming traditional farming practices. From autonomous machinery to advanced data analytics, many companies are developing solutions that aim to save time, reduce resource use and increase productivity for growers. These cutting-edge tools, some of which were showcased in the Innovation Lounge at the AusMac2024 conference, offer a glimpse into the future of farming. Below are examples of some of the new technologies available to macadamia growers and other agricultural producers.

SwarmFarm Robotics

Australian company SwarmFarm Robotics manufactures agricultural robots that help growers adopt new farming methods and practices that aren't possible with traditional tractors. Unlike driverless tractors that automate existing processes, SwarmFarm's robots are lightweight, autonomous, and equipped with technology that enables innovative farming techniques. The robots can operate independently or as a coordinated "swarm".



SwarmFarm's robots can operate independently or as a coordinated "swarm".

Information. To find out more, visit the SwarmFarm website (www.swarmfarm.com) or call Kody Nelson on 0431 255 609.

Insights from SwarmFarm Robotics

SwarmFarm Robotics is an Australian company that is delivering new farming systems through integrated autonomy. To date, SwarmFarm Robots have farmed over 5.2 million acres of farmland and eliminated the use of around 5.1 million litres of pesticides. SwarmFarm partners with agricultural implement manufacturers to release new farming technology and attachments onboard the SwarmFarm platform, as integrated autonomy.

Key advantages and potential savings. Portfolio Manager Sam Finlayson highlights efficiency as a key advantage of SwarmFarm's autonomous robots. "By integrating robots into farming operations, farmers can focus their labour on high-value tasks, while the robots handle routine jobs like slashing and fertilising," he said.

The robots are designed to work 24/7 and are lightweight, minimising soil damage. They also offer flexibility, with 14 different manufacturers providing third-party implements such as spray booms, slashers, mowers and fertiliser spreaders that can be integrated into the SwarmConnect platform, giving growers a wide range of options to suit their needs.

What growers need to know. According to Sam, before deploying autonomy, farmers need to map their fields and obstacles like power poles and irrigation infrastructure using a GPS. This one-time mapping process allows SwarmFarm's FarmManager software to create paddock plans, allowing the robot to operate autonomously.

Cost. Pricing is available on request.

Agri Automation Australia

Agri Automation Australia provides advanced systems such as autonomous equipment and precision farming tools to help farmers improve productivity, reduce operational costs and improve worker safety.



GOTrack Auto Drive enables existing tractors and equipment to be operated autonomously.

Information. To find out more, visit the Agri Automation Australia website www.agriautomation.com.au or email info@agriautomation.com.au.

Insights from Agri Automation Australia

One system provided by Agri Automation Australia is GOtrack Auto Drive. This technology enables existing tractors and equipment to be operated autonomously for repetitive tasks such as spraying, slashing and herbicide spraying. It also offers auto-steering without GPS for more technical tasks that require an operator.

Key advantages and potential savings. Managing Director Cam Clifford said growers can achieve substantial productivity gains by automating simple tasks. "By using GOtrack Auto Drive, farmers can significantly reduce labour inputs while freeing up skilled workers for more valuable tasks," he said.

Another key advantage of the system, Cam says, is that it offers pulse spraying for young orchards, which reduces spray volume by up to 80% per hectare and reduces off-target drift. As the orchards mature, the system can transition to prescription spraying for optimal canopy coverage.

Agri Automation Australia provides a free analysis service to growers to provide them with operation savings calculations and savings estimates.

What growers need to know. In most cases, no adaptations are necessary to use the technology on farms. "It depends on the type and scale of operations," Cam explains, "but generally, GOtrack Auto Drive technology functions just like standard tractor operations."

Cost. The system is commercially available across Australia and comes with a subscription cost of $3,900 per month, plus an installation fee starting at $5,000, depending on the tractor make and model.

Aerobotics

Ag tech company Aerobotics works with aerial imagery and AI to provide growers with detailed tree performance information at scale. The system's machine learning algorithms use high-resolution visual, multispectral and thermal drone imagery to isolate and analyse each individual tree canopy. Growers receive information about tree performance metrics, including canopy area, vigour, health and transpiration, with each survey available in an online platform at a farm, block or individual tree level.



Aerobotics uses drones to capture aerial imagery, which can help growers understand what is happening at a tree level.
Pic: Aerobotics

Insights from Aerobotics

Yoav Yichie, general manager of Aerobotics' Australia/NZ division explains that the company's Tree Insights product helps orchard growers optimise each tree's productivity by identifying areas of under-performance or variation within large-scale operations.

Key advantages and potential savings. Yoav emphasises the benefits of understanding what is happening at an individual-tree level, an impossible task for most growers without the help of technology.

"Each tree is a production asset, and growers need each tree to perform optimally to maximise yields. Tree Insights helps growers detect irrigation issues, implement variable rate applications, conduct accurate tree inventories, and identify missing trees – all of which impact a farm's production potential," Yoav said.

What growers need to know. Growers do not need to make any changes or adaptations on their farm to use the technology. Aerobotics schedules drone flights at the appropriate phenological stage to capture the relevant data for insights.

Cost. Aerobotics' Tree Insights is commercially available, with pricing provided upon request.

Information. Growers can find out more information at the Aerobotics website www.aerobotics.com.

Farm Concepts

Farm Concepts focuses on providing customised, data-driven solutions that address specific challenges faced by farmers, such as labour-intensive management and the demand for more sustainable farming practices. The company's experience with diverse agricultural sectors demonstrates that autonomous technologies can be adapted to various farming operations.



Farm Concepts' ROBOTTI LongRange is an autonomous implement carrier for tasks such as plant establishment.

Insights from Farm Concepts

Braden Hellmuth, director of Farm Concepts, says that Farm Concepts' technology is designed to suit existing conditions on farms. "Especially in a tree crop, growers already have existing equipment, fields and processes that technology needs to support," Braden said. "Growers need to approach technology with an open mind and flexibility but should not have to vastly change their operations to suit the technology."

Key advantages and potential savings. Innovations like Farm Concept's ROBOTTI LongRange, an autonomous implement carrier for plant establishment and similar tasks, and the company's robotic mower, can be applied in a range of scenarios. These technologies can reduce reliance on labour, increase operational efficiency, and can improve sustainability in macadamia orchards.

Braden emphasies that it's a good idea for growers to approach technology with an open mind. "Finding the right solution needs to be an individual discussion," he said. "Take time to consider the options and ways you can begin to integrate technology into your operations. It's about taking small steps towards a larger goal of farm automation and productivity."

What growers need to know. Growers do not need to make any changes or adaptations on their farm to use the technology.

Cost. Pricing is available on request.

Information. To find our more, visit www.farmconcepts.com.au or contact Braden Hellmuth on braden@farmconcepts.com.au.

Inform Ag

Inform Ag provides a set of digital tools called the GrowData Suite that includes three main products:

- GrowData Irrigate, which centralises irrigation control and deploys farm-wide connectivity
- GrowData Track, GPS-enabled technology which provides detailed yield and machinery insights
- GrowData OPS, a farm management platform that streamlines tasks like planning, reporting, and inventory.



Inform Ag's technology helps growers optimise water use, streamline farm operations, and improve production data accuracy.

Insights from Inform Ag

Steve Lockyer, CEO at Inform Ag, explains that Inform Ag's technology helps growers optimise water use, streamline farm operations, and improve production data accuracy. "Our goal is to help farmers manage their resources more efficiently while also simplifying day-to-day tasks," Sam said.

Key advantages and potential savings. Inform Ag's tools deliver tangible savings, particularly through date-driven and controlled irrigation management, which can lead to over 20% improvement in water use efficiency. The ability to access real-time data on jobs, inventory or spray diaries, for instance, also allows for more informed decision-making, improving overall production efficiency and planning.

What growers need to know. According to Steve, most growers don't have to make major changes to start using Inform Ag's technology. "Our goal is to integrate seamlessly into existing farming operations," he said. "Technology is a tool to make life easier on the farm and improve on existing operations, not complicate them." Inform Ag provides support to ensure smooth adoption and ongoing success.

Cost. Pricing is tailored to each farm's needs, and costs vary. Clients range from small farms to large corporate operations, so the products and solutions are adapted to the business needs.

Information. Growers can contact Inform Ag for more information or visit www.informag.com.au.

John Deere

John Deere, a global leader in agricultural equipment, provides a range of solutions to help growers improve efficiency and productivity across the farming spectrum. Their technologies include precision tools for remote operation management and reducing labour. One key offering is their advanced spray systems, which enable growers to apply chemistry more accurately and reduce chemical use.



John Deere's advanced spray systems help growers apply chemistry more accurately.

Insights from John Deere

John Deere's product marketing manager, Erin Wagstaff, explains that the company's focus is on precision technology to help growers optimise their resources. She points to the Smart Apply system, GUSS (Global Unmanned Spray System), and the John Deere Operations Centre, which allows farmers to remotely monitor their operations from any device.

Key advantages and potential savings. The Smart Apply system uses LiDAR to spray only where canopy foliage exists, helping to reduce chemical use. GUSS allows one operator to control up to eight blast sprayers simultaneously, reducing labour costs. The John Deere Operations Centre, which is included in equipment purchases, allows growers to track their machines and operations remotely, so they can manage their orchards from anywhere in the world.

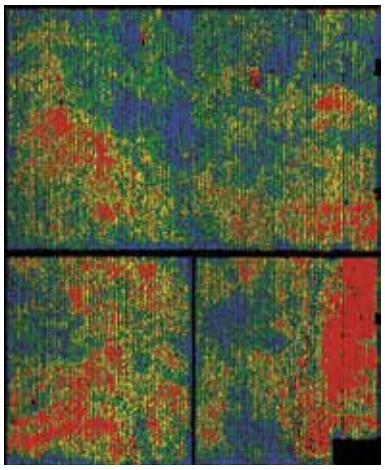
What growers need to know. Erin says growers generally do not need to make significant physical changes to adopt John Deere's technology. However, they may need to adjust their operational workflows to fully integrate these solutions. Local John Deere dealers can provide specific advice on how best to get started.

Cost. Pricing available on request.

Information. To find out more, visit your local John Deere dealer or visit the speciality tractor page on the John Deere website: www.deere.com.au/en/tractors/specialty-tractors

Ceres AI

Ceres AI, formerly Ceres Imaging, was founded in California, inspired by emerging technology in AI and spectral imagery. The company uses high resolution imagery and data analytics to help growers make informed decisions to improve productivity and operate more sustainably.



An example of the imagery layer in Ceres AI's app, showing water-stressed areas in red.

Insights from Ceres AI

Rajandeep Singh, Ceres AI's customer success manager, explains that the company focuses on solving farm issues related to irrigation, crop health, and overall productivity by providing high-resolution aerial imagery and data analytics.

Key advantages and potential savings. Ceres Imaging helps farmers make data-driven decisions to improve yields, reduce input costs, and promote sustainable practices. The technology pinpoints water management issues, nutrient deficiencies, and early signs of pests or diseases. "Early detection is crucial," Rajandeep says. "Our imaging can identify problems before they cause significant crop damage, helping farmers optimise inputs like water and fertilisers." The imagery also reduces the need for manual scouting, freeing up labour and cutting costs. Farmers can target areas needing attention and avoid blanket applications of inputs, reducing waste.

What growers need to know. No on-farm changes are necessary to use Ceres AI's services. The platform is flexible, offering per-flight, per-hectare pricing with customisable plans to suit different operations.

Cost. Ceres Imaging is commercially available with pricing based on a per-hectare, per-flight basis.

Information. Find out more at www.ceres.ai.

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Bundaberg trial shows benefits of agtech in orchard management

Eve White

Technology is revolutionising the way macadamia growers manage their orchards, helping them make decisions, reduce labour and improve yield and productivity. Using tools like LiDAR, high-resolution imaging, and artificial intelligence (AI), these systems can detect mistletoe infections, monitor tree growth at a detailed level, predict yields, and even assess soil health and monitor plant conditions.



The system sits on the back of an ATV that is driven up and down rows and can cover 10ha/hr.

One local company that helps growers benefit from these tools is Crop Scan Tech (CST), which provides data to tree crop growers in the Bundaberg region. The business uses technology developed by an Australian company called Green Atlas Technology to measure and map tree characteristics such as nut density, mistletoe infection, height and total leaf-matter.

How the system works

The cartography system utilises multi-directional high-definition cameras that sit on the back of an ATV that is driven up and down tree rows, travelling at speeds of 25km/hour, covering 10 ha per hour.

The system takes four photos of each tree, using high powered strobes to penetrate deep into the canopy. Each photo is GPS referenced, and AI is used to recognise the features of interest. The trained sensing technology can measure anything that is visually identifiable in trees, such as mistletoe and nuts. The detection algorithms are continuously being updated and trained for the different macadamia cultivars.

As well as providing data, the cameras and LiDAR provide detailed visual information for the grower, including:

- maps of canopy geometry
- aerial images of the orchard to compare blocks and look at patterns within blocks
- high resolution images of individual trees.

Over the last three years, CST has been running an ongoing trial with one of Bundaberg's major macadamia growers to demonstrate how it can be used to assist with mistletoe management, yield estimation and other tasks.

Mistletoe detection and eradication

The trial has shown that by using AI to analyse high resolution images, the system can objectively measure the scale of mistletoe infections and the success of eradication programs.

Matt Johnson, managing director of CST, said, "We scanned the orchard each year for three consecutive years. The grower did no eradication between the first and second year, and we could see from the second-year scans that the mistletoe was in the same places as it was a year before. We could also see where it had spread to between the first and second years.

"After the second year, the grower conducted an eradication program. The scan the following year showed us how effective the eradication was and where patches were missed.

"The grower can also overlay total leaf matter, tree height and nut density data to see how mistletoe infestation affects the trees. You can clearly see the impact on nut density, which is dramatic for some cultivars.

"All this information can help growers make decisions about where to focus their eradication efforts."



Examples of different sized pieces of mistletoe being detected in the trees.

Estimating yield

The system can estimate yield from the nut count during scans. This data is calibrated with harvest results, and Matt says the accuracy looks promising so far, with estimates falling within 10% of the actual yield.

Since the system provides data at various scales, down to tree level, it can allow growers to look at correlations between soil and environmental conditions and nut density. Growers can pinpoint areas with low nut density, prompting further investigation into conditions in these patches.

Growth performance and management decisions

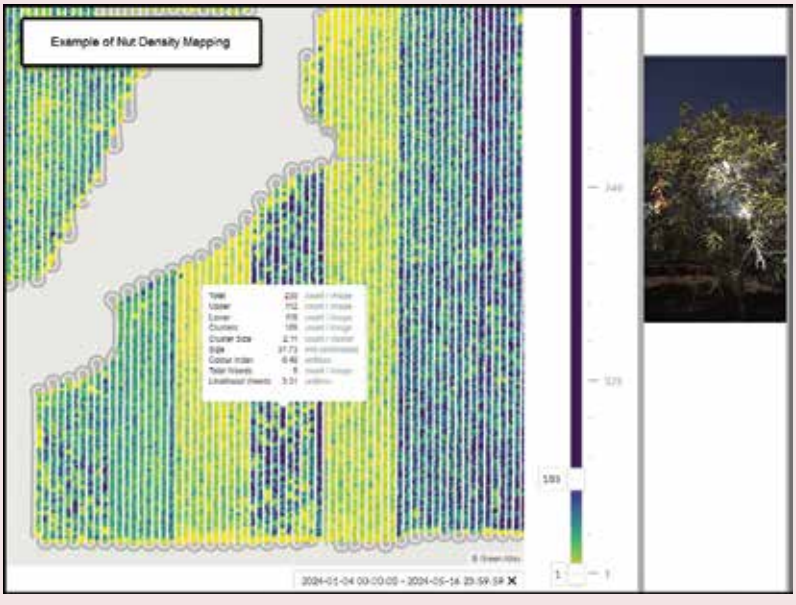
Using LiDAR, the system measures tree canopy geometry, including height, canopy area/volume, and density. This data helps assess health and growth performance and this too can be overlaid with other datasets, such as soil conditions, to identify potential problem areas. This information can help growers to define treatment zones and make informed decisions about operations such as spraying and pruning.

The system can also produce georeferenced contour maps that can be used by automated spraying units.

What's in store

As technology continues to develop, it could serve more functions, such as mapping flowering density and detecting blocked sprinklers, according to Matt. Over the coming years, services of this kind are likely to become more widely used, saving growers time and helping them to improve productivity.

The cost of scanning is $150 + GST per hectare.



Example of nut density mapping. The system can allow growers to look at correlations between soil and environmental conditions and nut density.

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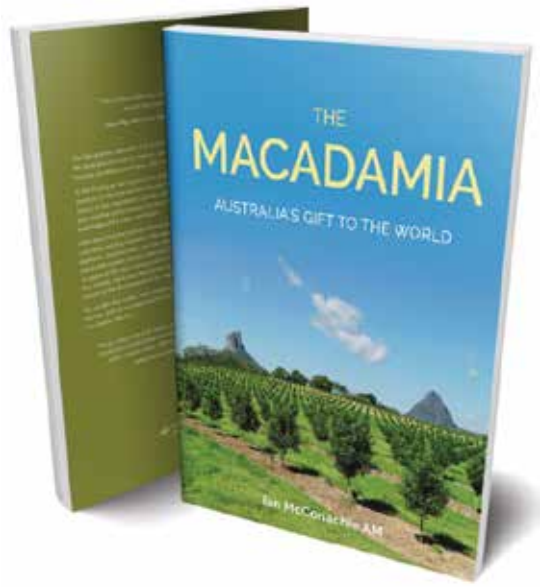
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BOOK REVIEW

The Macadamia – Australia's gift to the world

Denise Bond, Executive Officer, Macadamia Conservation Trust
P: 0488 432 226 | E: denise.bond@macadamias.org



Ian McConachie AM is a Member of the Order of Australia for services to the macadamia industry. He has unparalleled knowledge of the people and history of the industry, gained through his many contacts and friendships within the macadamia community. In The Macadamia – Australia's gift to the world, *he draws on 60 years of archival material and research to tell the story of the industry and the Australian native species that supports it.*

The prologue, "A life with macadamias", introduces Ian's lifelong passion for macadamia nuts and his dedication to the industry. From boyhood, he studied their botany, distribution and history, and he continues to find joy in learning about the species. His career as an industrial chemist, designer and builder of processing factories, grower consultant, macadamia farmer and cultivar breeder covered many aspects of the industry, including orchard management, quality control, harvesting, processing and storage. He joined the AMS in 1974, serving on the board for 30 years. While farming his own trees, Ian selected Australia's most popular new macadamia variety, MCT1, which he and his wife Janet gifted to the Macadamia Conservation Trust to support conservation efforts.

In Part 1, Ian outlines the evolution and botanical classification of macadamias and details their early use by Australia's First Nations people, including Aboriginal names and legends. He traces the discoveries of European explorers and botanists and the early settlers' enthusiasm for the nut. In Part 2, he recounts the challenges faced by pioneering farmers and marketers in the 19th century, explaining why the industry developed in Hawaii before booming Australia, growing from 40 to 60,000 t over 50 years. Part 3 chronicles the expansion of plantings in the 20th century, highlighting the industry's struggles, post-World War II investments and the roles of CSR and the AMS. Personalities and circumstances are shown to have shaped the industry as much as research and logic.

In the eye-opening Part 4, "The rest of the world", Ian documents efforts to grow macadamias in 44 countries, ranging from small-holder family plots in developing countries to commercial industries in 24 countries, including major competitors with Australia. Finally in Part 5, "Mac Facts" presents a fascinating collection of myths, trivia and anecdotes alongside some wise observations. In "The Future", Ian envisions the potential for the Australian and global macadamia industry to double or even triple by 2030.

Ian's goal in publishing this book is to provide a valuable resource for the continued development of the macadamia industry. The book includes a comprehensive index, allowing readers to follow subjects and individuals as they shape the industry's development. This beautifully presented, full-colour coffee table book has nearly 300 pages of text and illustrations. It is priced at $49.95 and can be purchased through Australian Scholarly Publishing (www.scholarly.com) and at selected Dymocks stores and other retailers.

Ian has gifted ownership of the book to the MCT with proceeds directed towards wild macadamia conservation.

Visit Australia Scholarly Publishing by scanning the QR code to purchase The Macadamia – Australia's gift to the world.



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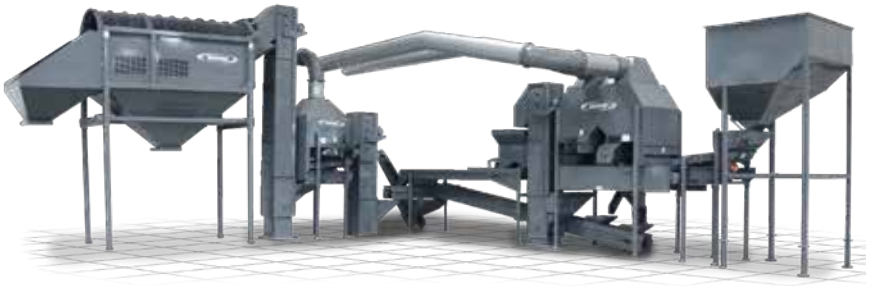
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Our experts at Savage Equipment have been crafting nut-cleaning machines for decades. We have also created designs for small and large-volume cleaning plants in many parts of the world. All of the equipment seen here comes in a variety of sizes. Let us know what size and configuration you need for your world-class macadamia cleaning operation.



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Nuts for Life update

Nuts for Life provides health and food service professionals with up-to-date information on the benefits and uses of nuts. Through resources like The Healthy Handful podcast, which covers topics such as sustainable macadamia farming, and the 'Cooking with Nuts' hub, they offer practical tools for incorporating nuts into everyday diets. Recent research, including findings on the potential role of nuts in brain health, continues to highlight the nutritional value of nuts, while new culinary resources aim to make nuts more of an everyday staple in kitchens across Australia.

NEW podcast episode: Sustainability in a macadamia orchard



Nuts for Life's monthly podcast, *The Healthy Handful,* aims to help busy health professionals stay up to date on all things nuts. It launched in late 2020, and now features 47 episodes.

In episode 47 of *The Healthy Handful,* macadamia grower Ross Arnett shares his approach to sustainable agriculture, and the simple, yet effective, practices he's established on Malua, his 10 ha orchard on the Alstonville Plateau.

He describes 'low input sustainable agriculture' (LISA), with its focus on sustainable farming practices, such as prioritising soil health. Drawing on guidance from mentors, Ross has continually refined his approach to LISA, and increased biodiversity with cover crops such as sunflowers and hemp. This has helped to minimise off-farm inputs and reduce the carbon footprint.

Macadamias also feature in some of our past episodes, including episode 39 where Jacqui Price, AMS Marketing Manager, discusses food trends, and episode 8, which covers sustainability in the macadamia industry, with former AMS CEO Jolyon Burnett.

You can find the Healthy Handful podcast on the Nuts for Life website: www.nutsforlife.com.au

Resources for food service professionals



Nuts for Life has been engaging with health care professionals for many years. Added to this key group, is a new target audience for our 2023–2026 program – food service professionals.

Earlier this year we launched the 'Cooking with nuts' hub on our website, with handy culinary resources, including fact sheets (e.g., Simple swaps for your favourite dishes), graphics (e.g., Storing nuts), and videos (e.g., How to make nut 'mince') – plus recipe inspiration.

We've now added 'Culinary guide to nuts' graphics (one for each nut type) to our suite of resources - and a booklet, which combines all the graphics.

Each graphic contains four sections:
- Flavour profile
- Pairs perfectly with . . .
- Get inspired!
- Did you know?

Launched to coincide with Nut Day (22 October), the graphics support health and food service professionals to inspire more Australians to use nuts in cooking.

Check out the 'Cooking with nuts' hub at: www.nutsforlife.com.au/cooking-with-nuts/

Research update: Nuts may help prevent dementia

Consuming nuts daily may help prevent dementia, according to new research published in the journal GeroScience.

The UK-based study analysed data from 50,386 participants, with an average (mean) age of 56.5 years, and without dementia, at the start of the study. They were tracked across seven years.

All-cause dementia (that is, Alzheimer's disease, frontotemporal dementia, or vascular dementia) was assessed at baseline and at follow-up. And a 24-hour dietary questionnaire at baseline was used to assess nut consumption.

At the end of the study period, the incidence of all-cause dementia was 2.8% (1,422 cases). Daily nut consumption was associated with a 12% lower risk of all-cause dementia, compared with not eating nuts. Digging deeper, nut consumption of *up to one 30 g handful a day, and unsalted nuts,* were linked with the greatest protective benefits.

Access monthly summaries of all the latest published nuts and health research, from the Nuts for Life website: https://www.nutsforlife.com.au/

Fact sheet: Nuts and brain health

Nuts, as a key component of healthy dietary patterns, have been linked with improvements in brain health, including:

- better cognitive function
- a reduced risk of depression
- better mood, and
- enhanced memory, learning and attention capacity.

Our newly updated fact sheet for health professionals sums up the evidence to date in this area, and outlines the protective nut nutrients that help support brain health.

It's free to download and print at: https://www.nutsforlife.com.au/resource/nuts-and-brain-health-fact-sheet/

About Nuts for Life

We're Australia's voice for the vital role nuts play in good health and nutrition. Nuts for Life is facilitated by the Australian Nut Industry Council in partnership with Australian nut industry members, from all sectors of the supply chain.

We are funded through Frontiers developed by Hort Innovation, with co-investment from the Australian nut industry, and contributions from the Australian Government.

Nuts for Life works closely with health and food service professionals, government, and other bodies to improve the nutritional reputation of nuts.

For more information visit www.nutsforlife.com.au, follow us on LinkedIn, or contact:
Belinda Neville, Program Manager, belinda.neville@nutsforlife.com.au

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Benchmarking provides sustainability insights

Shane Mulo and Grant Bignell, Queensland Department of Primary Industries

A recent survey, part of a sustainability pilot study, was carried out within the macadamia industry's latest benchmarking project (MC22000), led by Queensland's Department of Primary Industries.

The survey aimed to gather early insights into important sustainability issues, including orchard floor management, biodiversity, nutrition, pollination, and on-farm biosecurity. It also assessed the availability of data regarding resource inputs on farms, such as water, fuel, and energy. This information will help the industry benchmark performance not only by land area (e.g. tonnes per hectare), but also by resource use efficiency – such as the amount of nut-in-shell produced per unit of water, fuel, or electricity used.

The results of the survey will provide valuable information to the macadamia industry and will help the project team and the industry's Project Reference Group fine-tune the scope and focus of future data collection efforts. This will ensure that future benchmarking efforts are more targeted and can better support sustainable practices.

Survey responses

The survey drew responses from 112 participants, representing 183 farms from all major growing regions. Together, these farms accounted for 8,169 planted hectares and produced 26,030 t of nut-in-shell in 2022, which represents nearly 46% of the national macadamia production for that year.

Below is a summary of the findings, highlighting how they relate to the indicators within the 'Planet and Resources' pillar of the 2023/24 Horticulture Sustainability Framework.

Soil and orchard floor

Indicators:

- *percentage of farms with steady or improving organic carbon in topsoil*
- *proportion of businesses using management practices to maintain ground cover for horticultural plantings.*

More than 85% of respondents noted that their soil organic carbon levels were either steady or improving, while fewer than 15% of growers did not measure or were unaware of their soil's organic carbon levels. Furthermore, 39% of respondents had conducted soil mapping on their farms, which helps growers identify zones that may require varied management approaches or inputs such as nutrition or irrigation.

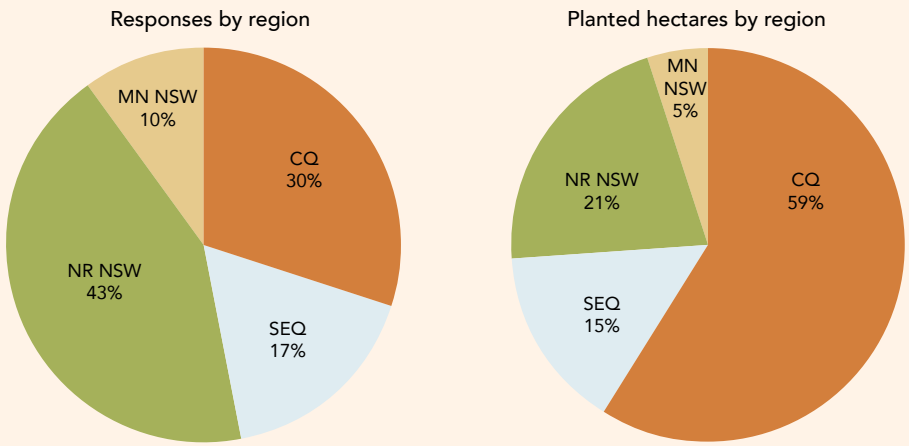
Most growers (89% of those surveyed) actively maintain groundcover.

Nutrition

Indicators:

- *percentage of farms with soil maps*
- *percentage of producers using a strategy to match nutrient use to crop needs*
- *the use of best practice to manage manures and composts.*

Effective nutrition management is a key focus for growers with more than 90% of respondents conducting



Survey responses and planted hectares and regions.

regular soil tests and nearly 70% performing regular leaf tests. Almost 90% of growers reported using an informed strategy to match nutrient inputs with crop needs. Additionally, 95% of respondents routinely apply organic matter such as manure, compost, wood chips, and tree prunings to their soil.

Orchard environment

Indicators:

- *the use of strategies to manage high-risk run-off areas*
- *percentage of businesses allocating land for conservation or protection*
- *objective measures guiding more efficient water use and the extent of these practices.*

Most growers are actively engaged in erosion management: 95% of respondents use erosion control strategies in high-risk runoff areas.

Some 70% of growers report setting aside land for environmental benefits and 64% undertake activities to encourage biodiversity on their farms.

Less than a quarter (23%) of respondents reported using objective measures such as soil moisture or water demand to inform irrigation and other management practices. Of this group, 17% use soil moisture and sap flow meters, while 6% use other methods. However, 73% of respondents, many of whom are from non-irrigated farms, do not monitor soil moisture levels.

Resource use

Indicator:

- *percentage of producers monitoring/reviewing use of electricity and fuel.*

More than 70% of growers can provide information about their electricity and fuel use.

Pollination

Indicator:

- *the demand for pollination services and practices to increase orchard pollinators.*

Most respondents (81%) use hives to improve pollination, recognising the benefit of pollinators for maximising nut set. Additionally, 43% of respondents are actively using strategies to attract pollinators to their orchards.

Biosecurity

Indicator:

- *percentage of producers with a biosecurity plan.*

Only 35% of respondents have a biosecurity management plan, although this figure increases to 66% when considered by planted area.

Guidance for growers

The survey was an initial scan to determine available data and current industry approaches to farm business sustainability. Based on survey findings the benchmarking team added key resource use metrics to its data collection for the 2023 season. A total of 146 farms subsequently provided data on applied fuel, water, electricity and gas, which was related to farm productivity to provide participants with insight into their relative resource use efficiency.

Where to now

The ability to demonstrate our sustainability and environmental stewardship as an industry is critical, particularly in a competitive global market. The project team will continue to refine and collect resource use and other relevant data to help industry demonstrate its commitment to sustainable production practices.

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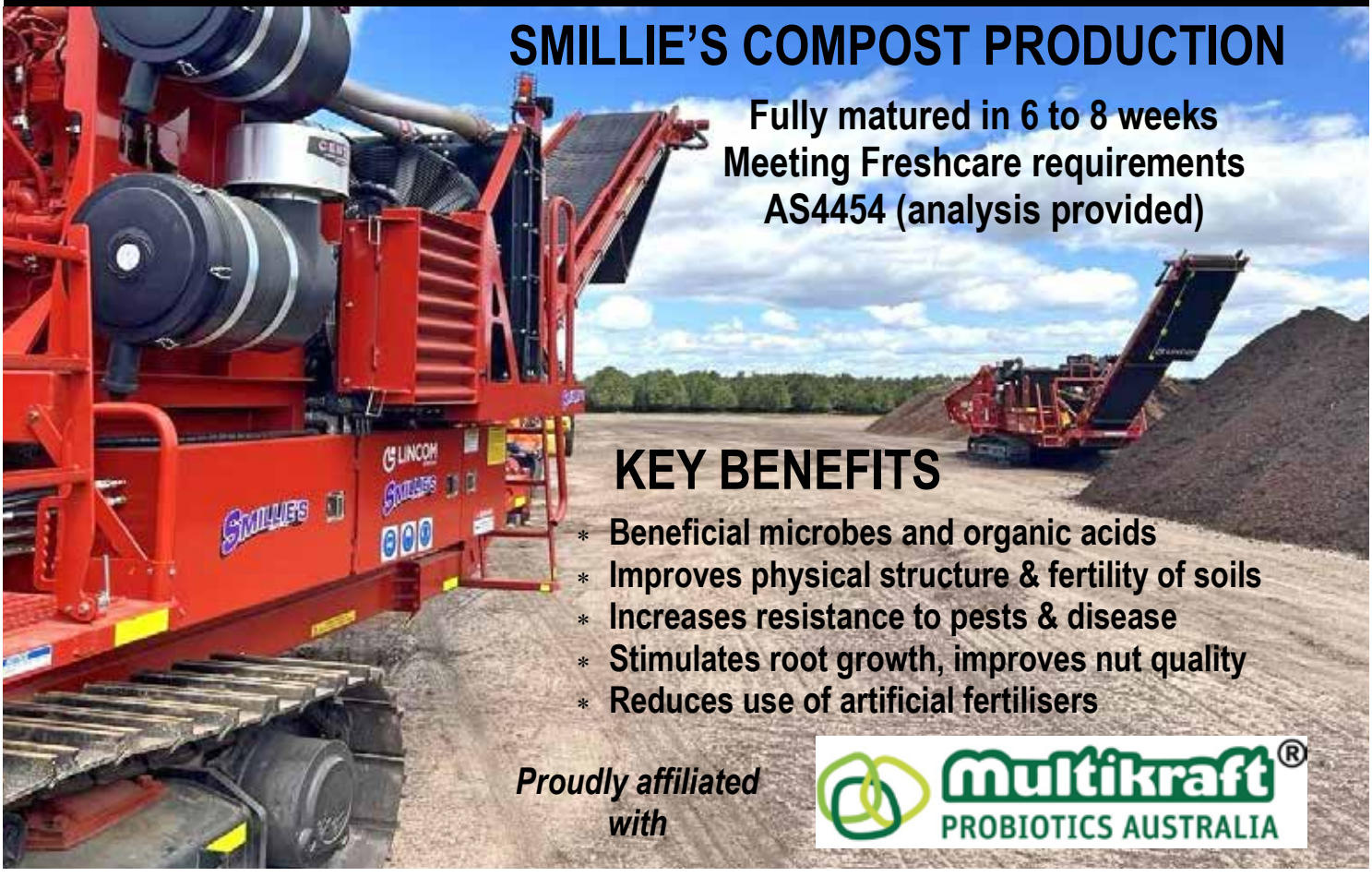
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Insights from the latest industry benchmarking data

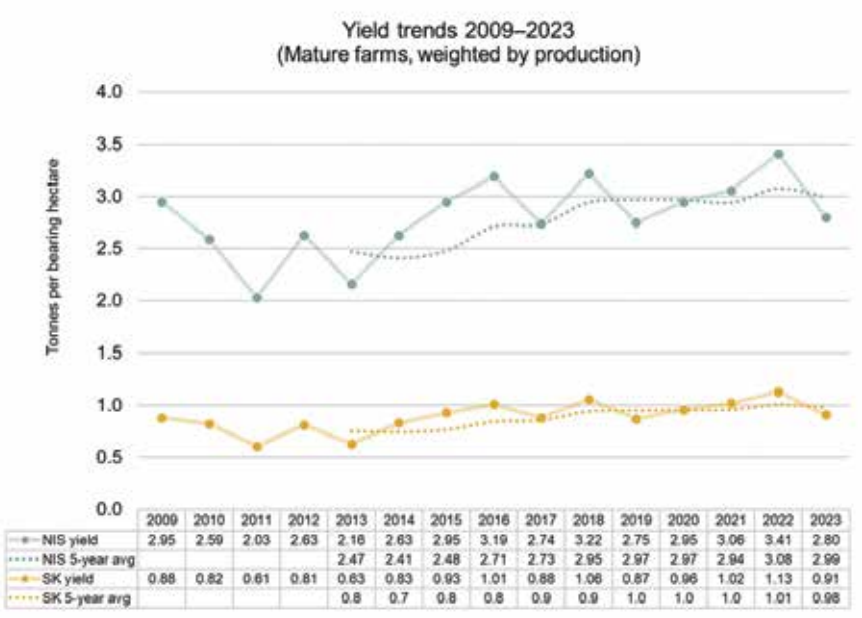
The recently released Macadamia Industry Benchmark Report *for the 2009–2023 seasons offers a comprehensive overview of trends in productivity, quality, costs, and resource use. This article highlights the key findings from the 2023 season as well as overarching trends since 2009.*

Region	Farms providing yield and quality data (%)	Average planted hectares	Total planted hectares (%)	Total bearing hectares (%)	Average tree age	Total tonnes of nut-in-shell (%)
Central Queensland (CQ)	60 (28%)	95	5704 (58%)	5283 (57%)	17	15,281 (60%)
South East Queensland (SEQ)	38 (18%)	36	1364 (13%)	1291 (14%)	27	4484 (17%)
Northern Rivers NSW (NRNSW)	96 (44%)	24	2330 (25%)	2246 (24%)	28	5003 (20%)
Mid North Coast NSW (MNNSW)	22 (10%)	19	419 (4%)	415 (5%)	26	884 (3%)
All regions	216	45	9841	9235	24	25,652

Table. *Summary of yield and quality data from 216 farms for the 2023 season*

In the 2023 season, data was submitted from 269 farms covering 13,050 ha. Of these, 216 farms (totalling 9,235 bearing hectares) provided yield and quality information, resulting in the production of 25,652 t of nut-in-shell (NIS) at 10% moisture content. Cost data came from 79 farms, encompassing 4,545 ha, while resource use data was contributed by 146 farms. The benchmark sample represented approximately 50% of national industry production in the 2023 season, based on the Australian Macadamia Society's total crop estimate of 51,903 t of NIS at 10% moisture content. This estimate is based on factory receipts of the Australian Macadamia Handlers Association (AMHA).

Figure 1 illustrates trends in nut-in-shell (NIS) and saleable kernel (SK) productivity for mature farms (10+ years). In 2023, average NIS yield was slightly below the long-term average of 2.86 t/ha, while saleable kernel productivity matched the long-term average of 0.91 t/ha. All production regions saw a minor decline in productivity, with Central Queensland experiencing the most significant drop, attributed in part to prolonged cloudy weather impacting nut development.



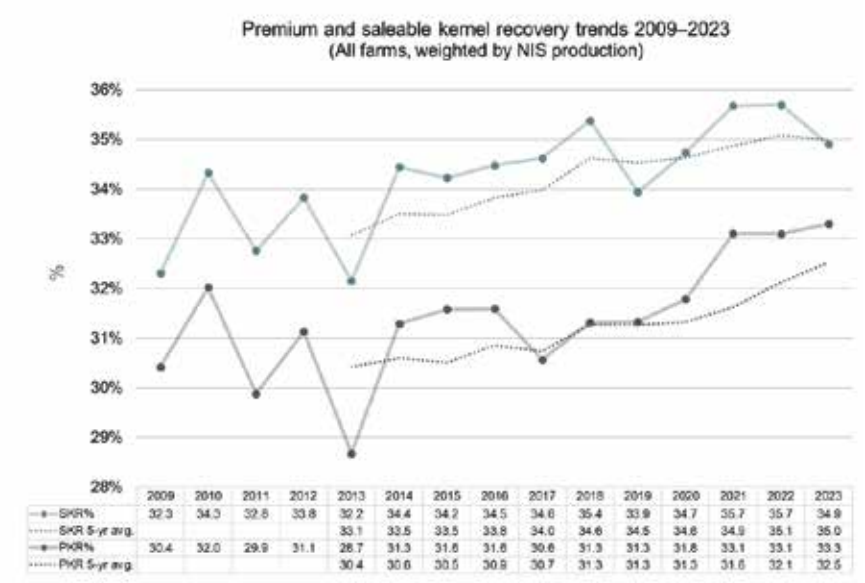
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NIS yield	2.95	2.59	2.03	2.63	2.16	2.63	2.95	3.19	2.74	3.22	2.75	2.95	3.06	3.41	2.80
NIS 5-year avg					2.47	2.41	2.48	2.71	2.73	2.95	2.97	2.97	2.94	3.08	2.99
SK yield	0.88	0.82	0.61	0.81	0.63	0.83	0.93	1.01	0.88	1.06	0.87	0.96	1.02	1.13	0.91
SK 5-year avg					0.8	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0	1.01	0.98

Figure 1. *Seasonal and five-year average nut-in-shell and saleable kernel productivity trends for 2009 to 2023.*

Figure 2 shows trends in saleable (SKR) and premium (PKR) kernel recoveries since 2009, while Figure 3 shows commercial (CKR) and reject (RKR) recoveries. The 2023 season recorded the highest premium kernel recovery since benchmarking began, while commercial and reject recoveries hit their lowest levels. While dry weather during harvest potentially contributed to lower-than-average commercial and reject kernel recovery, many growers also undertook extra sorting to avoid penalties associated with high reject levels.

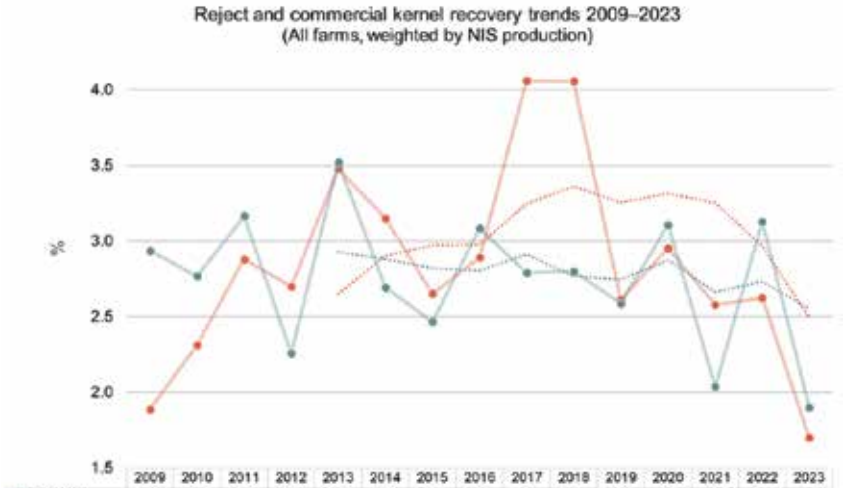
Figure 4 details factory reject trends for the benchmark sample. Categories include insect damage, mould, discolouration, brown centres, immaturity, and germination. Averages shown are weighted by NIS production, so farms with higher production exert more influence on the mean.

Insect damage and brown centres are the primary cause of factory rejects in most seasons. In 2023, the number of rejects was generally lower than in the previous season and below long-term averages, except for insect damage which has generally increased over time.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
SKR%	32.3	34.0	32.8	33.8	32.2	34.4	34.2	34.5	34.6	35.4	33.9	34.7	35.7	35.7	34.9
SKR 5-yr avg.					33.1	33.5	33.5	33.8	34.0	34.6	34.5	34.6	34.9	35.1	35.0
PKR%	30.4	32.0	29.9	31.1	28.7	31.3	31.6	31.6	30.6	31.3	31.3	31.8	33.1	33.1	33.3
PKR 5-yr avg.					30.4	30.6	30.5	30.9	30.7	31.3	31.3	31.5	31.6	32.1	32.5

Figure 2. *Saleable and premium kernel recovery trends for 2009 to 2023.*



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
CKR%	1.9	2.3	2.9	2.7	3.5	3.2	2.7	2.9	4.1	4.1	2.6	3.0	2.6	2.6	1.7
CKR 5-yr avg.					2.7	2.9	3.0	3.0	3.2	3.4	3.3	3.3	3.3	3.0	2.5
RKR%	2.9	2.8	3.2	2.3	3.5	2.7	2.5	3.1	2.8	2.8	2.6	3.1	2.0	3.1	1.9
RKR 5-yr avg.					2.9	2.9	2.8	2.8	2.9	2.8	2.7	2.9	2.7	2.7	2.6

Figure 3. *Commercial and reject kernel recovery trends for 2009 to 2023.*

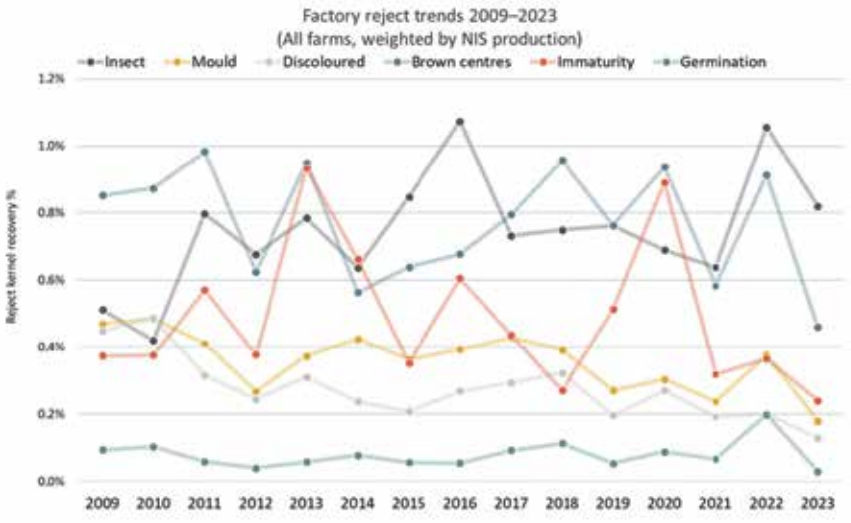


Figure 4. *Factory reject trends for 2009 to 2023.*

Figure 5 presents seasonal expenditure per planted hectare for mature farms that provided cost data. Average cash operating costs per hectare have increased by over 80% in the last decade and by 20% over the last five years. The seasons in which costs increased most significantly coincided with similar increases in NIS price.

Feedback from growers suggested the recent sharp decline in NIS price and associated reduced margins contributed a slight reduction in average expenditure in 2023.

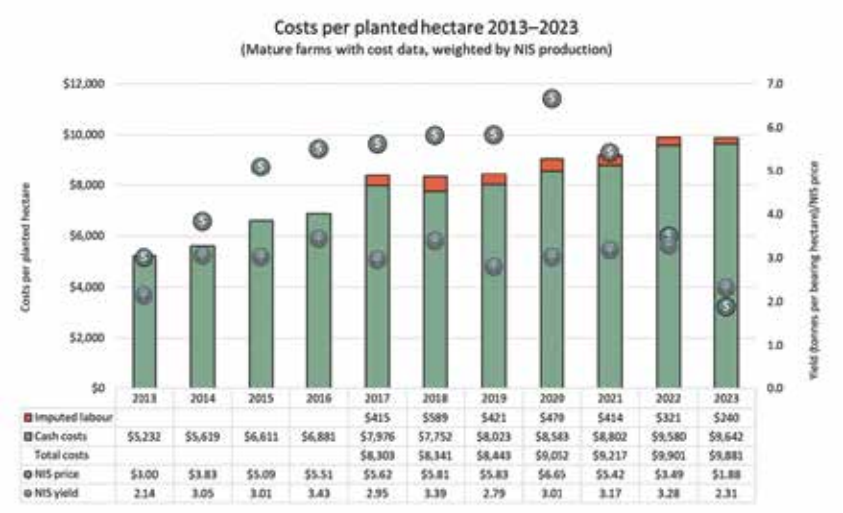


Figure 5. *Costs per planted hectare, yield and NIS price for 2013 to 2023..*

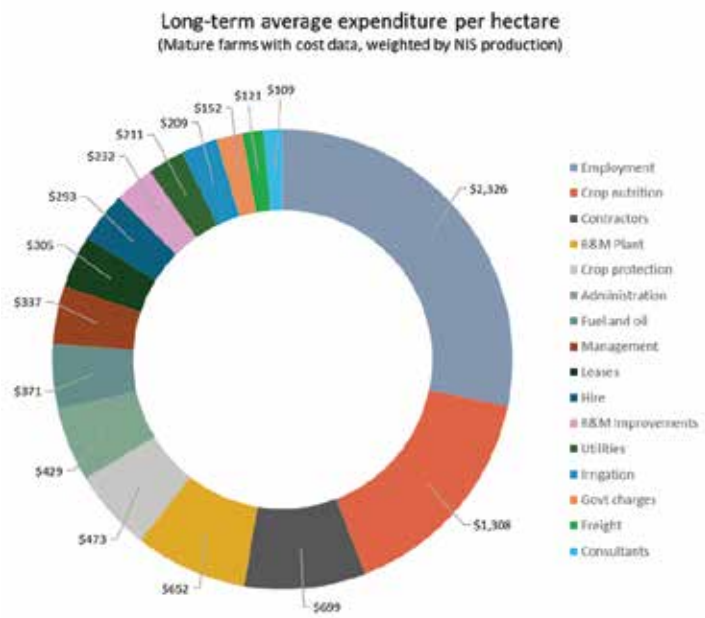


Figure 6. *Average operating costs for mature farms by heads of expenditure 2013-2023.*

Figure 6 highlights average costs across major expense categories from 2013 to 2023. The average cash costs for mature farms were $8,228/ha, with employment costs making up over 28% of total cash expenses, followed by nutrition (16%), contractors (9%), repairs and maintenance of plant (8%), and crop protection (6%).

Current benchmark participants will be contacted shortly as data collection gets underway for the 2024 season. To get started in benchmarking contact your local benchmark team member below. All you need is details of your plantings and seasonal consignments. You can provide your consignment details yourself if you wish, or alternatively the benchmark team can source these from your processor(s) with your consent. If you have any questions or would like further information don't hesitate to contact the team.

Queensland

Grant Bignell - QDPI:
grant.bignell@qld.gov.au
or 07 5381 1334

New South Wales

Jeremy Bright - NSW DPIRD:
jeremy.bright@dpi.nsw.gov.au or
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Benchmark your way to better production

Emily Grieve, Industry Development Officer, AMS, M: 0438 772 757 | E: emily.grieve@macadamias.org

Macadamia benchmarking snapshot

Free, levy-funded service available to all Australian growers

Participants receive a personalised, confidential farm benchmark report

The report compares productivity, quality, costs (optional) and resource use against similar farms, based on region, farm size and tree age

Free regional benchmark group meetings offer opportunities to network with local growers and discuss seasonal outcomes and farm management approaches.



Emily Grieve pictured with Jeremy Hutchings, Managing Director, Farm Owners Academy and Christopher Waring, Director and Manager of Australian Macadamia Operations, MWT foods.

Benchmarking in agriculture offers a clear, data-driven understanding of your farm's performance, replacing guesswork with precise insights. Armed with this knowledge, you can develop strategies to increase business performance. The industry's long-running and successful macadamia benchmarking project provides essential metrics for growers, helping them assess production and pinpoint areas for improvement. Simply put "If you don't measure, you can't improve".

In June this year, I had the opportunity to attend the two-day "Top Producers Program" run by the Farm Owner's Academy on the Sunshine Coast. The Farm Owners Academy teaches farmers the importance of examining their enterprises and comparing financial performance, offering advice from top-performing farm owners on how to avoid common business mistakes and master key skills. The workshop provides a blueprint used by the top 20% of farm owners to consistently outperform the average. The program places a strong emphasis on knowing your numbers and tracking key performance indicators (KPIs) through industry benchmarking, which are vital to the success of any farming business.

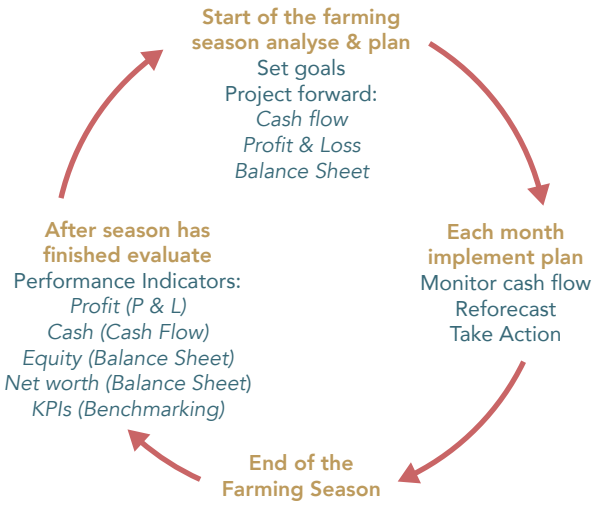
Chris Waring, director and manager of Australian MWT Macadamia Operations and MWT Agri, recognises the value of courses like those offered by Farm Owners Academy, which guide growers in understanding their production numbers and support on-farm decision-making. MWT is offering its growers the two-day Top Producers Program to equip them with the critical skills and insights needed to maximise productivity, improve financial performance, and ensure long-term sustainability in the macadamia industry.

In today's competitive horticulture and agricultural sectors, benchmarking and understanding the financial and operational metrics of a farming business are crucial for success. For macadamia growers, this means having a deep understanding of key performance indicators (KPIs) that directly affect productivity, profitability, and sustainability. Farm Owners Academy (FOA) provides practical courses to help farmers better manage their operations.

Benchmarking provides a decision-making tool

One of the key benefits of industry benchmarking is that it allows business model forecasting. As shown in the diagram (over page), KPIs gained from a benchmarking report allow analysis and planning for the next season.

According to Farm Owners Academy CEO, Sam Johnsson, successful farm owners share one vital skill that sets them apart: the ability to manage their numbers effectively. Top producers don't just understand their financials – they actively use them to make informed decisions throughout the season. By mastering this skill, they reduce guesswork and gain the confidence to tackle challenges and seize opportunities.



Common mistakes to avoid

While financial forecasting is essential, Sam points out that it's easy to make missteps that can undermine its effectiveness. He identifies six common mistakes that farmers fall into – and offers guidance on how to avoid them.

1. Assumptions not documented. Forecasting relies on assumptions around production, price, risk, and costs, which all drive the cash flow. These assumptions must be clearly documented to link them with decisions. When changes occur, this documentation makes your forecast actionable and allows you to adjust decisions based on accurate data.

2. Too much detail. Trying to predict income and expenses to the nearest dollar or having lots of line items in your cash flow forecast adds limited value and can obscure the bigger picture. Too much detail is a key reason why business owners stop using their cash flow forecast as a decision tool for their business; it takes too much effort to keep it updated. If you group small incomes or expenses together, this will remove the noise and allow you to stay focused on what drives your business.

3. Short timeframes. A useful forecast should span three to five years in annual increments and at least 12 months ahead in monthly increments. If you don't do this, you risk short-term decision-making that does not account for the impacts of current decisions on future cash flow. Many changes, such as responses to drought, take two or three seasons to see the full effect.

4. Irregular updates. Your forecast should be updated at least monthly. Consistent updates allow you to respond to changing conditions and capitalise on opportunities. Once set up, this can take as little as 30 minutes each month, yet it's a powerful tool for staying on track.

5. Poor structure. Ensure your forecast is designed as a decision-making tool. It should clearly track cash inflows and outflows and allow you to calculate key performance indicators (KPIs). This structure helps you understand whether your business is on target.

6. Not tailored to your business. Your forecast should be for you, not just the bank or accountant. Using a template designed for others might not align with your business needs. The goal is to have a tool that helps you manage your farm effectively.

Mastering the numbers

The good news is that no one is born with the skill of mastering their numbers – it's a learned ability. By committing to this skill, farm owners can improve their performance, reduce uncertainty and make more confident decisions.

To paraphrase Henry Ford, "to learn is to stay young". Developing a financial forecast that works for your farm is a key step toward long-term success.

Free benchmarking service for levy payers

Macadamia levy payers can access a free service that helps in understanding production numbers and guiding future decision-making. If you are not benchmarking yet and would like to get started, simply contact your Benchmark team member below. All you need are details of your orchard and seasonal consignments, which can be sourced from your processor(s) with your consent. For any questions or further information, contact Grant or Jeremy.

Queensland

Grant Bignell (QDPI)
grant.bignell@qld.gov.au
07 5381 1334

NSW

Jeremy Bright (NSW DPIRD))
Jeremy.bright@dpi.nsw.gov.au
02 6626 1346

Information. To learn more about how FOA can support you:

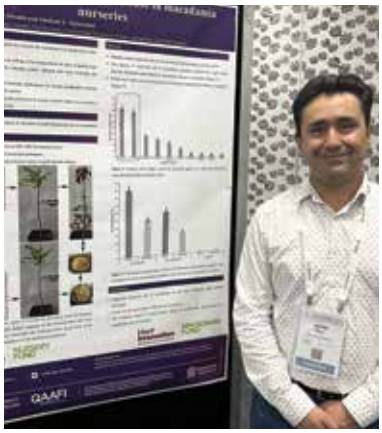
- book in for a complimentary coaching call to uncover the next steps to take control of your business: www.farmownersacademy.com/coaching
- attend the upcoming Top Producers Event on the Gold Coast 24-25 February 2025: www.farmownersacademy.com/event
- visit www.farmownersacademy.com/ or call 0447 184 167

A sneak peek at projects from the AusMac2024 research hub

New to the program at AusMac2024 was a research hub, where researchers working on projects presented information about their projects and outlined progress and implications of their findings for growers. Feedback about the research hub was positive, so to make sure those who were not able to attend the hub or the conference don't miss out on what is happening in the macadamia research world, we are summarising presentations from nine researchers, four in this edition of the News Bulletin and five in the Autumn 2025 edition.

Phomopsis graft dieback disease in macadamia nurseries

Research team. Jahangir Khan, Andre Drenth and Olufemi Akinsanmi, Centre for Horticultural Science, QAAFI, The University of Queensland.



Jahangir Khan presented an update on his team's research into Phomopsis.

Project snapshot

Graft dieback disease has significant implications for macadamia nursery profitability and nut yield. The goal is to determine the source of graft dieback disease in macadamia plants so nurseries can optimise hygiene practices and potentially trace back infected scion source stock and reduce further spread and thereby improve the success rates of healthy seedlings. Two key plant pathogens, *Diaporthe litchicola* and *D. australiana* are indicated as key causes of graft dieback, with the scion as the main site of infection.

Identifying the cause of graft dieback

Graft dieback is a common limiting factor in the success of grafting healthy macadamia plants. It leads to the wilting of young scion shoots of grafted trees.

Once the cause of the dieback is understood, nurseries can take measures to address it and reduce the high rate of plant loss that growers experience. This will also have economic benefits, saving the costs of replacing failed plants and reducing the spread of disease to healthy plants in an orchard.

The fungal pathogen *Phomopsis*, also known as *Diaporthe*, has been found to cause graft dieback in other tree plants and is the most likely culprit in macadamia plants. Among the over 1,165 known species of *Diaporthe*, a dozen or so are found to cause diseases in tree plants. They can also live in the plant for a substantial time before causing any damage if the plant is stressed, as it is during grafting.

Research progress

Researchers gathered samples over three years in the 2021-2023 seasons from five major nurseries in Australia. They dissected each plant, isolating the pathogens of symptomatic plants. Next, they separately infected rootstocks and scions of healthy grafted plants with the fungus to determine the main site of infection.

The researchers found multiple fungal *Diaporthe* species in the symptomatic macadamia plants. Two pathogens - *Diaporthe litchicola* and *D. australiana*, were found to be the main culprits in macadamia causing large lesions and graft dieback disease symptoms.

Implications

Infected scions were found to be a major source of the disease in nurseries.

The researchers also saw higher dieback symptoms in summer and winter, when plants were more stressed by extreme temperatures. This suggests that autumn and spring are ideal times to conduct grafting to optimise success and reduce losses.

To reduce the spread of infection, researchers say that nursery operators should ensure all tools have proper sterilisation between each plant grafting, which means cleaning the tools after each plant.

Growers should record the sources of scion and rootstock to assist nurseries in tracing back the source of infection and ensuring those sources are not used for further grafting.

Next steps

The researchers will examine how nurseries can manage and develop a test to detect the presence of *Diaporthe* pathogens in health-looking or suspicious plant materials for grafting. This will allow nurseries to reduce issues of infected plants, avoid further spread

of the pathogens and reduce plant loss. The overall goal is to increase knowledge about graft dieback disease to support decisions for nursery operators so that growers can be confident of receiving healthy grafted trees entering their orchards.

The impact of extreme weather events on Scolytid beetle activity

Research team. Saleh Adnan, Craig Maddox, Jeremy Bright and Kevin Quinlan, NSW Department of Primary Industries and Regional Development, and Jay Anderson, Southern Cross University.

Project snapshot

Scolytid beetles can damage or kill macadamia trees, though the exact mechanisms of damage and the possible role of pathogenic fungus they carry remain unclear. This two-year project is investigating how bark beetles impact macadamia crops.

The researchers found that while some Scolytid species carry fungi, others do not. The study found that as well as damaging the bark and stems, bark beetles penetrate through the leaf axis, causing substantial leaf drop. Extreme weather, particularly prolonged wet conditions, can waterlog trees of all ages, making them more vulnerable to attack.

The findings underscore the importance of maintaining healthy trees to reduce vulnerability to insect infestation, particularly after extreme weather events. Early monitoring and management of bark beetles following such events is recommended to reduce both their impact and the cost of replacing trees.

Impact of bark beetles

In the Northern Rivers region, pest insects have substantially reduced macadamia yields in recent seasons. Populations of Scolytid (bark) beetles, in particular, have increased, but the nature and extent of their impact on macadamia tree health and productivity remains unclear.

Bark beetles feed through bark and stems, and females lay numerous eggs in the cambium layer beneath the bark, leading to ringbarking damage from larval feeding. There are other beetles that damage nuts as well, reducing the yield. Researchers suspect that the beetles may carry fungi in their mouthparts that could infect or kill macadamia trees.

Understanding how bark beetles cause damage and which factors make trees more susceptible is essential for developing effective pest management strategies.

Studying Scolytid beetle impacts

Researchers in this project addressed two main questions:

1. Do waterlogged trees harbour more Scolytid beetles?
2. Do Scolytid beetles carry fungus that can damage trees?

Researchers surveyed Scolytid beetles on young and old trees from farms in the Northern Rivers region in the 'normal' 2017 and post-flood 2023 seasons. They also dissected beetles to culture and grow fungi found in mouthparts. To determine the impact of beetle activity and fungi damage, the researchers then exposed healthy trees to six species of bark beetle and different fungi under field conditions at the Alstonville Centre for Tropical Horticulture.

Research outcomes

The researchers recorded seven species of Scolytid beetle on the farms. As well as being present on the bark and stems, the beetles damaged the leaf axis, leading to substantial leaf drop, stressing the plant and reducing photosynthesis and yields.

Importantly, they found an almost 20-fold increase in beetle numbers in the post-flood 2023 season, compared with the 2017 season. The results indicate that trees that were waterlogged and stressed become vulnerable to attack. Experimental branches of healthy trees had low or no infestation of both beetles and fungi, indicating that healthy trees can largely withstand beetle attack.

In future, the researchers plan to expose stressed trees to bark beetles and associated fungi to understand how they damage trees.

Implications

Early monitoring and management of bark beetles after extreme and prolonged weather events is critical to prevent damage to vulnerable trees.

Feeding the bees: supplementary feeding of native stingless bees in macadamia orchards

Research team. Claire Allison, James Makinson and James Cook, Hawkesbury Institute for the Environment, Western Sydney University

Claire Allison is a member of a Western Sydney University research team identifying ways of improving the health of native bee colonies kept in macadamia orchards.



Claire Allison is a member of a Western Sydney University research team identifying ways of improving the health and size of native bee colonies.

Project snapshot

With *Varroa destructor* mite threatening honeybee populations, native stingless bees are emerging as an important alternative pollinator for macadamia crops. Larger, healthier colonies can increase pollination, so it's important to find ways to help these bee populations thrive.

This project investigated the use of supplementary feeding and its impact on colony health. Early results show that providing sugar solution seems to be effective in improving colony size and productivity. Providing extra cover crops, particularly on large conventional farms with limited natural cover crops, may improve the size and health of hives.

Background

Pollination is critical for maintaining and improving yields in macadamia crops. Native stingless bees are active all year round and have become a popular additional pollinator to honeybees, which are under threat from *Varroa destructor* mite.

The larger the healthy colony, the more pollination activity can occur – but sufficient floral diversity is needed to maintain large colonies. Orchards may not consistently provide enough floral diversity to sustain large, healthy stingless bee colonies.

Project progress

Researchers set up control and experimental hives on eight orchards in the Northern Rivers, NSW from November 2023 to October 2024. Four orchards had cover crops that provided floral resources and four were control orchards without cover crops.

The bees were given either sugar solution on its own, or sugar solution and commercial bee supplements (Dynavyte or Vitahive). Control hives were left to forage normally.

The health of the colonies was measured using different methods, including by the weight of the hives and the brood circumference.

Early results show that hives fed the additional sugar solution gained more weight, particularly with the addition of the pre-and probiotic Dynavyte solution. The researchers suggest that providing additional floral cover crops may be more beneficial in large conventional orchards that have limited natural floral plants.

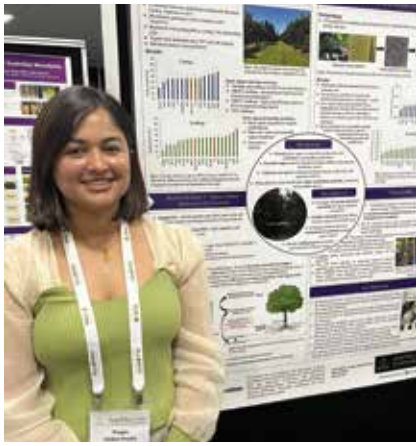
More research is needed to better understand the effects of the brood-boosting supplements. Researchers also plan to study the key pollen species collected and how foraging activity varies between hives. This will help growers select the most beneficial cover crops and provide insights into the role of stingless bees in macadamia pollination.

Implications

The early findings suggest that growers could provide supplemental sugar solution to help sustain the size and health of stingless bee colonies.

Vigour in macadamia: Genetic and physiological insights into rootstocks

Research team. Pragya Dhakal Poudel, Lindsay Shaw, Bruce Topp and Mobashwer Alam, Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland.



Pragya Dhakal Poudel is helping to investigate macadamia vigour.

Project snapshot

Macadamia vigour is a challenging issue that can limit growers' productivity and profitability. This project is evaluating 24 rootstocks for potential development of productive dwarfing trees to allow for higher tree density in orchards. One wild and a few selections from the national breeding program have been identified as potential dwarfing trees.

The problem of macadamia vigour

The naturally large size of macadamia trees presents a challenge for growers as it limits tree density in an orchard, thereby capping production efficiency, yield and profitability. Excessive vigour can lead to overcrowding and shading, which causes loss of groundcover and erosion, and reduced access for machinery. Managing vigour is costly and labour intensive and can reduce yield. To increase macadamia tree density, the problem of vigour needs to be addressed.

Project process

This project looked at possible rootstocks that could be developed to control vigour with targeted genetic selection – with dwarfing trees and smaller breeds being ideal.

The project had four aims:

1. Investigate the genetics of rootstocks for vigour control.
2. Evaluate rootstocks for their effects on scion vigour and stomatal traits.
3. Investigate possible molecular mechanisms of rootstock control.
4. Identify potential genes associated with rootstock vigour control.

Researchers established a trial at the Maroochy Research Facility in 2017, with ongoing evaluation of 24 rootstocks and a common scion. The rootstocks included common commercial cultivars, commercial rootstocks, various selections from breeding program and wild species.

The researchers measured the canopy volume of four-year-old trees. BDW3 seedlings, a potential dwarf selection from the national breeding program, showed the lowest canopy volume of all the rootstocks. Other rootstocks that had lower canopy volumes were:

- BHY3 cuttings and BHY4 seedlings, also selections from the breeding program
- A16 seedlings
- both seedlings and cuttings of wild *M. jansenii*.

Next, stomatal density was measured to assess to what extent vigour-controlling rootstocks compensate for their smaller canopy by limiting the number of stomata. Lower density of stomata indicates less capacity for photosynthesis and gas exchange, which may reduce productivity. Surprisingly, *M. jansenii* cuttings and BDW3 seedlings recorded some of the highest stomata densities, suggesting they can maintain high productivity with their smaller canopies.

Researchers also investigated the molecular mechanism associated with vigour control using three larger grafted trees and four smaller ones. They found that dwarfing rootstocks had a higher expression of the plasma intrinsic protein (PIP) genes, which regulate water transport efficiency – indicating that the dwarfing rootstocks may have improved resilience and water efficiency.

Next steps

Researchers will continue to evaluate the 24 samples until age seven, and test with multiple scions before making recommendations for rootstocks. From the results so far, they have selected candidate rootstocks for the next series of testing. They also aim to genotype all 24 rootstocks to identify genetic markers associated with plant vigour. These genes could then be used to genetically enhance new plants to improve water efficiency and resilience.

Implications

The results so far suggest that rootstocks wild *M. jansenii* cuttings, BDW3 and A16 seedlings are possible options for dwarfing rootstocks as these have less canopy volume compared with industry standard rootstocks 'H2' and 'Beaumont'. Rootstocks such as *M. jansenii* and BDW3 may also have better water efficiency. Moving to these alternate species may increase the productivity and profitability of orchards.

Researchers found that PIP genes are involved in overcoming water stress, so vigour-reducing stocks with higher expression of these genes could perform better under stress.



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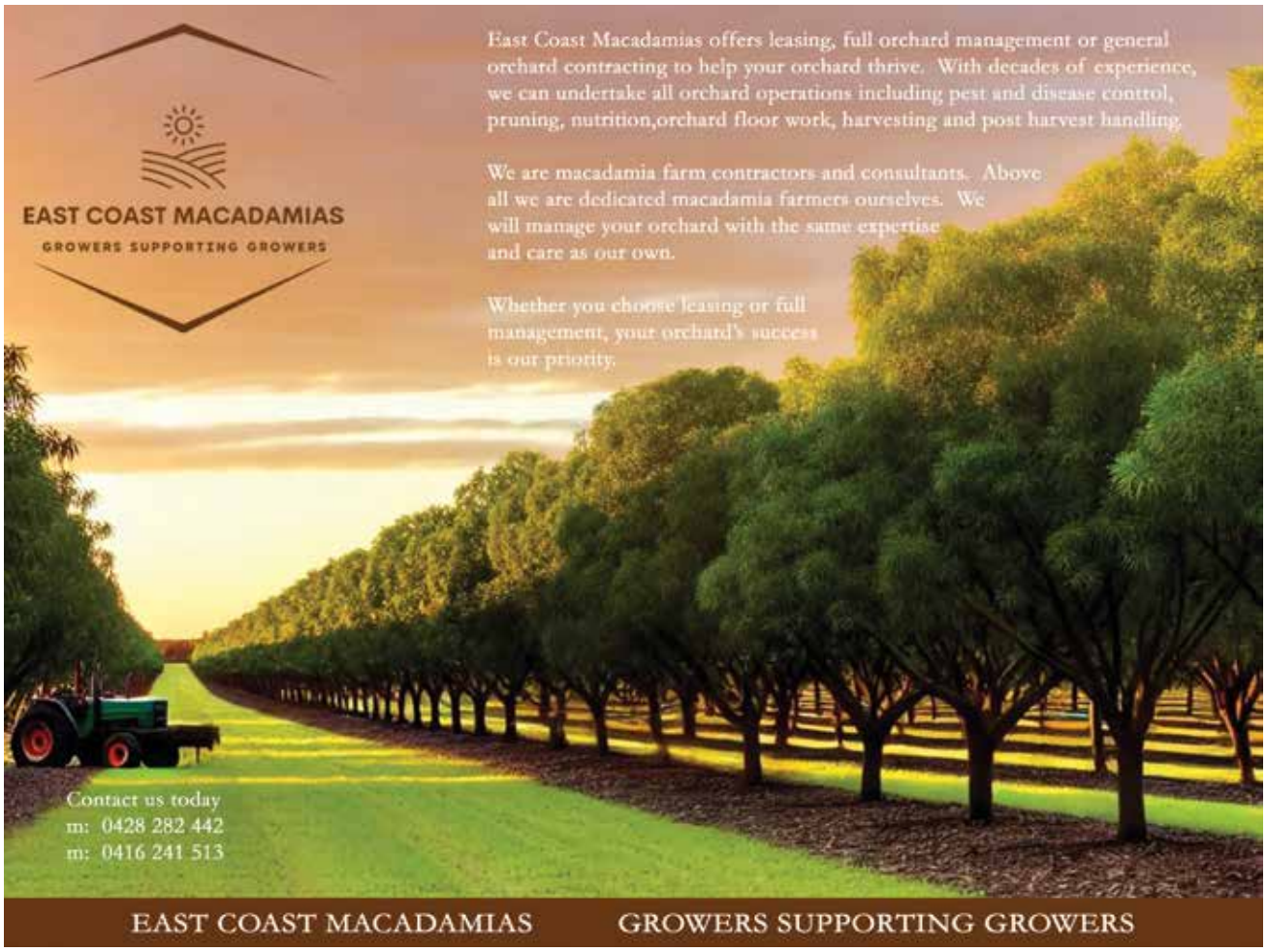


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Bioeconomics of macadamia pest management – current status

Bishwo Mainali, Jarrah Coates, Chris Fuller, Chris Themsen, Earl Yandall, Christopher Carr, Syed Rizvi, George Revell, Carles Amat Gomez, Karol Kozyra, Tania Yonow and Darren Kriticos

Project snapshot

A five-year collaborative research project, led by Macquarie University and partners, is developing a decision support system (DSS) for pest management in the macadamia industry.

The project targets five pest species: banana spotting bug (BSB), fruit spotting bug (FSB), macadamia seed weevil (MSW), *Leptocoris,* and lace bugs. It aims to create bioeconomic models that combine biological, environmental, and economic data for pest control.

Researchers are modelling the phenology of macadamias and pests, helping to pinpoint the best timing for pest management actions.

An initial stocktake revealed major gaps in existing knowledge, which are being addressed through field trials and lab experiments, including thermal threshold trials for pests like FSB and Leptocris.

The role of generalist predators in pest control is being studied, with early results showing that farms with lower spray regimes have higher predator diversity, potentially enhancing natural pest control.

Key progress includes the development of preliminary models for pest and crop phenology, along with ongoing trials to better understand pest population dynamics and inform management strategies.

A collaborative five-year project, led by Macquarie University with partners Cervantes Agritech, AgEcon, Agreco Australia, Agronica, Nutworks and Coates Horticulture, is tackling the complex pest management challenges in the macadamia industry. The project is approaching its halfway mark.

This article outlines the project's scope and progress as it works to develop the research foundations for an operational decision support system (DSS) targeting key macadamia pests. The system aims to identify optimal pest management strategies by improving our understanding of pest biology, population dynamics, and economic impact, ultimately promoting more efficient and sustainable practices.

Scope and aim of the project

The primary aim of the project is to develop bioeconomic models for five key macadamia pest species: banana spotting bug (BSB), fruit spotting bug (FSB), macadamia seed weevil (MSW), *Leptocoris,* and lace bugs. The models will integrate biological, environmental, and economic data, including the timing and cost of chemical applications, to provide optimised solutions for growers.

A central aspect of the project involves modelling the phenology of macadamia alongside that of the pests. Incorporating plant phenology into insect models improves accuracy by aligning insect life stages with the availability of their food and habitat, enabling better predictions and management.

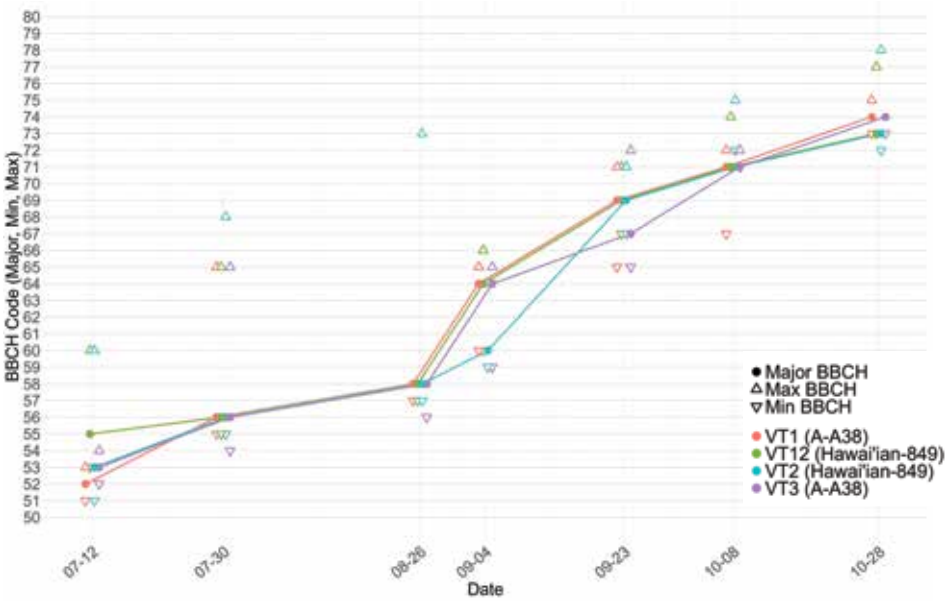


Figure 1. *Phenology for Knockrow farm. The majority BBCH value of the tree indicated by circles and line; maximum and minimum BBCH values indicated by upwards and downwards facing triangles, respectively. BBCH 51- Inflorescence or flower buds visible, 60- first flowers open, 69 - end of flowering, fruit set visible, 74 - 40% of fruits have reached final size or fruit has reached 40% of final size.*

Information stocktake and knowledge gaps

The project began with an extensive stocktake of publicly available information on the five key pests and *Anastatus* sp., an egg parasitoid considered to be a crucial biocontrol agent for FSB/BSB. During this process, we identified major knowledge gaps across all six species.

Progress

Sampling. The first-year sampling was a pilot phase, during which we addressed practical difficulties in obtaining reliable data. This season we are using the BBCH scaling system, a standardised method commonly applied in other crops, to describe the main phenological stages of trees (see Figure 1). The BBCH scale provides a framework for identifying growth stages, making it easier to align pest management strategies with specific stages of crop development.

Some of the key pests in the study are difficult to find and quantify using standard visual search methods. For instance, anecdotal evidence suggests that *Leptocoris,* FSB and BSB tend to prefer the upper canopy. To address this, we used drop-sheet sampling to learn more about the phenology of these key pests and their natural enemies. This sampling also revealed various biodiversity patterns of insects within macadamia orchards. We are currently analysing the data, and this season, drop sheet samples are being collected more intensively to provide further insights.

Lace bugs. Due to the lack of economic data on lace bug damage suitable for modelling, a pilot field cage study is being undertaken at Malua Farm, Northern Rivers. The study aims to capture data on the pest's biology, including reproduction, fecundity, and longevity, as well as the damage it causes. The findings from this trial will be crucial for improving management strategies and understanding the per capita impact of lace bugs on macadamia yield.



Cage trials at Malua farm. Early instar lace bugs are released in the cages to record their development, reproduction and longevity.



One trial is investigating how temperature affects the development, reproduction, fecundity and longevity of BSB/FSB.

Banana spotting bug/fruit spotting bug. We used the first season's field data to inform the modelling of FSB populations in orchards. In addition, we are running a thermal threshold trial at Macquarie University to observe development, reproduction, fecundity, and longevity at five temperatures (15, 20, 25, 30 and 35 °C). We also plan to assess the effects of low, medium, and high relative humidity on their development and reproduction. Understanding how temperature influences insect development and survival is vital for modelling their population dynamics.

Macadamia seed weevil. Since there is no published data on the thermal biology or reproduction of MSW, we are planning laboratory experiments and a field cage trial to gather essential information.

Leptocoris. A thermal biology experiment on *Leptocoris tagalicus* was completed at Macquarie University, examining development, reproduction, fecundity, and longevity at six different temperatures (10, 15, 20, 25, 30, and 35°C). The trial found that:

- males survived for more than five months at 25 °C
- eggs did not hatch at 10 °C, 15 °C or 35 °C
- neonate mortality was significantly higher at 35 °C, where the rate exceeded 80%
- egg viability was significantly higher at 25 °C than at 20 °C and 30 °C.

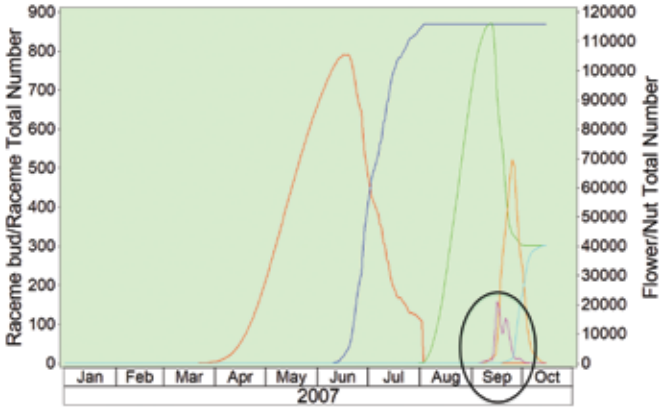


Leptocoris tagalicus *in growth chambers for thermal biology studies*

A feeding trial revealed that *L. tagalicus* can develop to adult solely on macadamia, but with an extremely low survival rate, suggesting that they might switch hosts to improve developmental and reproductive success.

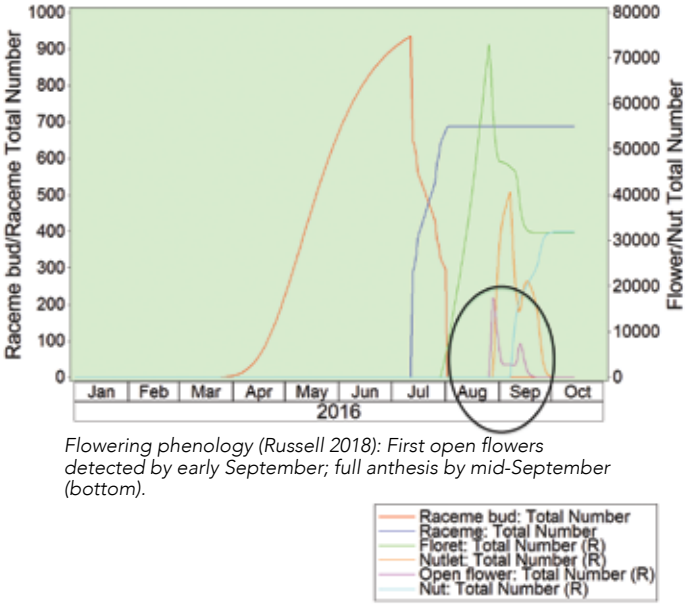
Anastatus. Macquarie University is conducting a trial to evaluate the efficiency of *Anastatus*, sourced from Bioresources Pty Ltd and reared to the second generation on BSB eggs. The trial measures parasitism rate, developmental time, adult emergence, sex ratio, and adult longevity on BSB eggs and is expected to be completed by November 2024. Once thermal threshold trials for FSB/BSB are completed, a similar experiment for *Anastatus* will begin, as these trials require at least five controlled growth chambers per species. Additionally, sentinel egg cards are being deployed in the field to intercept other potential parasitoids, such as *Ooencyrtus* sp. and *Gryon* sp., to further assess their effectiveness and commercial viability.

Alstonville 2007



Flowering phenology (McFadyen et al. 2012): Approximate time of anthesis on 4-26 of September, depending on macadamia variety.

Alloway 2016



Flowering phenology (Russell 2018): First open flowers detected by early September; full anthesis by mid-September (bottom).

Figure 2. *Simulated macadamia flowering phenology for Alstonville and Alloway.*



Anastatus *laying eggs (parasitising) on BSB eggs.*

Generalist predators for pest control

In addition to pest-specific research, the project also considered the role of generalist predators in macadamia orchards. Early- and late-season surveys documented the invertebrate community, and genetic techniques were used to identify the prey of these predators.

The study found that spiders, lacewings, ants, coccinellid beetles, hoverflies, assassin bugs, damsel bugs, mantises, and katydids are potential predators for controlling macadamia pests. Farms with lower spray regimes had a higher diversity of predators compared with those with more intensive spraying. Predator-prey experiments showed that these species generally reduced pest numbers, either alone or in combination with others. Green lacewings *(M. signatus)* were unmatched in reducing aphid, fall armyworm, and lace bug nymph populations. While these predators show potential for pest control, augmented releases may be needed for full effectiveness.

Models

Several preliminary models have been developed, including:

- **Macadamia phenology model.** This model simulates flowering phenology across different locations (see Figure 2). Its output has been compared to published information on flowering phenology at numerous locations, and the model performs very well.
- **Fruit spotting bug population model.** Since the drop sheet collections found few spotting bugs per tree, the model now includes a feedback mechanism that limits population growth when there are five or more FSB per tree. This feedback simulates how the FSB population is affected by crowding – essentially, when too many bugs gather on a single tree, their population growth slows

due to limited resources. The model shows how FSB populations behave under different climatic conditions: in Northern New South Wales (NNSW), population growth is limited by temperature, while in North Queensland it is constrained by density (Figure 3). In Bundaberg, as populations rise, reproduction slows to keep the population below the estimated carrying capacity (blue line).

- **Lace bug model**. The lace bug model shows exponential population growth, highlighting the importance of timely management interventions (Figure 4). These simulations confirm farmers' observations that quick action is needed to prevent population explosions. We are conducting field experiments to better understand environmental or resource limitations that may influence maximum lace bug population size and their per capita damage.

Information. For more information, contact Dr Bishwo Mainali: Bishwo.Mainali@mq.edu.au

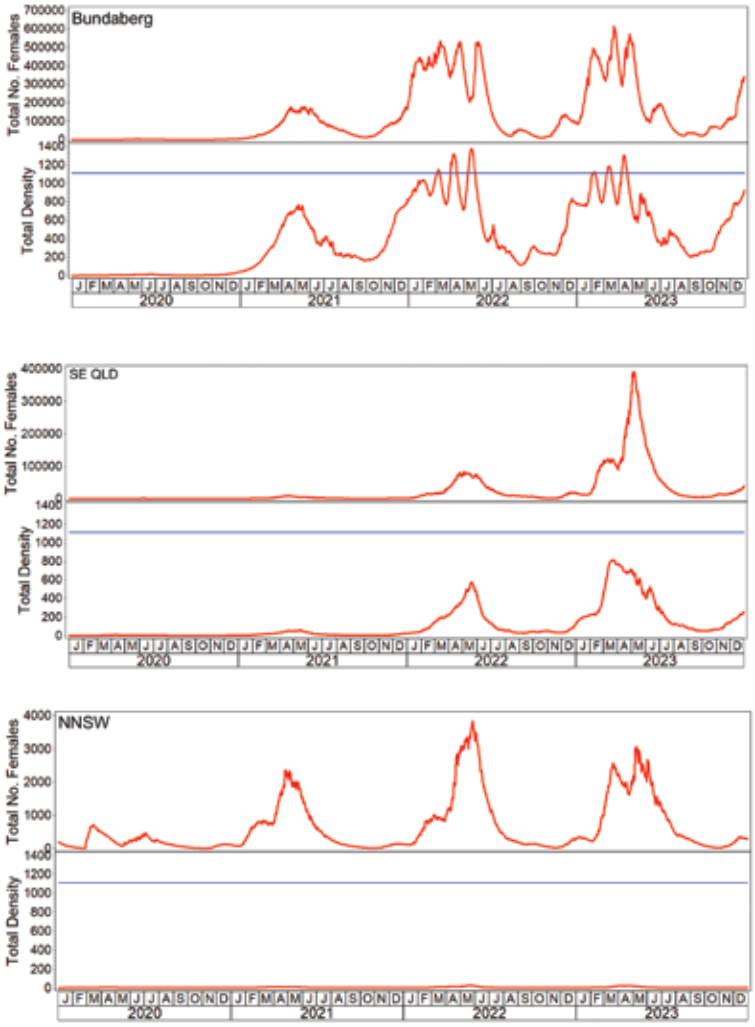


Figure 3. *The FSB simulation graph illustrates population dynamics across different life stages over multiple years. The simulations are identical, with variations only in the meteorological data used.*

Panel 1:
FSB Females
Panel 2:
Total FSB Density
Maximum FSB Density

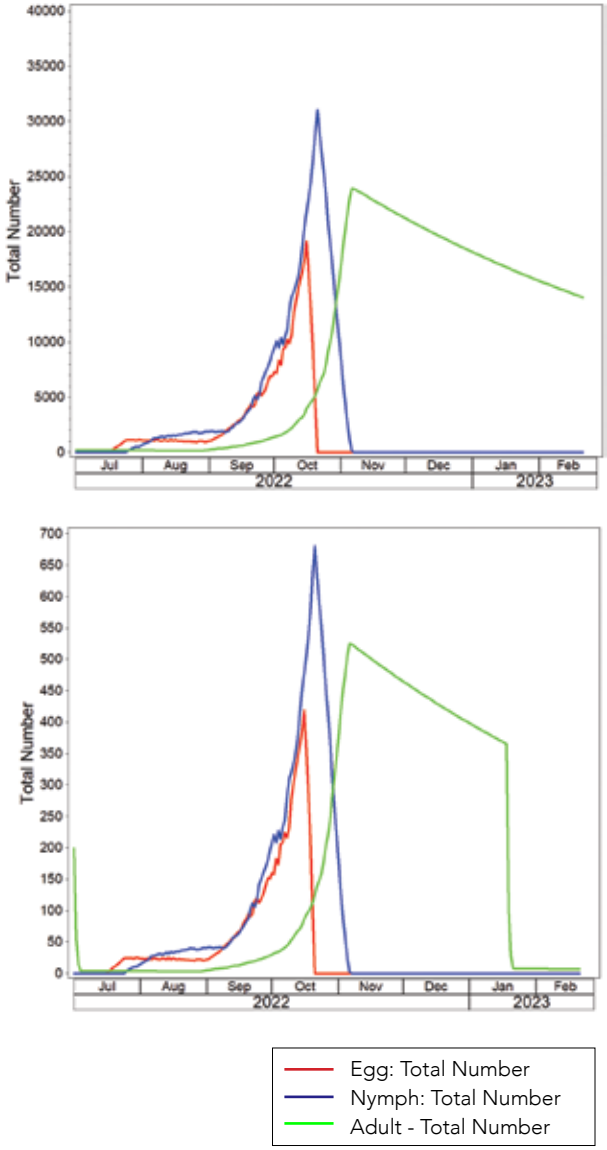


Figure 4. *The lace bug simulations with no control (top); with control added when total density (adults and nymphs) exceeds 100 ha-1 (bottom). Efficacy of the insecticide was 80% mortality per day for 3 days (leaving 0.8% survival after the 3 days). The simulation demonstrates the substantial effect of the insecticide and the limited ability of the population to rebound from the pesticide. Note the difference in absolute numbers of lace bugs (y-axis) in the 2 simulations.*

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R&D UPDATE

Microbats for insect pest control in macadamia orchards

Rani Davis, The University of Queensland

Project snapshot

Identifying effective pesticide alternatives is essential to limit further pesticide resistance and avoid impacts to human and wildlife health.

Supporting wildlife that prey on insects in and alongside orchards could serve as a natural alternative to chemical insecticides as part of an integrated pest management approach.

Microbats can consume between 30-100% of their body mass in insects each night and are known to selectively consume agricultural pests.

In my PhD research at the University of Queensland I will explore the insect pest control benefits that microbats provide to Australian macadamia orchards. The goal is to understand how microbats can be supported on farms to enhance their insect pest control service while protecting these valuable species.



*Rani Davis sampling macadamia nut borer moths (*Cryptophlebia ombrodelta*) captured on a pheromone trap.* Photo: Amy Thomas.



Setting up a harp trap to capture microbats in a macadamia orchard. Photo: Rani Davis.

Project aims

Microbats have potential to help growers manage and monitor insect pests in Australian macadamia orchards, but the specific pest species they consume are not yet known. The initial stages of my research during the 2024-25 macadamia season will identify the insect pest species eaten by microbats and track how microbat activity and diet relate to pest levels within orchards.

It will also investigate the potential for using bats for pest monitoring – a method called chirosurveillance (derived from Chiroptera, the scientific order to which bats belong).

I am currently working with macadamia farmers in the Glass House Mountains area, using sticky traps and pheromone lures to monitor insect pests, and acoustic microbat detectors to measure microbat activity. I am also collecting microbat faeces for dietary analysis by capturing microbats and visiting their roosts. Later in my research, I plan to test strategies to enhance microbat pest control services, such as installing 'bat boxes' in orchards and investigating the optimal tree trimming practices and spacing to encourage microbat activity.

Promising previous research

Research from South Africa has shown that microbats eat many macadamia insect pests, including some that are found in Australia, such as the green vegetable bug, and pests similar to those in Australia, such as the South African nut borer moth. In South African macadamia orchards, microbats were found to provide significant pest control, reducing husk and kernel damage by Tortricid moths by 35%.



A common blossom bat (Syconycteris australis) captured within a macadamia orchard. Photo: Rani Davis.

Microbats could also help monitor hard-to-detect insect pests through chirosurveillance, which involves using bats for pest surveillance through DNA analysis of insects in their faeces. A US study found that chirosurveillance was effective for monitoring the brown marmorated stink bug – a major pest in the northern hemisphere and a serious biosecurity threat to Australia. The study revealed that this pest could be detected in microbat faeces three to four weeks earlier than with light traps, highlighting bats' potential for early pest detection and improved pest monitoring.

In Australia, microbats have already proven beneficial in cotton crops in New South Wales, saving the cotton industry approximately AU$63.6 million in avoided pest management costs. Ongoing research funded by Wine Australia is also exploring their role in vineyards. A previous PhD study in the Bundaberg region recorded 17 species of microbats in macadamia orchards and found that large, interconnected woodland patches surrounding orchards promote higher microbat activity. However, there has been no research on their potential as biological pest control agents in Australian macadamia orchards, the pests they might control, or strategies to enhance their services. This is the focus of my research.

Results so far

Although my research on farms has only just begun, I have already recorded 13 microbat species within the orchards using acoustic microbat detectors. To date, I have collected faeces from seven microbat species and have several research trips planned for the 2024-25 season to collect more samples for diet analysis. I have even recorded the common blossom bat – Australia's smallest flying fox, which pollinates native plants and potentially macadamia. I am investigating this connection as part of this project.

Information
For information about the project, contact Rani Davis, P: 0423 595 113, E: rani.davis@uq.net.au

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Australian macadamia minor use permits

Current at November 2024

Chemical	Permit no.	Pest/Disease use	Application rate	Withholding period (no. days)	Minor use permits
Minor use permits					
Abamectin	PER87510	Thrips and flat or broad mites	• Product containing 18 g/L abamectin: 750 mL /ha plus 5 L summer spray oil/ha • Product containing 36 g/L abamectin: 375 mL /ha plus 5 L summer spray oil/ha	28	All states and territories except VIC
Chlorpyrifos & maldison	PER13642	Australian plague locust	• Product containing 500 g/L chlorpyrifos: 350 mL/ha • Product containing 440 g/L maldison: 1.4 or 1.9 L/ha • Product containing 500 g/L maldison: 1.2 or 1.7 L/ha • Product containing 1000 g/L maldison: 600 or 850 mL/ha • Product containing 1150 g/L maldison: 520 or 750 mL/ha • Ground application	Chlorpyrifos: 30 Maldison: Not required when used as directed	All states and territories except VIC
Diazinon	PER14276	Macadamia lace bug	• Product containing 800 g/L diazinon: 120 mL product/100 L	14	NSW, QLD & WA only
Ethephon	PER11462	Promote nut fall after maturity reached	• Product containing 480 g/L ethephon: 65–250 mL/100 L water • Product containing 720 g/L ethephon: 55–165 mL/100 L water • Product containing 900 g/L ethephon: 44–132 mL/100 L water • Do not spray stressed trees • Refer to critical comments for varietal rate adjustments	7	NSW, QLD, WA & NT only
Indoxacarb	PER86827	Macadamia seed weevil	• Product containing 150 g/L indoxacarb: 50 mL product/100 L • Product containing 300 g/kg indoxacarb: 25 g product/100 L	42	NSW & QLD only
Methomyl	PER90592	Banana fruit caterpillar	• Product containing 225 g/L methomyl: 1.5–2 L/ha • Spraying ground mulch/soil surface up to treelines only • Do not spray tree foliage, flowers or developing nutlets	Not required when used as directed	QLD only
Petroleum oil	PER11635	Macadamia felted coccid	• Product containing between 763 and 861 g/L petroleum oil: 1 L/100 L water	Not required when used as directed	NSW & QLD only
Trichlorfon	PER13689	Macadamia lace bug, fruit spotting bug, banana spotting bug and green vegetable bug	• Product containing 500 g/L trichlorfon: 200 mL/100 L • Do not apply a spray volume exceeding 1500 L/ha • Do not apply by aircraft or to plants in flower • Not compatible with integrated pest management	2	NSW & QLD only

All efforts have been made to provide the most current, complete and accurate information on these permits, however, AMS and NSW DPI recommend that you confirm the details at the APVMA website portal: https://portal.apvma.gov.au/permits.

Growers wishing to use a chemical in the manner approved under a permit should obtain a copy of the relevant permit from the APVMA and must read and comply with all the details, conditions and limitations relevant to that permit.

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4625 Goodwood Road, Alloway Qld 4670
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