AUSTRALIAN MACADAMIA SOCIETY

# News Bulletin

VOLUME 52 | NUMBER 3

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Spring 2024




AMS Strategic Plan 2024-2028

P 4



Planting native species to support pollinators in macadamia orchards

P 22



IOM principles guide McLeans Ridges orchard makeover

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AUSTRALIAN MACADAMIA SOCIETY

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**Front cover image.** *The biennial AusMac conference is being held 29 to 31 October at the Gold Coast Convention and Exhibition Centre. Register by 31 August to take advantage of the earlybird offer.*


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Hort Innovation MACADAMIA FUND

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# CEO's Report

The release of the updated 2024 crop forecast in early July reflected the impact of weather and associated challenges across most production regions. The initial forecast of 56,000 t in-shell at 3.5% moisture (60,000 t in-shell at 10% moisture) was revised back to 50,830 t in-shell at 3.5% moisture (54,500 t in-shell at 10% moisture). Several other macadamia origins including South Africa and Kenya have also recently revised their 2024 forecasts, due to adverse weather impacts. The South African crop reduced from 92.000 t in-shell to 76,753 t in-shell at 3.5% moisture.

With the harvest nearing completion in Queensland, and well underway in the weather impacted regions of NSW, quality reports for the 2024 crop have generally been good, with improvements in kernel recovery and nut size compared to 2023 servicing strong demand for both NIS and kernel.

Stopping the proposed Biosecurity Protection Levy (to add an additional 10% to current levy charges) in the Senate was a massive achievement and reflected the huge collaborative effort from across rural industries. There has been some acknowledgment from the government that there were flaws in both the process and the proposed levy, and we are hopeful of much improved government/industry engagement in this space in future.

As a signatory to the Emergency Plant Pest Response (EPPR) deed, the macadamia industry has cost-sharing obligations for the management of pest incursions, when deemed an impacted industry. The *Varroa destructor* response is one such instance and information has been circulated to levy payers about the proposed re-activation of the EPPR levy to cover this commitment. More detail on both the varroa incursion and the EPPR levy is included on page 16 and in Leoni's Industry Insights column.

Representing the Australian industry, I met with the World Macadamia Organization (WMO) Board in May and have subsequently been working with the WMO and Australian industry representatives about options for Australia's ongoing involvement in the strategic elements of the WMO. The Australian industry's commitment to the WMO for the 2023 season was met through a combination of co-contribution (recognition of the value of the Australian Marketing Program) and US$ contribution from all the members of the AMHA. An ongoing model that recognises the contribution of the Australian Macadamia Marketing program and is based on the concept of a WMO Strategic Foundations Committee is currently being considered.

Several important industry initiatives are now underway, including the development of the macadamia industry risk and crisis management plan, an initiative that will ensure we are prepared to ensure risks, as diverse as environmental impacts on farm or the reputational impact from poor quality in market, never become a crisis. My thanks to the industry representatives who helped set the foundations for this important initiative by participating in the recent risk workshop.

The Masterclass in Macadamia Management has also been re-launched and will run annually commencing in September. The masterclass is a 12-month program of face-to-face and online learning activities focusing on key aspects of macadamia orchard management.

Both the AMS and the Macadamia Conservation Trust have recently completed valuable planning exercises, re-focusing on strategic direction and resourcing, to ensure our respective deliverables for industry and conservation are appropriate, practical and achievable. The AMS strategic objectives are detailed in the following pages.

My thanks to all of you who have already renewed your AMS membership for 2024/25. Membership income is a critical component of AMS funding, enabling us to deliver effectively for members and wider industry. With our clear strategic direction now in place, over the coming months, we will also be focused on building additional member benefits in collaboration with partner organisations, adding further value beyond our core deliverables.

One AMS member benefit is discounted registration for the biennial AusMac conference. The AusMac2024 program has been redesigned based on your feedback. This includes fewer, more focussed plenary presentations, more time in the exhibition area, more opportunity to engage with innovators and researchers, more time to network, and venue and accommodation options that allow maximum flexibility for delegates. For more information we have included a conference brochure as an insert in the News Bulletin

Finally, I would like to thank NSW grower Daniel Howorth for his contribution to the AMS Board since joining in November 2022. Daniel recently stepped down as director, and his place has been filled by Andrew Waddell from Stahmann Webster. As chair of the Australian Macadamias Marketing Committee and a representative of a vertically integrated grower/processor we welcome Andrew's insight and experience to the AMS Board.

I look forward to seeing many of you at AusMac in October, and in the interim, as always, don't hesitate to contact me by phone or email.

**Clare Hamilton-Bate**

AUSTRALIAN MACADAMIA SOCIETY

# Strategic Plan

2024-2028

## Our Vision

AMS is trusted and valued as a leader and service provider supporting a progressive and sustainable Australian macadamia industry.

## Our Purpose

To create real value for our members and the broader Australian macadamia industry by promoting the industry and delivering effective representation, advocacy and services.

## Our Values

### Leadership

Be innovative, adaptable and adept in supporting the industry to achieve its potential.

### Integrity

Always act with integrity and professionalism.

### Influence

Inform and advocate to lead change.

### Collaboration

Foster a culture of cooperation recognising collective efforts yield greater impact.

## Strategic Objectives

### Representation and Advocacy

We will proactively represent and advocate to achieve beneficial outcomes for the Australian macadamia industry.

### Communication and Engagement

We will ensure our members are heard, the industry is engaged, and our key stakeholders are informed.

### Market Development

We will grow demand for Australian macadamias by managing market development programs effectively seeking best trade outcomes.

### Industry Development

We will enable improved quality, productivity and sustainability outcomes for the Australian macadamia industry.

### Entrusted Services

We will drive and promote initiatives that deliver industry-wide benefit, where AMS is the natural custodian on behalf of industry.

# Strategic Objectives IN DETAIL



## Representation and Advocacy

**We will proactively represent and advocate to achieve beneficial outcomes for the Australian macadamia industry.**

- Effectively represent the industry in prescribed representative roles[1].
- Actively engage and represent the industry on key industry forums[2].
- Advocate and represent the industry on key issues, holding all levels of government and relevant agencies to account.
- Advocate for effective and appropriate investment of macadamia R&D and marketing levies.
- Develop and maintain industry position in key policy areas.
- Represent the industry to maintain our social licence.
- Build, maintain and leverage strong, informed, and effective networks to strengthen advocacy.

## Communication and Engagement

**We will ensure our members are heard, the industry is engaged, and our key stakeholders are informed.**

- Effectively deliver the levy funded industry communication program.
- Regularly engage in dialogue with members and key stakeholders on issues affecting industry sustainability.
- Communicate with industry on current and emerging issues.
- Communicate with industry stakeholders, wider networks, and the community to promote the industry and raise awareness of the economic, social, and environmental benefits the industry delivers.
- Effectively communicate AMS roles, responsibilities, and the value we provide to our members and industry.

## Market Development

**We will grow demand for Australian macadamias by managing market development programs effectively.**

- Effectively deliver the levy funded market development program, managed in collaboration with Hort Innovation.
- Create and maximize non-levy funded marketing and collaborative opportunities to raise awareness and visibility of Australian macadamias.
- Work with key stakeholders, including Austrade and State Trade Agencies, to maximise market development opportunities.
- Advocate for improved market access protocols and trade outcomes.
- Support the industry by providing access to robust production and market data and insights.

## Industry Development

**We will enable improved quality, productivity and sustainability outcomes for the Australian macadamia industry.**

- Effectively deliver the levy funded industry development program.
- Seek other funding to deliver industry development activities, which address industry priorities.
- Leverage our knowledge, industry position and networks to strengthen R&D outcomes and maximise benefits.
- Work with Hort Innovation to identify and address any strategic gaps in the industry R&D planning.
- Engage and collaborate with commercial services and innovation hubs to help embed new technologies and systems to improve business outcomes.
- Assist industry in managing emerging issues impacting production.
- Ensure stakeholders are engaged and informed through communication programs and industry activities.

## Entrusted Services

**We will drive and promote initiatives that deliver industry-wide benefit, where AMS is the natural custodian on behalf of industry.**

- Develop, maintain, and update, as necessary, key frameworks, plans and policies which inform industry-wide position and practice in areas such as good agricultural practice, sustainability, biosecurity, food safety and risk & crisis management.
- Set the standard and facilitate the accreditation of laboratories through the Kernal Laboratory Accreditation Scheme (KLAS) to ensure clear and objective assessment of kernel quality.
- As trustee, continue to support the Macadamia Conservation Trust, through strong governance and strategic and operational support, in its objective to conserve wild macadamia populations.
- Build industry capacity through education and development pathways.

[1] The Australian Macadamia Society is the prescribed industry body or lead industry contact for Hort Innovation (HIA), Plant Health Australia (PHA), Consultative Committee on Emergency Plant Pests (CCEPP), National Management Group (NMG), Dept. Agriculture Fisheries and Forestry Levy Revenue Service (DAFF LRS), Australian Bureau of Statistics, National Residue Survey (NRS) and Australian Pesticides & Veterinary Medicines Authority (APVMA)

[2] AMS is the representative industry member for Australian Nut Industry Council (ANIC), Nuts for Life (N4L), International Nut and Dried Fruit Council (INC), International Macadamia Symposium (IMS), World Macadamia Organisation (WMO), Plant Industry Forum (PIF), NFF Horticulture Council (though ANIC)

Hort Innovation MACADAMIA FUND

# 2024 global forecast reductions signal future supply challenges



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## Global supply

In July, several origins made mid-season updates to their forecasts because of ongoing weather challenges. This resulted in a reduced 2024 global crop forecast of 313,133 t in-shell @ 3.5% moisture, down 1% on the 2023 season and a 9% reduction on the initial crop forecast published in March.

The Australian forecast was revised to 50,830 t in-shell at 3.5% moisture (54,500 t in-shell at 10% moisture), down from the previous estimate of 56,000 t in-shell at 3.5% moisture (60,000 t in-shell at 10% moisture) with adverse weather conditions the main factor. Despite the 9% reduction from earlier projections, the revised forecast still anticipates a crop 5% larger than the previous year, with improvements in kernel recovery and nut size compared to 2023, and overall quality looking good.

South Africa revised its crop down from 92,000 t in-shell at 3.5% to 76,753 t, a 3.7% reduction on last year and a 16% reduction on the initial 2024 forecast. It was reported this was due to poor weather conditions across three of the major growing regions. Kenya also reduced its crop from 46,000 t in-shell at 3.5% to 44,000 t; however this is still 3.5% ahead of last season. China's 2024 forecast is marginally up on 2023 at 68,500 t in-shell.

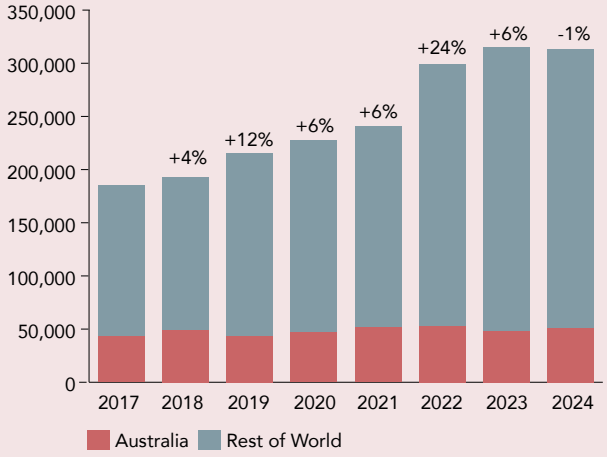



***Figure 1.*** *Global macadamia crop volumes 2017-2024 (tonnes)*
*Source: AMHA, WMO, INC. All volumes are at 3.5% MC.*

## Global demand

In the 12 months to May 2024, global macadamia kernel imports to the top five markets combined decreased 9% on the prior period. This result was driven mainly by a falling USA market for imports, while in contrast other key markets enjoyed an upward trend. China/Hong Kong (+29%), Europe (+21%) and domestic markets (+18%) continue to experience strong growth.

The Japan market is down 11% and the US market continued to experience low imports over the last two quarters driving the annual result down. Reports indicate these two markets have been impacted by reduced global kernel availability.

Exceptionally high volumes of nut-in-shell continued to enter the China market. Macadamia nut-in-shell imports reported by China Customs for the period June 2023 to May 2024 were up 78% compared to the year before, increasing from 53,557 to 95,478 t.

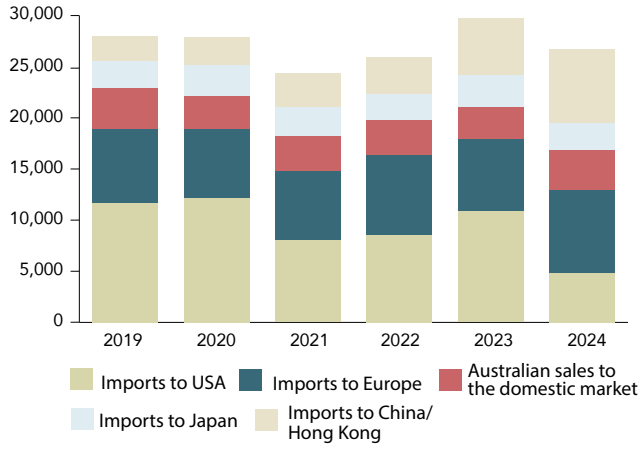



***Figure 2.*** *Macadamia kernel imports to top five markets (tonnes) MAT June to May*
*Sources: USDA, Eurostat, Japan Customs, China Customs, Hong Kong Census & Statistics Department via IHS Markit Inc, AMHA*

## Australian sales

The change in the sales mix of nut-in-shell and kernel continues to impact Australian kernel availability. The domestic market continues to perform strongly, up 18% compared to the prior MAT period. However, South Korea is Australia's only export market currently in growth (+5%). The South Korean market has grown significantly in the last 12 months and imports from competitor origins have increased, reducing Australia's market share from 99% to 82.6%. Market share losses in the kernel market compared to the last MAT period have also been experienced in Europe (from 9% to 5%), China (from 66% to 24%) and Taiwan (from 57% to 38%). All three markets are in growth, with South Africa filling most of this new demand. Australia has performed better in Japan, with its market share down just 5%, from 66% to 61%.

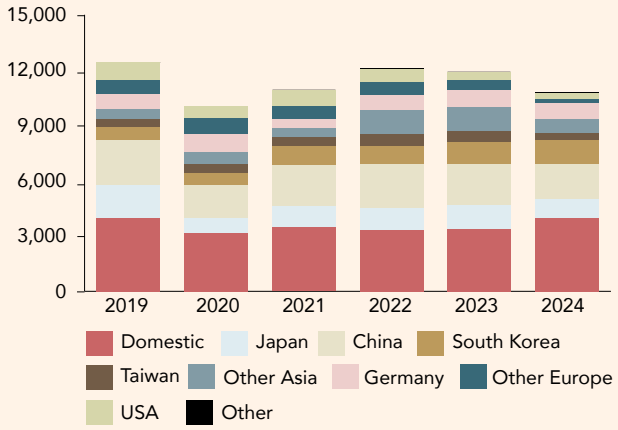



***Figure 3.*** *Australian macadamia kernel sales (tonnes) MAT (June-July) Source: AMHA. AMHA represents 95% production, sales are adjusted to represent non-AMHA members*

# New Australian Macadamias Marketing Program set to launch

In March 2024, the AMS partnered with Hort Innovation to jointly facilitate a two-day strategic marketing planning workshop. Participants included growers, industry stakeholders and senior marketers and management from Hort Innovation.

The workshop's objectives were to:

- co-design a new three-year macadamia marketing plan with key stakeholders
- review the current marketing plan to determine measurement and effectiveness
- share the latest data from a wide range of third-party independent sources
- stop and think about key learnings from the data and identify the implications for the marketing strategy
- recommend marketing activities and investments.

Before the workshop, macadamia growers were invited to share their feedback either directly to the Macadamia Marketing Manager or by responding to a survey sent out to all levy payers in the Hort Innovation and AMS member databases. The grower survey identified four key challenges and six opportunities addressable by the marketing program.

| Challenges | Opportunities |
|---|---|
| 1. Position as premium rather than commodity<br>2. Compete with rising global supply<br>3. Increase consumer awareness<br>4. Research evidence to enable the promotion of health benefits | 1. Measure marketing effectiveness and success<br>2. Develop new markets<br>3. Promote clean and green image<br>4. Increase domestic consumption<br>5. Develop consumer friendly positioning<br>6. Leverage health benefits |

The process validated the strategic integrity of the current marketing strategy and highlighted areas for improvement, leading to an evolved three-year marketing plan.

The focus on inspiring food manufacturers to use macadamias in their new products was unchanged and is considered critical to ensure increased demand across ingredient styles. The two key projects underpinning this pillar are the global trade communications program and the development of an Applications Solutions Guide (ASG).

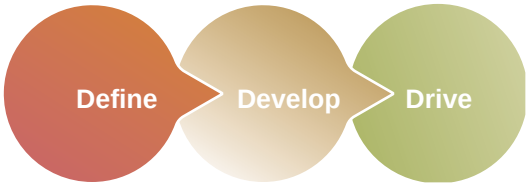
The ASG project will provide a series of technical resources which demonstrate how to successfully formulate with macadamias, remove barriers to adoption, and provide product inspiration, ultimately helping to fast-track innovation with macadamias among manufacturers. This project is being delivered by the Food Science Innovation team at the Queensland Department of Agriculture and will be finalised for launch by mid-2025.

The importance of the domestic market was elevated, and investment endorsed for the continuation of the successful *Macadamias Make It Special* consumer marketing campaign and the ongoing support of the health professionals' research and extension program, Nuts for Life. While the consumer marketing campaign is still in development, we can confirm macadamias will make a return appearance in the *Christmas with the Australian Women's Weekly* television special supported by recipes across the AWW's print and digital formats during the festive period.

| SIP Goal | Grow consumer demand in domestic and international markets to support farmgate growth |
|---|---|
| Vision | The first choice for macadamias |
| Business Goal | Drive profitable, sustainable growth across the supply chain for Australian Macadamias |
| Consumer Goal | Increase the number of people consuming Australian Macadamias in all forms and across more occasions |
| Key Category Benefit | **A delicious, indulgent experience that elevates food and life** |
| Strategic Pillars | **PILLAR 1**<br>**INGREDIENT INNOVATION**<br>Get more food manufacturers to use Australian Macadamias |
| | **PILLAR 2**<br>**DOMESTIC**<br>Get more Australian consumers to eat Australian Macadamias |
| | **PILLAR 3**<br>**EXPORT**<br>Drive demand in new and existing markets |

***Table.*** *Marketing plan for financial years 2025 to 2027.*

A new approach to export markets was introduced using Hort Innovation's international marketing strategy framework: Define, Develop and Drive. In the Define phase, the focus lies on understanding the core needs and preferences of our trade customers and consumers so we can tailor our marketing strategies accordingly. Within the Develop stage, our attention shifts towards retailers and consumers to elevate brand visibility and influence purchasing decisions. The Drive phase encompasses targeted marketing efforts to drive demand and grow market penetration.




This portfolio approach ensures balanced and appropriate activity across the three areas dictated by the maturity of the selected markets. The intention is for markets in the Develop and Drive sectors to be part of the levy-funded program. For emerging markets with potential, the AMS will seek alternative funding streams to enable activity to be undertaken under the Define sector. An example of this approach is the recent activity in India, which was made possible by the Australian Nut Industry Council's Nut Expansion project funded under the Commonwealth Government's Agricultural Trade and Market Access Cooperation (ATMAC) Program.

The FY25-FY27 Macadamia Marketing Plan has identified India and Korea as 'Develop' markets and Domestic, Japan and China as 'Drive' markets. Some initial outreach in Indonesia has occurred under the 'Define' sector in partnership with Hort Innovation, however, further work is required to confirm the market with the greatest potential to progress.

As we continue to navigate shifting global supply and demand dynamics, promising opportunities are fast emerging to enhance awareness and consumption among both consumers and the trade. This three-year Macadamia Marketing Plan, grounded in solid foundations and ongoing data measurement and research, positions Australian-grown macadamias at the forefront of the most significant prospects, both domestically and internationally. By strategically targeting the right markets and sectors, we are poised to drive the long-term demand that will be key to the prosperous future of our industry.

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# Influencer partnerships drive awareness and purchase among millions in key markets

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*Influencer marketing is a powerful tool in the modern marketing arsenal, with the potential to deliver impressive results. We recently partnered with a new generation of influencers in Japan, South Korea, China and Australia, leveraging the trust and connection these food and lifestyle experts have built with their large and engaged audiences.*

The macadamia content these partnerships have generated is helping to amplify the taste, versatility and origin story of Australian-grown macadamias to consumers in these markets in a way that's boosting the visibility and relevance of our product.

## Japanese and South Korean influencer tour achieves 6.9 million online impressions

We recently invited food, travel and lifestyle influencers from Japan and South Korea on a four-day educational tour of the Northern Rivers region. The activity exceeded all performance targets, with the influencers' macadamia content reaching 5 million consumers and achieving more than 6.9 million online impressions.

Japan and South Korea are important markets, with Australian origin constituting more than 60%[1] of macadamia imports into Japan and 85%[2] into South Korea. Investing in expanding awareness and purchase among Japanese and South Korean consumers is therefore an important priority to preserve the gains already made and help grow future demand.

Bringing these highly skilled content creators onto Australian soil allowed them to generate and share macadamia content with their large audiences, taking their followers along for the ride as they experienced Australian macadamia orchards, recipes, menus and products and met growers, product innovators and chefs. Highlights of their time in macadamia country included:

- **Macadamia orchard experience:** An afternoon at grower Ross Arnett's macadamia farm, where he introduced macadamia growing and regenerative farming, and demonstrated how macadamias are harvested and sorted.





*Influencers experienced a taste of life on a macadamia orchard.*

- **Macadamia cooking masterclass:** A lesson on how to make macadamia lip balm, macadamia milk and roasted macadamia butter.
- **Macadamia processing:** A visit to Marquis Macadamias' processing facility demonstrated macadamia processing first-hand, including drying, cracking, sorting and packing.
- **Macadamia cuisine:** Guests were treated to examples of how macadamias can be incorporated into everyday dishes and fine dining, with a macadamia fine-dining experience created by MasterChef Australia alumni and Indigenous chef Mindy Woods.
- **Product tasting:** A tour of the Byron Farmers' Markets enabled our influencers to taste products featuring Australian grown macadamias as an ingredient.
- **Hot air ballooning over macadamia country:** A balloon experience had guests gazing down at the expanse of macadamia orchards 2,000 feet below.
- **Rainforest experience:** Brookfarm's Pam and Martin Brook led the group through the rainforest they have restored on their property, explaining how it encourages biodiversity and provides habitat for native wildlife.



*Getting a bird's-eye view of macadamia orchards in the Northern Rivers.*

## Personal experience proves potent

In-person familiarisation with a product or brand is the gold standard in influencer marketing due to its immersive nature. The resulting content is often more insightful and has greater impact, driving higher engagement and effectively conveying the brand's value to a broader audience. The influencers enthusiastically embraced the itinerary and the learnings it delivered. Here's a taste of what they said:



"This was the first time I had seen how macadamias are produced and being here I can see it's so clean, natural and eco-friendly. As a consumer, I can buy Australian macadamias and know they're a nutritious and trustworthy food that's grown in a clean environment."
*Nannika Kim, food influencer, South Korea*



"I was surprised how well they work in any type of dish. I want to take what I've learned and use Japanese ingredients with Australian macadamias to create some special Japanese and Australian macadamia fusion recipes for my followers."
*Ryogo Morishita, food influencer, Japan*



"In Korea a lot of people think the macadamia is from Hawaii. But Australia is the natural home of macadamias, so I want to educate my audience about their true origin."
*Seunga Lee, travel influencer, South Korea*



"Australian macadamias taste wonderful, and I admire the commitment of the farmers, particularly the measures they take to protect nature."
*Rina Ishii, lifestyle influencer, Japan*

## Influencer marketing in China helps rise above the noise

The Australian Macadamias Marketing Program leverages festivals and celebrations in all key markets, with Chinese New Year being one of the most notable. This year we partnered with seven influencers who posted their Chinese New Year macadamia content on RED, one of China's newer and fastest-growing social media platforms.

Hampers of macadamia products and macadamias in-shell were gifted to the influencers. They used these to create original content promoting macadamia consumption during the holiday period. The resulting content showcased a variety of macadamia uses and benefits, from their gifting and entertaining potential to their healthy fats and suitability to post-exercise snacking.



## Macadamia chia pudding goes viral in Australia

Back home, we have established relationships with many food, health and lifestyle influencers to help amplify key macadamia messaging in the domestic market. A recent partnership with Instagrammer @littlekalegirl saw her mesmerising recipe video for macadamia chia pudding go viral notching up more than 5.3 million views, with the vivid colours and layers of flavour proving to be a hit with her audience and ours.



[1] Japan Ministry of Finance via IHS Markit Inc

[2] Korea Customs and Trade Development Institution via IHS Markit Inc

# Industry Insights



**Leoni Kojetin, Industry Development Manager, AMS**
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*Most of the 2024 crop has been harvested with growers reporting that the season is pulling up sooner than many expected. The expected crop was recently reduced from the initial forecast of 60,000 t in-shell (@10%MC) to the latest estimate of 54,500 t in-shell (@10% MC). If achieved, this will still be a larger crop than 2023, but only marginally. Weather impacts during summer leading to greater disease incidence and higher levels of immaturity, as well as unfavourably wet harvest conditions for many regions, are large contributors to the reduced crop. Total kernel recovery for 2024 is tracking above long-term averages at just below 38%.*

As we approach flowering season, there is a lot of discussion about varroa mite and its impact. One consequence is the proposed Emergency Plant Pest Response (EPPR) to meet the macadamia industry's financial commitment to the attempted eradication and subsequent transition to management. The new EPPR levy will be 0.79 c/kg of dried saleable kernel as of 1 January 2025. The article on page 16 explains the background to the levy and how it was set.

Growers have been asking the AMS how varroa mite will be managed in future in Australia and what its impact on the macadamia industry is likely to be, so in this article I answer these questions based on what we know so far.

## Is the varroa mite EPPR levy activated for macadamias fair?

The Australian macadamia industry benefits from the 'peace of mind' that comes from sharing the cost of management of varroa mite with other agricultural industries by being a party to the EPPR Deed. The deed is a government-industry partnership designed to respond to and eradicate emergency plant pests. This means that when there is a major pest incursion, the government and other industries share in the response burden and growers can also be eligible for compensation.

One of the questions has been to what degree are macadamias an affected party of a honey bee pest? This certainly has been a contentious topic and one that the AMS has actively been advocating for over the last two years. Core to this discussion has been how reliant on pollination macadamias are, as this is significant in determining each industry's financial obligation.

We know that horticultural crops like almonds are almost totally if not totally reliant on pollination for nut set, and this occurs mainly through the introduction of managed honey bee hives into orchards. While we don't have a reliance figure for macadamia, research shows clearly that we can **improve** our crop with cross pollination, thus potentially increasing yield, ensuring better nut retention through to maturity and improving kernel recovery and quality.

But research is also clear that many insects pollinate macadamias, including flies, beetles and native bees. By their nature and as a result of grower management, macadamia orchards have abundant populations of beneficials that do the job of pollination free of charge. In almost every case though, bringing managed bee pollinators into the orchard has a positive impact on production and quality. We also know that while many macadamia cultivars are self-pollinating, many aren't, including a number of our newest cultivars. The answer of pollination reliance is uncertain.

There is a new levy-funded research project that will look to better define macadamia's dependence on pollination and understand how many growers are using managed pollination services. Details of how you can be involved in this research will be communicated in the following months. For now, we face the varroa transition to management phase.



*A varroa mite on a honey bee pupa.* Photo: CSIRO

## What does varroa mite transition to management mean?

This phase aims to slow the spread of varroa mite to allow beekeepers, pollination-dependent industries and the community enough time to prepare for the time when varroa becomes endemic in Australia. This is particularly relevant for states and regions that have not seen any *Varroa destructor* incursions, such as Queensland and Western Australia. The primary focus of this phase will be to minimise ongoing impacts of varroa mite naturalisation on the bee industry and pollination-reliant industries. This includes training beekeepers and pollination service users, providing them with the skills needed to manage varroa mite and providing management options that support healthy hives.

In practice this means ending the strategy by NSW DPI of euthanasia of hives and classification of red, purple and blue management zones, and transitioning to an ongoing state heat map based on varroa detection reports. Beekeepers are required to regularly monitor for varroa mite, and any detections must be reported to the Exotic Plant Pest Hotline (1800 084 881).

Hive movement regulations are also in place. Each state has different rules, but generally hives can be moved within the state if movement records are kept, but movement of hives or beekeeping equipment from NSW into Queensland requires a permit from Biosecurity Queensland. An exception to the free movement of hives within Queensland are hives that have been in the Brisbane area where another species, *Varroa jacobsoni* was detected at the port in February 2024. Hives in these areas are subject to movement permit orders.

## What will the spread of varroa mite mean for macadamia production?

The impact is unknown, but it is likely that there will be pressure on the availability of honey bee hives and potentially a flow-on effect to native beehive availability. Although native bees aren't affected by varroa mite, there may be fewer hives available if growers are struggling to find honey bees. Before the varroa incursion, the number of native bees being placed in macadamia orchards had been increasing because of their efficiency as macadamia pollinators. As well, while it has cost nothing or very little to place honey bee hives in macadamia orchards, this may change with costs potentially rising. For now, growers are cautiously optimistic that because macadamia flowers have such a positive impact on hive strength and health, our mutually beneficial relationship with beekeepers will continue.

## More information

You can hear about pollination in macadamia and a host of other production topics at the AusMac2024 conference on the Gold Coast from 29 to 31 October 2024. There is something for everyone – opportunities to meet people from other growing regions, machinery displays and large exhibitor space, and the latest insights on macadamia growing and research.

Be on the lookout for the latest edition of the 2024-25 *Macadamia Plant Protection Guide* produced by NSW DPI. It has a wealth of information about managing pests and diseases. Copies are available from NSW DPI and your processor, and you will also be able to pick up the guide at AusMac2024.

Lastly, please take the time to read the articles on pages 50 and 53 about the crucial task of preparing our industry better through mapping orchards and understanding the crop we produce. If you want any more details about the orchard information we are gathering, don't hesitate to contact Emily Grieve, our Bundaberg-based industry development officer, or myself. You can scan the QR below to complete the mapping survey and tell us the details about your orchard.

I look forward to seeing you at AusMac in a few weeks.

**Leoni**

1 Visit the AMS website: australianmacadamias.org and follow the link from the home page to the online survey **OR simply scan the QR code on the right with your mobile phone to go to the survey.**

2 Contact your state-based AMS staff member (see below) and attach a KML file from your farming/mapping APP. Please also include the additional information listed above. If this is not possible, contact the AMS for an alternative method.

**NSW**

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# Loss of modern pioneers: Stanley Thomas Henry and Thomas Ashley Hoult

**Ian McConachie**

*The industry mourns the loss of two remarkable figures who were instrumental in shaping the modern Australian macadamia industry.*

## Stanley Thomas Henry (1934 – 2024)



*Stan Henry (left) and Norm Greber in CSR's first nursery at Beerwah late 1960s.* Credit: CSR Ltd.

Stan Henry played a pivotal yet understated role in the commercialisation of the Australian macadamia industry. With no formal horticultural training, Stan's natural talent and keen observation of plant phenology set him apart.

Recruited by Arthur Lowndes as nursery manager for the CSR Macadamia Division in 1966, Stan's impact was profound. At a time when nurseries were just mastering grafting techniques, Stan, mentored by Norm Greber, quickly became a problem solver and pioneer in macadamia tree culture. His innovative approach led to the successful punch budding propagation method, initially using a 303 cartridge, a feat few could replicate.

Under his guidance, CSR's nursery produced more than 200,000 grafted trees, setting high standards for orchard development. After retirement, Stan continued to contribute to horticulture through his research on breeding and producing flowering eucalyptus.

Supported by his wife Nancy, Stan inspired his three children to excel in plant science. Robert Henry is Professor of Innovation in Agriculture, was the Founding Director of QAFFI, and is a leader in genetic macadamia research and macadamia plant breeding. John has continued his father's eucalyptus research and Anne is involved in orchid breeding.

## Thomas Ashley Hoult (1939 – 2024)



A moment in time, a waft of roasting nuts and four macadamias for 20 cents were the inspiration for an Australian industry pioneer.

Tom Hoult with his partner Mel Braham came to Australia from New Zealand with $6000, intent on making their fortune. In 1965, walking down the main street of Brisbane, they struck a macadamia nut vendor and were hooked. Surely something so delicious and expensive would be the foundation of their future.

Further inquiries revealed these macadamias were rare and almost unobtainable. Despite initial discouragement from CSR's Macadamia Division, citing their difficulty to cultivate and uncertain future, Tom saw an opportunity amid CSR's substantial investment in industry development.

In 1967, Tom and Mel planted macadamias on a steep former banana farm near Lismore, later relocating them to Dunoon where they laid the groundwork for their empire. Through perseverance, thrift and diversifying their income streams, they planted 80,000 trees themselves and championed macadamia cultivation as a legitimate tax shelter for investors.

Tom envisioned macadamias as 'the money tree', unabashedly promoting them with the slogan 'Money really does grow on trees'. His bold marketing tactics and strategic investments not only fostered orchard development but also catalysed the growth of the industry across the Northern Rivers and, to a lesser extent, the Atherton Tablelands.

In 1978, they established the Macadamia Plantations of Australia [MPA], pioneering retail value addition and forging a premium image for themselves and the industry. By 1989, they began divesting parts of their business, which persists today under the banner of Macadamias Direct.

Tom's foresight, colourful personality and bold and entrepreneurial spirit inspired many others to enter the industry on a commercial scale, leaving an indelible mark on Australia's agricultural landscape.

Stan Henry and Tom Hoult's contributions laid the foundation for the thriving macadamia industry in Australia. Their legacies will continue to inspire future generations of horticulturists and entrepreneurs.



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# EPPR levy re-activated to fund industry share of *Varroa destructor* response

## Snapshot

**As a signatory to the Emergency Plant Pest Response (EPPR) Deed, the macadamia industry is required to contribute to the cost of the varroa mite response**

**Response costs are funded via the Emergency Plant Pest Response levy**

**In July 2024 the industry was notified of the proposed EPPR levy re-activation at 0.79c/kg of dried kernel**

**Subject to ministerial approval, the re-activated EPPR levy will take effect from January 2025**

The AMS has been actively involved in the sector-wide response for the eradication and management of varroa mite since it was first detected in the Port of Newcastle in June 2022. The response has now been finalised, and the National Management Group has agreed on a transition to management plan, as eradication is not possible.

As a signatory to the Emergency Plant Pest Response Deed, the macadamia industry has cost-sharing obligations to repay the industry's percentage of the total cost of $100 million for the varroa mite response.

Following pro-active engagement from the AMS and other industry representative bodies, varroa mite was reclassified from a Category 3 to a Category 2 pest in mid-2023. As a result, the government will pay 80% of the cost of managing the incursion and affected industries will pay 20%. If varroa mite had remained a Category 3 pest, the funding ratio would have been 50:50, resulting in a substantially higher cost to all contributing industries (and an estimated macadamia industry contribution of $3.175 million).

The Category 2 classification means the macadamia industry's share of the total cost is now $1.27 million, which includes both the cost of the transition to management plan and the cost of the previous eradication attempt.

On behalf of the macadamia industry, AMS has asked the Australian Government to underwrite the industry's cost-sharing obligation for the response to varroa mite, using the EPPR levy as the mechanism for repayment within the recommended 10-year period.

The macadamia industry is currently not paying the EPPR levy as, historically, it has only been activated on a needs basis to cover the cost of pest incursions. The last activation was for the *Varroa jacobsoni* response from 2017-2021.

With forecast crop increases as planted macadamia orchards come into production (from 2025 to 2029), it is proposed to reactivate the EPPR levy at 0.79c/kg of dried kernel from January 2025. If crop volumes align with forecasts, it will enable the industry to repay its obligation in seven years, while providing a three-year buffer for full repayment of the government loan should crop volumes not meet current forecasts.

As required under the EPPR Deed, the AMS has written to the Minister for Agriculture, Fisheries and Forestry, to request the reactivation of the EPPR levy to meet the macadamia industry's cost-sharing obligation for the varroa mite response.

Following the notification to levy payers in mid-July, a 30-day objection period allowed for submission of an objection about the levy details or process; any objections received will be taken into consideration by Minister Collins when making her decision on the activation of the levy.

The AMS will keep industry updated with the progress of the levy throughout the process.

## Transition to management of varroa mite



- **June 2022.** Varroa mite is detected in sentinel hives in Port of Newcastle, NSW.
- **June 2022 to September 2023.** National Management Group (NMG) is convened under established emergency plant pest response procedures and deems eradication is feasible and agrees to a response plan.
- **September 2023.** It is agreed nationally that eradication of varroa mite is no longer feasible based on technical grounds. Response moves to transition to management phase.
- **February 2024.** The National Management Group endorses the transition to management plan. The costs of the response, including transition to management activities, to be shared up to a revised limit of $100 million, on the basis of a Category 2 Emergency Plant Pest categorisation.

For more information, contact info@macadamias.org



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# Weathering two major storms

**Eve White, White Editing**

*Brett Newell is a third-generation farmer from Beerwah. His father originally cultivated pineapples and later avocados. When Brett returned to the family farm in 1998, the Newells planted their first macadamia trees and lychees to complement the avocados. Over the years, Brett has gradually expanded his macadamia orchard, with the latest additions planted just four years ago. This year the crop looks promising, offering hope after several challenging seasons marred by two severe storms.*



*In some areas of the orchard every tree was damaged..*

| | |
|---|---|
| **Grower** | Brett and Kirsty Newell Beerwah (Glass House Mountains region) |
| **Size** | 17.5 ha, between 4 and 25 years old |
| **Cultivars** | A29, A268, A4, A203, 741, 816, Daddow, all on 9 x 4 m spacings, irrigated |
| **Soil type** | Sandy loam |

## The 2017 storm

The first storm was on 9 December 2017, when powerful microbursts caused substantial wind damage, particularly in the mature parts of the orchard.

Brett noted that the level of damage varied between cultivars. The worst damage happened in a block of A29s and 741s. The very brittle A29s incurred the worst damage while the 741s stood up much better.

The damage – mainly branch loss – was huge but so too was the amount of help Brett received from local growers.

"Ten or so of the other growers gave us a hand, with four tractors running. The amount of help was astounding," Brett said.

Until the storm hit, this was shaping up to be Brett's best crop yet. However, the damage left him with two windrows of downed tree material, and he estimates that the storm cost them around 25% of the 2018 crop alone, with unknown crop loss for the following years while trees recovered.

## The 2022 storm

Four years and five months later, on 3 March 2022, a second big storm hit. This coincided with the end of the big floods and the start of harvest; the ground was saturated.

The storm, which was similar in intensity to the 2017 storm, came 3 am, and this time brought hail as well as wind. It stripped at least three quarters of Brett's avocado crop off the trees, damaged the remaining fruit, and left a big repair bill for the lychee netting. The macadamias didn't incur substantial hail damage but were severely damaged by the wind.

Brett said, "We were fortunate to miss the worst of the hail. Some of our poor neighbours weren't as lucky – they copped the wind and the worst of the hail. But we had a huge amount of canopy damage. There were localised pockets – in some areas, every tree was damaged."

The worst-hit area was a block of six- to seven-year-old trees, where 30% of the trees were lost, roots and all. Brett estimates that in total about two-thirds of the canopy was destroyed in that block.

Brett again observed that damage varied between varieties. The brittle A29s had more branches broken out but less whole-tree loss. The A203s fared better in terms of branch damage but in those that were damaged, a greater proportion of the tree was lost.

Brett doesn't have crop insurance. Luckily in 2022, he was eligible for a $75,000 state government grant, which helped but still didn't cover the full cost of the clean-up. Once again, he estimated that the storm cost him 20 to 25% of the crop, and an unknown reduction in yield for years to come.

## Cleaning up and replanting after the 2022 storm

After the storm, the community again gathered around to help. The clean-up options were limited by the wet ground, and using tractors wasn't an option.

Brett said, "We were fortunate to get hold of a local contractor with a 90 hp Posi-Track and a decent-sized stick rake attachment. Then a local grower, who also helped us after the 2017 storm, called me to see what he could do to help. He offered the hire of his 3.5 t excavator with log grab/shear attachment. This was really generous considering he had his own farm to prep for harvest."

The excavator went through first and cut off any branches that were still attached to the tree and then lay all the branches across the interrows, snipping anything that was too long to fit across. Then the Posi-Track swept them to the ends of the blocks into a long windrow. This proved to be an efficient way of clearing the large branches.

"After the machines had finished, we had friends and family wanting to help. We went through on foot with trailers, picking up branch material that was left behind so we could run the harvester through. The first harvest round was still a nightmare, though, because there was still so much material left behind. Once we got the harvester and mowers through it was in better shape," Brett said.

However, in the process of pushing the material out, the grass in the inter-row area suffered. Brett said it took a full 12 months to recover.

The clean-up didn't end there. Once harvesting was finished, Brett had more pruning to do, as lots of broken branch material was caught up high in canopy. He ran a cherry picker and hydraulic polesaw through and removed the remaining branches. He dragged them out of the orchard and added them to the windrow of material waiting to be processed.

This essential task had further flow-on effects, which Brett observed following both the 2017 and 2022 storms. Surviving branches that been shaded were suddenly exposed to sun. Sunburn can damage the bark and the damaged areas can become sites for fungal infection, which in turn can lead to rot. This meant that for the next two or three years, branches were getting sunburnt, rotting and breaking.

By September 2022, Brett could finally get a horizontal grinder and 35 t excavator in to process the windrows of material into mulch. Brett ended up with 900 cubic metres of processed material, which is currently piled in windrows with the plan to return it into the orchard this year, now that it has had a chance to break down.

Most of the whole trees that were destroyed were in the younger blocks, and Brett replanted in the gaps. Many mature trees lost branches back to main trunk, and Brett has left them to recover and return to productivity. Recently, Brett checked the 2022 regrowth to see if flowers are appearing, but there are none to be seen yet. He hopes to see some next year.



*By September, Brett was able to get an excavator and horizontal grinder into the orchard. He ended up with 900 cubic metres of processed material.*

## A better harvest

This year's harvest is looking promising.

"It's been one of the toughest harvest seasons I can recall with the consistent wet weather. We've had issues with the amount of nut we're throwing out on farm because it's been on the ground for too long in the wet. But when I've looked at tonnage and quality, I've been pleasantly surprised. It's shaping up to be a decent harvest," said Brett.

## Looking ahead

Brett is constantly striving to improve his orchard management practices and trying new approaches. But he notes, that with so many ever-changing variables, particularly around seasonal conditions, it's always difficult to know for certain if a new practice is having an effect.

One change that he says has been worthwhile is the addition of an under-tree irrigation system ten years ago, consisting of 58 L/hr Netafim upside down sprinklers. He believes that irrigating has resulted in better yields and nut size in two recent dry seasons than he would have had otherwise, with the system paying for itself in this time.

On his thoughts for the future, Brett says, "I'm not planning to make any big changes. I'm just hoping that we get some kinder weather conditions – and that I can make some money off the orchard!"



# Join the industry's Masterclass in Macadamia Management

*Are you ready to advance your expertise in managing high-performing macadamia orchards? The industry's Masterclass in Macadamia Management, starting in September, offers a comprehensive 12-month program designed for experienced orchard managers.*

Developed by the AMS together with leading universities, research agencies and industry experts, the masterclass aims to deepen your understanding of macadamia production systems and the role of emerging technologies.

## Course structure and content

The masterclass covers six core topics:

- Orchard floor nutrition and soils
- Canopy management
- Water management
- Pests and diseases
- Harvest and post-harvest management
- Sustainability and innovative technology

It also includes aspects of advanced management, such as integrating digital technologies, leadership skills and workplace health and safety.

## Hands-on learning and expert guidance

Participants will benefit from flexible online self-directed study, face-to-face workshops, in-field activities and farm visits. Highlights include bi-monthly workshops in Bundaberg and a four-day visit to the Almond Centre of Excellence in South Australia. The program features presentations and mentorship from leading macadamia researchers, industry consultants and technical advisors.

## Exclusive opportunity

This masterclass is a fantastic opportunity to enhance your orchard's productivity, profitability and sustainability. It is limited to current macadamia farm managers with at least two years of management experience. Places are limited so don't delay.

Submit your expression of interest today.

### Cost and registration

AMS Member: $3,200 inc GST

**Information**
To submit your EOI or find out more, email: office@macadamias.org or phone: (02) 6622 4933

# Rising star nominated for Young Grower of the Year award



*Jennifer Hulme was nominated recently for the 2024 Corteva Agriscience Young Grower of the Year award.*

*At just 25, Jennifer Hulme manages more than 3,000 ha of macadamia orchards for Hinkler Park Plantations, part of Saratoga Holdings, the largest macadamia producer globally.*

Jennifer was recently nominated for the 2024 Corteva Agriscience Young Grower of the Year award. The Horticulture Awards for Excellence, presented at the Hort Connections 2024 Conference in Melbourne in June, recognise Australia's leading growers and industry contributors.

Jennifer spoke to us about her passion for sustainability and her thoughts about being nominated for the award.

## From glasshouses to macadamia orchards

Before moving to the Bundaberg-Childers region of Queensland in 2022, Jennifer had never seen a macadamia tree, but despite being new to the industry, her background in agriculture and glasshouse horticulture prepared her well for the role. Jennifer was soon promoted to horticultural manager.
"My role involves managing all the soil and tree health, pest and disease management, irrigation, Freshcare auditing, nutrition, spraying, machinery calibration and orchard management. It's always something different every day, which I love," Jennifer said.

## Innovations and future plans

Jennifer is particularly focused on adopting a "reef safe" mindset in orchard practices, conducting trial work with promising new products, and improving irrigation efficiency. Her efforts aim to enhance production and increase productivity while ensuring sustainable practices.

Jennifer said, "Trying to be more efficient in the practices we do as well as constantly re-evaluating methods we use is important. Canopy management changes are a big focus for me this season, as a lot of our trees are growing too big to manage using the current practices.

"Irrigation is also something I'm focusing on, both to use water more efficiently as well as knowing more accurately how many litres we use and where. I think proper irrigation is an under-appreciated tool in the orchards."

Jennifer completed last year's Masterclass in Macadamia Management, something she benefited from hugely.

Looking ahead, she is eager to seize more opportunities for personal and professional growth.

"There's still so much for me to learn and get more confident with, and I can't wait to see how that looks in five- or ten-years' time. I think the macadamia industry is still evolving, and there are so many unknowns compared to other, older farming industries.

"I love this; it keeps everyone researching and experimenting and interested, which can only be beneficial for the industry as a whole. It's an exciting place to be in," she said.

"I feel very honoured to have been nominated for the award," Jennifer said. "I haven't been in the industry for long, so it was definitely a surprise! It shows I'm on the right path in my own personal work life, but it also shows there is recognition for hard work and encouragement for young growers out there to strive for innovation and bettering the industry."

# Planting native species to support pollinators in macadamia orchards

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

*Craig and Barbara Van Rooyen moved to Australia from South Africa in 1998. Craig worked on an avocado farm for eight years before buying a farm, where he and Barbara grew a variety of crops, including lychees and strawberries. In 2008, they decided to transition to a crop that was less labour intensive than strawberries, and they invested in their first 8,000 macadamia trees. Over the years, they purchased more land and expanded their macadamias to more than 100,000 trees over more than 200 ha.*




*Craig Van Rooyen is deeply committed to environmental protection and strives to manage his orchards in harmony with nature.*





*A passion for pollinators runs in the family: Craig's sons, Connor (left) and Jayden, keep honeybees and native hives throughout the orchards and bushland*

## Integrated pest management

Craig and Barbara have always been passionate about protecting the environment. They take a multi-faceted approach to farm management, underpinned by the philosophy: 'If you look after nature, nature will do a large part of the work for you.'

The Van Rooyens have focused on increasing soil carbon to reduce leaching into the river and to the Great Barrier Reef. For the last 15 years, they've used integrated pest management. Craig said they only use 'soft chemicals' and apply spray when necessary, not by the calendar, and only to thresholds.

Craig uses beneficial insects in the orchards every week and keeps populations in his garden as a reserve. He notes that while it can take some time to breed a population of beneficial insects, it is worthwhile, as they can dramatically reduce pest species.

## Supporting pollinators

The Van Rooyens' sons keep European honey bees and native hives scattered throughout the orchards and bushland along the Burnett River.

To support and encourage pollinators, Craig has recently started planting native trees around his orchards. In the last six months he has hand-planted 500 native trees across five properties and has plans to plant another 300.

Craig notes that a main issue to consider when planting natives is where to plant them. He focused on creating bee corridors between the nearby bush and macadamia crops – in some cases even taking out rows of macadamias to enable the bees to follow a line of bush.

Native trees have similar irrigation and nutrition requirements to macadamias. Craig applies slow release Osmocote Native fertiliser and irrigates with the same 40 L/tree sprinklers as he uses for macadamias. Native trees need to be protected with frost guards until established.

## Why incorporate native trees?

- **A more diverse diet.** Honey bees and native stingless bees are healthier when they have a diverse diet supplied through a range of floral sources.
- **Alternative pollen sources.** Native plants provide an alternative pollen source before and after macadamia flowering, which increases the colony strength and ensures bee health is maintained.
- **Buffer zones.** A buffer zone of natives can reduce drift into sensitive areas. It should be sufficiently open to allow the spray to penetrate and deep enough to trap the bulk of any drift.
- **Wildlife corridors.** Wildlife corridors are connections across the landscape that link areas of habitat. They support the movement of species and processes such as pollination, seed dispersal, and genetic exchange.
- **Increasing integrated pest management.** Having native species nearby can help balance the insect life on farms, introducing supporting natural predators of pest insects.




*Craig planted larger trees near the bush and smaller species along the edge of the orchards to avoid shading out the macadamias.*

## Which species to use?

Craig planted smaller native shrub species, such as blueberry ash and Fraser Island apple, which won't shade out the macadamias, along the edge of orchard. At the same time, he pulled out *Torellianas,* which were suckering into macadamias. He planted larger native tree species, such as blue gum and iron bark, around areas of already established bushland.

Entomologist and Nutworks Grower Liaison Officer, Chris Fuller, is a passionate advocate for Australian native bees and supports farming practices that minimise harm and disruption to bees. Chris recommends incorporating native species that flower at a different time of the year to macadamias.

Chris suggests *Buckinghamia celcissima, Corymbia* species (if you want bigger trees), tuckeroo (winter flowering) as well as *Banksia, Melaleuca, Syzygium* and *Xanthostemon* species.

He recommends avoiding the Casuarina and *Kurrajong* species as they are less attractive to bees. Additionally, foambark *(Jagera pseudorhus)* is best avoided as it attracts *Leptocoris* species, an emerging and potentially major pest of macadamia.

It is important to create an environment that is unfavourable to rats by selecting plant species that do not harbour or provide out-of-season food for them. Also, consider providing an environment for rat predators like owls by including perching points and nesting boxes.



*While it is too early to see the benefits, at a cost of only $5 per tree, Craig is convinced that the benefits will far outweigh the costs.*

## Incorporating natives — the way of the future?

Craig said that while it is too early to see the benefits of the native plantings, at a cost of only $5 per tree, he is convinced that the benefits will far outweigh the costs.

He believes that just as using compost and adding carbon to the soil have become standard practice, so too will incorporating natives to support pollinators.

**Information**

- Factsheet 'Planting and creating habitat to attract bees' by the Mary River Catchment Coordinating Committee: https://bit.ly/3xN3G27
- Factsheet 'Planting for Australian native bees' by Australian Pollinator Week: https://bit.ly/3XVn73z
- 'Growers guide: Supporting stingless bees for pollination of macadamia, 2022' by R. Wilson and H. Wallace. Download from the AMS website

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# New edition of the Macadamia plant protection guide out now

*The 10th edition of the* Macadamia plant protection guide *is now available, offering macadamia growers the latest information on effective pest and disease management. You can download it from the NSW DPI website and it will soon be available in hard copy through processors and from the NSW DPI Wollongbar office.*

## Feature article: pesticide management

This year's feature article explores pesticide management beyond the usual integrated pest and disease management protocols. It highlights the legal and practical responsibilities of macadamia growers during pesticide application, with a focus on sensitive areas and buffer zones.

The article explains how to identify and map sensitive areas on and around your farm, such as water bodies, neighbouring properties and wildlife habitats. Learn how to develop spraying strategies, such as considering favourable winds and tailoring buffer zones for each block.

The article also covers your responsibility as a property owner around chemical storage and best practices for chemical storage and disposal, including programs like drumMUSTER and ChemClear.

## A look back at last season

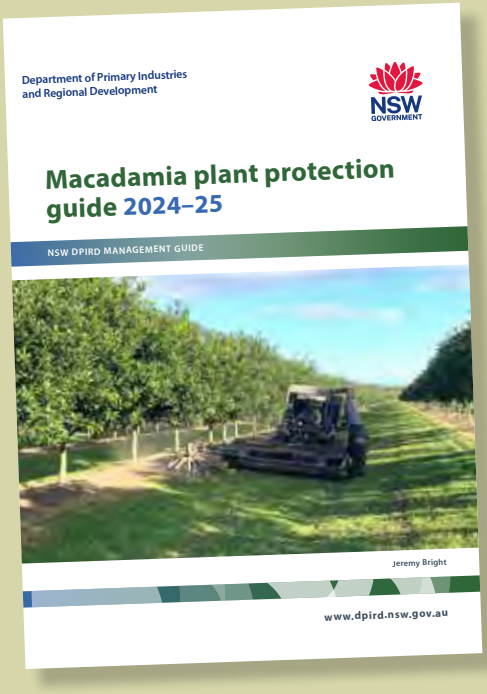
The guide reviews the past season's crop and the challenging conditions of 2023. This was a particularly hard year for the industry due to lingering effects from floods, low solar radiation and poor prices.

## Latest research on flower blight pathogen

Researchers Vivian Rincón-Flórez, Hariharan Ganeshamoorthy, Xiaxoue Xu and Femi Akinsanmi explore the ongoing research into the flower blight pathogen. The article presents new insights into further subdividing the flower stages to pinpoint when the diseases occur on the flowers. It discusses newly identified flower disease and the conditions that are optimal for their infection mechanisms.

## Chemical reviews and registrations

The Australian Pesticides and Veterinary Medicines Authority (APVMA) will make its final decision about diazinon use in September 2024. Based on their summary of diazinon's uses, certain applications of this pesticide in macadamia farming will likely be prohibited after this decision. Specifically, the use of diazinon for controlling macadamia felted coccid and macadamia leaf miner using a vertical sprayer will not be supported. This decision is influenced by concerns regarding pesticide residues in the nuts and trade implications.




Merivon® (250 g/L pyraclostrobin + 250 g/L fluxapyroxad; Group 7 + 11) is currently registered for macadamia husk spot and has now been registered for the control of botrytis blight (grey mould) in macadamia.

If you would like to provide feedback about the *Macadamia plant protection guide*, contact Jeremy Bright. Jeremy.bright@dpi.nsw.gov.au or 0427 213 059.

# A new strategy to prevent yield losses to flower blight

**BASF Australia Ltd**

*Flower blight is an exceptionally tricky disease. In fact, it's not even a single disease, but a complex of three interrelated ones: dry flower disease, green mould and grey mould (botrytis). The prevalence of the individual components varies from season to season and between growing areas. In the years since it was first identified in macadamia orchards in Australia, a lot of growers have found the complex hard to detect and identify – at least before it causes significant damage – let alone control.*

While there have traditionally been limited treatment options for flower blight, recently there has been a change to what is available. Importantly, this change may impact most growers' spray programs for husk spot as well.

## Registered fungicide another management tool

The headline news is that Merivon fungicide is now registered to control the whole flower blight complex, including *Pestalotiopsis* spp. and *Neopestalotiopsis* spp. (the groups of pathogens that cause dry flower disease), *Cladosporium* spp. (green mould) and *Botrytis cinerea*.

Bundaberg-based macadamia researcher Chris Themsen of Agreco Australia has been investigating flower blight and conducting trials using Merivon to control it for several seasons. He has found that the potential negative impact of the disease complex is widely underappreciated and that it often goes undetected and untreated until it's too late to avoid costly yield losses.

"After working on this pathogen for six years," Chris says, "we've become very sensitive to it and our threshold for treating it is really low."

Now that Merivon is available, Chris expects many growers to change their approach to disease management.

He feels that growers should be comfortable being more proactive, knowing that Merivon offers both high levels of control of all the pathogens in the complex using two modes of action (Mode of Action groups 7 and 11, rather than just Group 7) and excellent value.

Chris advocates a more proactive approach because he says the yield losses caused by flower blight can be catastrophic. He has seen yields fall by up to 75%, and in some cases, total failure of the crop.

The first symptoms of flower blight, like the spotty leaves just before flowering that indicate the presence of *Pestalotiopsis* and *Neopestalotiopsis,* appear when growers are generally still finishing up the previous harvest or busy with canopy and orchard floor management. This means that something growers will need to factor into their pre-flowering schedules will be monitoring and applying sprays, something that will involve time management and a change of mindset.

Chris expects high flower blight pressure this year around Bundaberg given the above-average rainfall since Christmas. He says there is a high level of inoculant on the trees, and rain in the lead-up to flowering will transfer it to the new growth and kick off the disease development.

The updated Merivon label recommends an application before the rachis is fully elongated and unopened green flowers have formed, with a follow-up spray at Stage 3 (fully open white flower).

Note: Being able to identify flower stages underpins effective control. For information on identification, refer to article "Monitoring and managing flower diseases in macadamia", page 56.

## Different regions, different pathogens

Agreco's research indicates that the most aggressive pathogens around south-eastern Queensland are *Pestalotiopsis* and *Neopestalotiopsis*, and that the infection spreads most readily through early flowering. Chris will begin his spray program with an application of Merivon before the rachis is fully elongated, probably followed by a second spray late in stage 2.

In northern New South Wales, where *Botrytis* is typically a more significant component of the complex, slightly later application timings may be more effective.

## Follow directions to avoid resistance

For growers who have been using Merivon (Groups 7 and 11) to control husk spot, Chris advises a switch to Belanty® (Group 3) as the lead treatment. Belanty can be first used at matchhead with a second application 21 days later, supported by a possible third and final spray of Merivon or the first use of an alternative fungicide. Belanty can be used a third time if required once another mode of action has been used after its second spray.

The rotation of those three modes of action in accordance with their label directions for use should provide excellent disease control while adhering to the CropLife resistance-management guidelines.



# Another season in the bag.

**As the 2024 season draws to a close, we're excited to keep growing for the next.**

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# We care about our growers.

**Here at Nutworks, we have nurtured meaningful relationships with our valued local macadamia farmers for the last 28 years.**

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During the growing, harvesting, de-husking, or drying process, we never hesitate to lend a hand to our farmers, whether that be through general agronomic and entomology assistance or specialised pollination advice.

But don't just take it from us – take it from Diane Cheal and her father, Graeme Cheal, who thoughtfully tend to 4,500 macadamia trees in the Sunshine Coast hinterland – the ancestral home of the macadamia tree.

**"Nutworks has always been good to us, and we love having them as our support team. It means a lot to have heartfelt people you can count on."**

"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.

"The people I've met through Nutworks are the salt of the earth. They not only take interest in you as a farmer, but also as a human being," she said.

Nutworks has a commitment to maintaining a premium position for Australian macadamias, and showcasing what Australian growers have to offer to the world.

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# Innovative pest management solutions for Gympie Region

*Suncoast Gold has joined forces with Growcom to address the pressing pest management challenges faced by horticulture growers in the Gympie region. The aptly named* Pests, Dirt and Fert *program, funded by the Department of Agriculture and Fisheries, is set to improve pest control strategies for growers within the Mary catchment.*

These strategies focus on the notorious "Three Fs" - fruit fly, fall army worm and fruit spotting bug - with the program being designed to provide growers with practical ways of managing these pests.

## RapidAIM: Game-changing technology

At the heart of this initiative lies the cutting-edge RapidAIM technology. This bio-digital real-time detection and crop protection is designed to alert growers to the presence of a wide array of pests, including Q-fly (fruit fly), macadamia nut borer, carob moth, budworms and fall armyworm.

With an impressive 98% accuracy rate, RapidAIM is making waves across horticulture. From mangoes and macadamias to blueberries and vegetables, and even extending to maize and sorghum, this technology is proving its worth.

The impact of RapidAIM is already evident in Bundaberg and Bowen, where a network of detection units provides growers with regional pest threat forecasts. This capability is being seen as a game-changer for the industry. Recognising its potential, the Bundaberg Fruit & Vegetable Growers (BFVG) group is working to establish a similar network in the Gympie region.

Importantly for the macadamia industry, while fruit spotting bug is not currently monitored, it is technically possible to develop this ability; however, resources would need to be committed to identifying a lure and developing the algorithm to enable detection.

## Beyond pest control: environmental stewardship

Michelle Haase, a Hort360 Facilitator with Growcom, emphasises the broader implications of these technologies. "Tools like real-time pest detection are extremely valuable in assessing if pest control strategies are effective and what practice changes are required to increase efficacy," she explains.

The Hort360 program, which supports growers in improving practices and demonstrating environmental stewardship, has seen significant engagement from the macadamia industry. Nearly half of the area currently certified under this program falls within the Great Barrier Reef catchment, highlighting the industry's commitment to sustainability.



*A RapidAIM detection unit being installed in an orchard.*

As the horticulture industry faces ever-evolving challenges, initiatives like *Pests, Dirt and Fert* demonstrate the power of collaboration, innovation, and shared knowledge in securing a sustainable and prosperous future for growers across the region.

**Information**
Growcom and Suncoast Gold Macadamias collaborated by organising a workshop in August, with funding from the Queensland Government and support from BFVG's VegNET project. This was just the first in a series of events planned for the Gympie and greater Mary region.

Growers interested in staying informed about future events are encouraged to contact Michelle Haase E: mhaase@qfvg.com.au or Paul Hibbert E: Paul.Hibbert@suncoastgold.com.au. Participation is free, and membership of Growcom or other industry groups is not required.

**Acknowledgment.** The VegNET project is funded by Hort Innovation using the vegetable research and development levy funds from the Australian Government. For more information on the fund and strategic levy investment visit horticulture.com.au.

# Nuts for Life update

*Sustainability is an ongoing priority for the Australian nut industry, including macadamia growers. Nuts for Life is aiming to share this message with Australians through its new industry-specific online sustainability hub.*

Nuts for Life recently launched a sustainability hub on their website to help people understand the role of nuts in healthy and sustainable diets, and the nut industry's initiatives in this space. The idea is to unpack the complex issue of sustainability, and the content will be built on over time. The hub also houses a new, free-to-download Sustainability Matters report.

In this article, we explore some of the key topics discussed on the sustainability hub.

## Sustainability matters in the nut industry

According to the United Nations' Food and Agriculture Organisation, a sustainable food system delivers food security and nutritious foods for populations in a way that does not impact future generations. The nut industry is aspiring to dojust that.

Belinda Neville, Program Manager at Nuts for Life, said, "The industry is committed to best practice and innovation in areas such as biodiversity, water conservation and soil health, while working to minimise waste and emissions.

"New technologies and different ways of doing things are continually being developed. That allows the industry to continue to produce nuts, a nutritious food, while at the same time preserving and protecting natural resources for future generations."

## Horticulture's sustainability framework

The nut industry operates under Hort Innovation's Australian-grown Horticulture Sustainability Framework. This maps back to relevant United Nations 'Sustainable Development Goals' – and specifically, these four goals and indicators:

- Nourish and Nurture
- People and Enterprise
- Planet and Resources
- Climate and Waste

The nut industry balances the use of natural resources by producing a nutrient-dense, whole food that benefits human health.

## Healthy and sustainable eating

Climate change, and its current and future effects on population and planetary health, is an urgent, complex issue. Tackling it requires massive societal shifts. This includes changes to our food systems – the way food is produced, processed, distributed and prepared – and our food choices. The good news is that transitioning towards healthier foods will generally also help people live more sustainably.




*The* Sustainability Matters *report is free to download from the new Nuts for Life sustainability hub.*

Nuts fit within many healthy, plant-based dietary patterns, including the Planetary Health Diet (PHD), which promotes plants as a primary protein source. The PHD recommends that plant-based options, such as nuts and legumes, make up 80% of the total amount of the 'protein' food group. It suggests people aim to eat 50 g of nuts a day (with a range of 0 to 70 g), consisting of 25 g each of peanuts and tree nuts.

Recent research has shown that the PHD is linked with a lower risk of early death from any cause, and a substantially lower environmental impact, than conventional Western diets, which are typically higher in animal proteins like red and processed meats.

Nuts also make a healthy and sustainable alternative to discretionary, or 'junk', foods. Discretionary foods contribute around 25% to the total water scarcity footprint of Australian adult diets, and around one third of the total food-related greenhouse gas emissions in Australia.

Nut trees are part of the lungs of our country. They remove carbon dioxide from the atmosphere, store carbon, and release oxygen into the air 24 hours a day, 365 days a year.

## Launching the sustainability hub

The sustainability hub was launched to health professionals at a July webinar supported by Nuts for Life. The webinar, 'From plate to planet: Transforming dietetic practice with sustainable principles', was presented by dietitian Nicole Senior, co-convenor of Dietitians Australia's Food and Environment Interest




Group, and chef Callum Hann.

Since then, the Nuts for Life team has shared the hub widely.

Access the Sustainability Hub at: https://www.nutsforlife.com.au/sustainability/

## In case you missed it: NEW 'Cooking with nuts' hub

We've recently launched a new hub on our website, with handy culinary resources and recipe inspiration.

The 'Cooking with nuts' hub includes fact sheets, graphics, and videos on topics such as how to roast nuts, buying and storing nuts, how to make nut 'mince' and tips on incorporating nuts into every day.

It also includes a suite of around 200 delicious recipes, including 10 brand new ones.

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

## 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 by the Hort Frontiers Health, Nutrition and Food Safety fund part of the Hort Frontiers strategic partnership initiative developed by Hort Innovation, with co-investment from the Australian nut industry and contributions from the Australian Government. Nuts for Life works with health professionals, government, and other bodies to improve the nutritional reputation of nuts.

**Information.** For more information visit www.nutsforlife.com.au, follow us on LinkedIn, or contact:
Belinda Neville, Program Manager belinda.neville@nutsforlife.com.au
Maree Hall, Digital and Communications Manager maree.hall@nutsforlife.com.au



# Funding supports pollination research

Funding from the macadamia industry and Hort Frontiers Pollination Fund is helping to support a number of projects through it's Pollination Fund. Recently completed and current projects have focused on:

- understanding pollination processes
- improving practices to increase yield and quality
- supporting the stingless bee industry
- safeguarding Australian honey bees from pests.

This article outlines the aims and findings of recent pollination projects.

## Increasing yield and quality in tropical horticulture by optimising pollination

This Hort Frontiers Pollination Fund project ran from 2018 to 2023. It investigated how both cross pollination and crop nutrition during pollination affect fruit quality and yield. The project focussed on macadamia, almonds, custard apples, lychees, mango and strawberry.

A key finding for macadamia growers is that planting different cultivars closer together is important because the trees rely heavily on cross-pollination. The project found that self-pollination provided less than 0.2 t of nut-in-shell per hectare and that self-pollinated nuts had lower kernel recovery than cross-pollinated nuts. The presence of self-pollinated nuts reduces the prices paid for nut consignments.

You can download the final report here: https://bit.ly/4cgxdjG

## Crop and varietal data to better understand the importance of pollination

This ongoing Pollination Fund project is compiling all available crop pollination dependency data for a range of crops, including macadamia. The project is standardising ongoing data collection to address research gaps.

An important aim of this project is to make this information easily accessible, via an updateable database, for growers, apiarists, consultants and plant breeders. The database will provide information about cultivar-specific crop pollination requirements, such as dependence on cross-pollination and ideal distance between cultivars, and key insect pollinators.

## Strengthening and enabling effective pollination for Australia

This eight-year Pollination Fund project finished in 2023. The project identified key pollinators across six crops and produced recommendations for pollination management to optimise yields and minimise the risk of pollination failure. It also assessed innovations to enhance honey bee health.

Field studies found that macadamia crops were visited by both honey bees and a range of non-honey bee insects. The abundance of these insects varied among regions and among farms within a region. The project provides recommendations for honey bee hive placement, stocking rates, and colony feeding regimes, to standardise and enhance their pollination potential for crops including macadamia.

A pollination manual for macadamia growers was produced as part of this project. It can be downloaded here: https://bit.ly/3xtAX2e

## Supporting the health and expansion of the Australian stingless bee industry

This ongoing Pollination Fund project is supporting the health and expansion of the Australian stingless bee industry. Researchers at the University of Western Sydney are investigating bee diet, health, pests and pathogens and deployment in pollination-reliant crops. The team is also testing nutritional supplements for stingless bees, including methods of providing supplements to hives, and whether supplementation can improve cross pollination.

## Stingless bees as effective managed pollinators for Australian horticulture

From 2017 to 2023, this Pollination Fund project explored the potential of stingless bees as managed crop pollinators by testing their effectiveness with selected field crops and suitability as glasshouse crop pollinators.

The macadamia component of the work had three objectives:

- Managing stingless beehive strength to increase pollination potential
- The impact of hive placement on cross pollen carried by stingless bees in macadamia
- Investigating management and maintenance strategies for stingless bees on macadamia farms in non-flowering periods.

The final report can be downloaded here: https://bit.ly/3xxoD0Y.

## Study of self-fertility in a macadamia breeding program

This is a PhD study being conducted at the University of Queensland as part of MC19000.

Macadamia is highly dependent on pollinators and efficient pollinisers for nut set. Research has found that cross-pollination gives higher yield than self-pollination. This makes self-fertility a significant trait to select for within our breeding program. The study aims to find associations between self-fertility and high-yield and the identification of the self-fertile cultivars.

## National Bee Pest Surveillance Program

This investment is delivering a national coordinated surveillance program to safeguard Australian honey bees and the cropping industries that benefit from pollination services. The National Bee Pest Surveillance Program (NBPSP), which is part of the National Bee Biosecurity Program, is a risk-based early detection system providing the best chance of eradication or containment of bee pests or detection of Asian honey bees and the exotic bee mites they carry.

The program will conduct surveillance for 13 mite and beetle pests that impact honey bees, and pest bees that could either carry hitchhiking parasites or could themselves cause detrimental impacts to honey bees. The program activities include upgrading sentinel hive arrays, strengthening relationships with surveillance operators and more. The surveillance is designed to enable the early detection of high-priority pest incursions that can affect honey bees, providing the best opportunity for successful pest eradication.

**Information**
Find out about these projects and others relating to macadamia from the Macadamia R&D project page on the Hort Innovation website: www.horticulture.com.au/growers/macadamia-fund/

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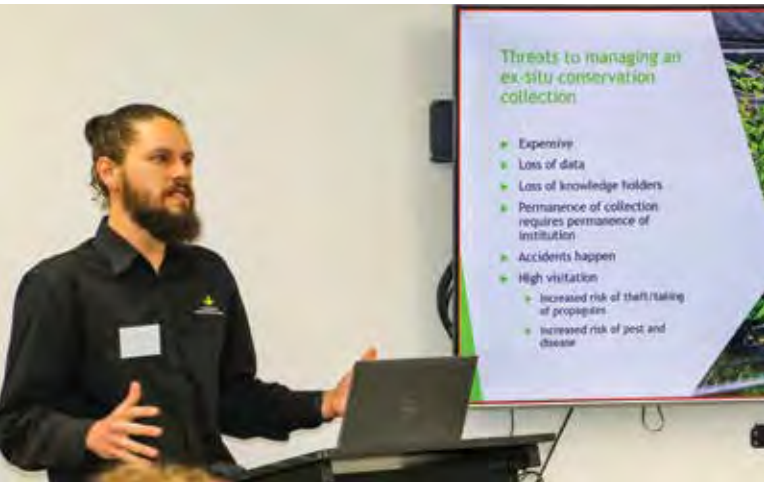
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## HIMAC SLASHER BLADES & FASTENERS COMING SOON!

# Technical team starts work on recovery and resilience of *Macadamia jansenii*

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

*In July this year, a new technical team met for the first time to share knowledge and experience about* Macadamia jansenii *and its subtropical forest habitat.*




*Joel Cohen, the new Curator of Tondoon Botanic Gardens, Gladstone, brings experience from the Royal Sydney Botanic Gardens where he worked on protection of the Wollemi Pine and the Restore and Renew project for NSW rainforest species.*

The team met at the Bargara headquarters of the Burnett Mary Regional Group (with a few brave souls joining via video link), supported by funding from the Australian Government through a Saving Native Species (Priority Species) grant.

This grant is for $500,000 over two years to address key threats to *M. jansenii* habitat in Bulburin National Park, and leverages $200,000 in kind from QPWS and BMRG, as well as significant input from other members of the consortium team.

The team comprises:

- **Gidarjil Development Corporation**, which implements custodian activities for the traditional owners of the region, the Bailai, Gurang, Gooreng Gooreng and Taribelang peoples.
- **Keith Sarnadsky and Ray Johnson**, who have combined their knowledge of the species and the landscape to locate new *M. jansenii* trees as well as searching in areas where the tree could grow, but doesn't, thereby confirming just how restricted and rare it is.
- **Dr Alison Shapcott** (University of the Sunshine Coast), who has led scientific research into the species and its habitat, published the papers that document research findings for the rest of us to use, and coordinated the establishment of reintroduction sites.
- **QPWS staff** from the Region and Head Office, who are responsible for day-to-day management of the park, as well as for long-term strategies to deal with the many issues impinging on the park, not least of which is balancing the needs of recreational visitors with the requirements of a delicately balance ecosystem threatened by invasive species and fire.
- **Plant conservation experts.** A complement to habitat conservation is protection of representatives of the species outside its natural environment, and Tondoon Botanic Gardens at Gladstone is host for the most important collection of ex-situ *M. jansenii*, with support from FAME (Foundation for Australia's Most Endangered Species).
- **Burnett Regional Management Group** (BMRG). As the natural resource management group for the area, with technical expertise in mapping and monitoring, BMRG is perfectly placed to attract and manage funding to supplement the resources available to QPWS for long-term management of the many and diverse species that live at Bulburin.
- **MCT.** Members of the original Macadamia Conservation Committee (notably Ian McConachie) have the longest involvement with rallying resources to protect *M. jansenii*. The MCT and the Macadamia Recovery Team now play a pivotal role in coordinating, storing and sharing information so that the best use can be made of the consortium's resources.

## Weed control and fire management top priorities

Everyone agreed that on-ground weed control and fire management are the top priorities to protect *M. jansenii* habitat. To be able to do this effectively, all the relevant players need to know where the population is, where extensions to that population might be and how weed species are introduced and spread throughout the Bulburin landscape.

After the workshop it was clear that the mechanisms spreading the worst weed species (wind, birds, water and feral animals) are not going to change



Saving Native Species Macadamia jansenii grant 2024 *has brought together staff from Gidarjil DC, BMRG, QPWS, Tondoon Botanic Gardens, University of the Sunshine Coast, MCT and dedicated individuals in a consortium to maintain or improve the current population of* M. jansenii.

in the short term. We need to make the best use of scarce resources to keep the worst of the weeds from impacting *M. jansenii's* ability to survive and reproduce by controlling what we can over the next two years while setting up mechanisms for longer-term management. At the same time, we need to facilitate landscape-level fire management to control fuel build-up in the face of a warming climate.

The shared input to the technical workshop has set the consortium up for a busy two years of combatting invasive species and fire in Bulburin National Park.

Joel Cohen, the new Curator of Tondoon Botanic Gardens, Gladstone, brings experience from the Royal Sydney Botanic Gardens where he worked on protection of the Wollemi Pine and the Restore and Renew project for NSW rainforest species.

*Saving Native Species Macadamia jansenii grant 2024* has brought together staff from Gidarjil DC, BMRG, QPWS, Tondoon Botanic Gardens, University of the Sunshine Coast, MCT and dedicated individuals in a consortium to maintain or improve the current population of *M. jansenii*.




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# IOM principles guide McLeans Ridges orchard makeover

**Robbie Commens, 2 tonne enterprises (2te)**

**Orchard owner and location:** Neo Farms Orchard JCR, Mcleans Ridges, Northern Rivers, NSW

**Size:** Property 33.5 ha total; orchard 32 ha in 2023 and 28 ha in 2024

**Cultivars and spacing:** Old Hawaiians including 344, 246, 741; mixture of 8 x 4 m, 10 x 4 m and 9 x 4 m spacings

**Topography:** Steep through to undulating hill flats



*Neo Farms JCR Orchard which is a 33.5 ha property with 32 ha of planted orchard area.*

Neo Farms Australia have been growing macadamias in Australia in the Northern Rivers of NSW for more than 10 years. They own six different orchards comprising more than 280 ha, with the orchards varying in age and location from one-year-old trees on their Cornerstone orchard in Pimlico through to the Southern Cross orchard in Eureka with trees more than 30 years old. The properties are grouped into 'hill orchards', located on the Northern Rivers tablelands (approx. 96 ha), and 'flat orchards', located on the Northern Rivers floodplains.

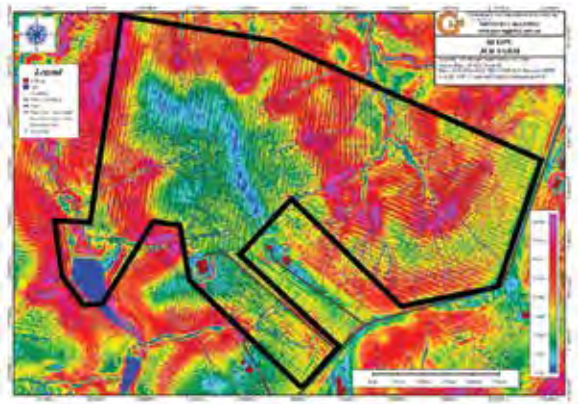
Initially Neo Farms managed their farms with their own staff, but in January 2023 they engaged 2te to manage all their orchards. Our management role includes providing qualified staff to operate Neo's machinery, which includes tractors, mowers, mulchers and harvesters, and implementing the annual operating plan (AOP). The AOP and budget are developed with Neo Farms Australia head office, in Seoul, South Korea.

While this article focuses on JCR, one of the hill orchards located in McLeans Ridges, in 2023 2te undertook the same process and works across all four of the Neo hill orchards, which total 96 ha.

## Orchard management priorities

Before taking on the management of the orchards, we undertook an IOM review, which was done in line with IOM principles and focused heavily on drainage, orchard floor and canopy management. Every red flag was identified at the JCR orchard, with drainage, orchard floor and canopy management all classified as stage 4.

Characteristic of a stage 4 orchard, production had declined over the previous three years, with yields averaging 0.9 t NIS/ha.



*A LiDAR map of the farm showing slope and water flow.*

Completing the IOM review of the orchard allowed us to develop priorities, which were:

- identify traffic-light zones
- improve drainage by grassing up the gullies
- apply organic matter to the tree row and improve machinery access by sweeping material in the inter row under trees
- control lace bug.

## Traffic-light zones

2te had access to some previous LiDAR maps completed by GES mapping, which provided an excellent perspective on slope, water flow and catchment zones.

These maps were used to allocate zones in line with a traffic-light system, as follows:

- Green = ideal slope
- Orange = manageable slope needing intervention to be sustainable
- Red = high risk slope that should not be actively farmed.

This helped both 2te and Neo to look at the orchards in a new light and focus on the green and orange blocks as opportunities for production and IOM improvements.



*Map of the farm with the red, orange and green zones highlighted.*

Based on the mapping, the AOP and the IOM review, we identified key opportunities for orchard improvement, which included:

- stop actively farming **red** zones (slope > 12.5 degrees), i.e. no operating expenses (OpEx) spend
- focus investment of OpEx on **green** zones
- develop strategies for **orange** zone improvements to turn them back into **green** zones (restricted and targeted OpEx spend).

Stopping investment in the red zones, which totalled 4 ha and reduced the orchard's productive area from 32 to 28 ha, was a key action. While these zones did not represent a large percentage of the total orchard area (12%), they did represent a large percentage of the previous OpEx investment of time, energy and funds. These blocks often were the hardest to access with machinery, had the most exposed roots and erosion, had the highest incidence of pests (rats, insects and others) and had the highest incidence of machinery repair and maintenance costs.

With the AOP and budget adjusted accordingly, with a $0 investment on all red zones in year 1, there was a saving of about $34,500 ($8,500/ha OpEx)

## Grass up the gullies

The IOM review highlighted that although all three pillars needed improving, the orchard floor and drainage pillars offered the greatest return from a modest investment.

The orchard suffered from deep and dangerous erosion gullies with some washouts over 0.5 m deep. These gullies were in the middle of blocks, prevented machinery access and were a significant safety hazard.

Using the LiDAR maps as evidence, the recommendation was to remove almost 600 trees in these gullies. This allowed the gullies to be reshaped in a manner that slows water flow and allows sun onto the floor, both of which encourage grass and vegetative growth.

The trees were removed using a 20 t excavator, operated by Hammond Earthmoving (Wardell, NSW), with assistance from 2te staff. The trees were stacked and burnt as this was the cheapest option for disposing of the material, and there was a lot of organic matter on the orchard floor already from previous years' harvesting and dehusking.

The gullies were repaired with strategically installed rock checks, the most successful of which were those that were sunk, i.e. where a hole was dug in the gully and filled with large rocks to surface level. This encouraged water to enter the rock check, slow down, then spill onto the next part of the gully. Raised rock checks added some value, but often caused water to pool around them during extremely heavy rain events.

To protect the soil, earthworks were undertaken in the spring, traditionally a dry time. Grass seed was spread directly after the earthworks were finished, and additional erosion control measures were taken as needed (including laying turf and installing sediment fences and hay bales). Wherever possible, the bottom of the gullies was flattened to spread water out and reduce the risk of deep water flowing with increased power and speed.

These gully improvements were put to the test in March-April 2024 when an extreme weather event





*Left A gully directly after trees had been removed, burnt and gully reshaped. Right. The same gully six months later after grass seed germinated (as well as natural germination).*

dropped more than 475 mm of rain. An excellent result was achieved, with the fully grassed gullies and the rock checks impeding water flow from the heavy rain, resulting in minimal wash into the gullies.

An added benefit has been a 'drying wick' effect on the orchard blocks where the gullies have been improved. The grassed gullies dry out first now, rather than last as was the case before the IOM works, and this, in turn, helps dry out the orchard blocks.

Before the IOM works, machinery had to stop before the gully wash out and do a ten-point U-turn in the inter row or reverse out. Machinery can now be driven from one end of the row through to the other end without turning around, which has added hugely to machinery efficiency and greatly improved staff safety.

The cost to remove the trees from the gullies, spread seed and install the erosion reduction measures was $28,000 (including the contractor, labour and input costs), the equivalent of $1,000/ha over this orchard.

## Sweep the organic matter

A lot of organic matter had built up in the middle of the inter row across the orchard as a result of previous years' harvest sweeping, blowing and dehusking. It was beautiful rich organic matter, but it was sitting right in the wheel tracks for machinery thus making access **very** difficult, particularly as it held moisture at the surface for a long time.

Recognising the value of this organic matter, we recommended that Neo invest in some orchard brooms to move it back into the tree row. Brooms leave soil intact, require modest power to operate and are relatively quick across the orchard, particularly when compared to spreading a similar amount of organic matter along the trees with a band spreader or profiler.

The end result was very impressive and exciting.

A test of the organic matter before sweeping showed that it was high in potassium. The sweeping moved the matter from a 25 mm deep layer in the middle 6 m of the inter row into a 40 to 50 mm layer of organic matter along the tree row (approx. 2 m wide along each tree row).

The fine feeder roots grew up into that material in a matter of weeks, helping consolidate it in the tree row. The broom also allowed the middle of the inter row, where the machinery wheels need to drive, to be free of organic matter thus allowing earlier machinery access. Previously, the organic matter held moisture and caused wheel slip.

Once the second-hand brooms were purchased (between $2,000 and $7,000 each) the cost to sweep was about $145/ha, including labour and diesel costs (no cost for machinery).



*Organic matter in the inter row held moisture, causing wheel slip and delaying machinery access.*



*Left: Sweeping organic matter from the inter row to under the tree row.*



*Swept organic matter 40 to 50 mm under tree rows promoted the growth of feeder roots.*

## Control lace bug

Lace bug was evident in the orchard, however, with canopies over 10 m high, and productive green canopy concentrated in the top 2 m, achieving spray coverage was a challenge.

Standard orchard air blast sprayers were tested and deemed to be unsuitable as they could not reach the top of the canopies. Consequently, the search for some tall tree sprayers was on.

2te worked with Robert Bianco to assess spray coverage with different machines. Spray units that concentrated air and liquid on a single side of

application (not a standard twin-side, air blast tower) were successful in reaching the top of the canopy, so we bought two second-hand Silvan spray units and put them to work completing critical lace bug control application, and subsequent crop protection sprays.

## Results prove the investment

The lace bug control was successful, with a crop being set in spring 2023 and maturing across the growing season. The improvements to the gullies allowed machinery (including the spray unit and tractor) to operate entire rows. The swept orchard floor and the drying wick effect from the grassed gullies allowed earlier machine access into the blocks for time-critical operations.

In 2023 the orchard produced 17.9 t of NIS at 10%, compared to the previous best production during Neo management in 2020 of 56 t harvested. Over the 28 ha of orchard area, this equated to 0.63 t NIS/ha. As of July this year, mid-way through a very difficult wet harvest season, the orchard has produced 48.6 t of NIS at 10%, equal to 1.73 t NIS/ha. We estimate that two-thirds of the crop has been harvested to date, with a further third remaining to be harvested, once the rain stops for longer than three days in a row! The target for the end of the season is to achieve over 2.5 t NIS/ha or more than 72 t of NIS at 10%.

The average RKR for the season to date is 1.58% and the average SKR is 34.79%.

While the production per hectare is modest when compared to the high performing farms in the industry benchmarking report, the increase is significant, with the orchard delivering a threefold increase in production in one year. The $28,000 invested into grassing the gullies, and the $4,000 invested into sweeping the orchard floor totals $32,000. This $32,000 investment has contributed to delivering an additional 30 t of NIS (about $95,000 worth of NIS @ $3.10/kg).

Controlling lace bug is a key driver of this increase in production; however, we were only able to implement a successful spray program because of the improved machinery access resulting from the IOM improvements.

It is also worth noting that all of the canopy red flags remain, and the canopy is still at a stage 4. Only relatively minor and modest works on the drainage and orchard floor red flags have been undertaken. However, in one year, those works has been able to move the orchard out of a stage 4 category on the orchard floor and the drainage pillars, into a stage 3.

As further improvements are implemented, and the orchard moves back to a stage 2 category across all of the IOM pillars (canopy, drainage and orchard floor), further production gains will be achieved. Watch this space for another update in the future.

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# CCC macadamia research update highlights benefits of IOM

**Jeremy Bright, NSW DPI, Wollongbar P: 0427 213 059 | E: jeremy.bright@dpi.nsw.gov.au**

*Almost fifty farmers, agronomists and key macadamia industry stakeholders headed to Alstonville on the NSW North Coast on Friday 14 June to learn more about integrated orchard management (IOM) and the latest macadamia research conducted by the Clean Coastal Catchments (CCC) team from the NSW Department of Primary Industries and Regional Development (DPIRD).*

The field day was held at the DPI Centre for Tropical Horticulture (CTH) to demonstrate how IOM techniques can lead to improved orchard sustainability, more profitable production and cleaner water in coastal creeks, rivers and estuaries.

## Integrated orchard management: Row removal and cover crop trial

CCC researchers have been working on an IOM trial at the CTH site in Alstonville comparing a macadamia block where rows have been removed (creating an orchard with a 16 x 4 m row configuration) with an adjacent orchard where the trees are more densely planted (in a traditional 8 x 4 m configuration).

Cover crops have also been sown between the tree rows in the IOM trial block, while this IOM technique has not been used in the adjacent pre-IOM block.

The macadamia industry has long known that using IOM techniques has both environmental and on-farm benefits, but the extent of these benefits has not previously been documented. CCC research on the CTH site aims to quantify the benefits of IOM.

Southern Cross University Industry Research Fellow, Dr Mitchell Call, has analysed run-off water from the research orchards for a range of parameters such as water quantity, soil loss and total nitrogen.



*Event organisers, Jeremy Bright, Diana Unsworth and Meg Strang from the DPI Clean Coastal Catchments Research project.*

The research was initiated by Department of Climate Change, Energy, the Environment and Water (DCCEEW) environmental scientist, Suzanne Acret, to deliver documented evidence of the benefits of IOM for growers, while also measuring the water quality benefits for the environment.

The research was funded in a collaboration between DCCEEW and the CCC Research project, through the NSW Government's Marine Estate Management Strategy (MEMS).



*Integrated orchard management with row removal creating a 16 x 4 m spacing between tree rows, allowing sunlight to promote grass growth.*



*A shaded row between trees in a pre IOM orchard with standard 8 x 4 m row spacing. The lack of sunlight inhibits grass growth creating greater potential for erosion and the loss of nutrients in rainfall run-off.*



*The photos above show almost clear run-off water collected from the IOM block on the left, compared with muddy run-off collected from the adjacent pre-IOM block on the right, demonstrating how IOM practices can reduce soil loss.* Photos: Dr Mitchell Call.

Dr Call's results have highlighted the benefits of IOM which include:

- Consistently reducing surface water run-off during rain events.
- Retaining soil and nutrients onsite that would otherwise be washed away during rain events. The dramatic difference in sediment load in run-off is evident in the images above.
- Improving soil, nitrate and phosphate retention on farm, particularly during large rainfall events as shown in the figure (opposite).

Attendees at the CCC Macadamia Research Update took part in a productive discussion about the benefits and the costs of IOM for growers, with DPIRD Macadamia Development Officer, Jeremy Bright, pointing out that row removal is only one form of IOM canopy management. The CCC project is trialling other orchard floor and canopy management techniques at the CTH site including drainage modification and limb removal.

The research will progress with the adjacent pre-IOM block to be converted to IOM over the next 12 months so that various IOM-related practices can be assessed.

## Benefits of organic amendments

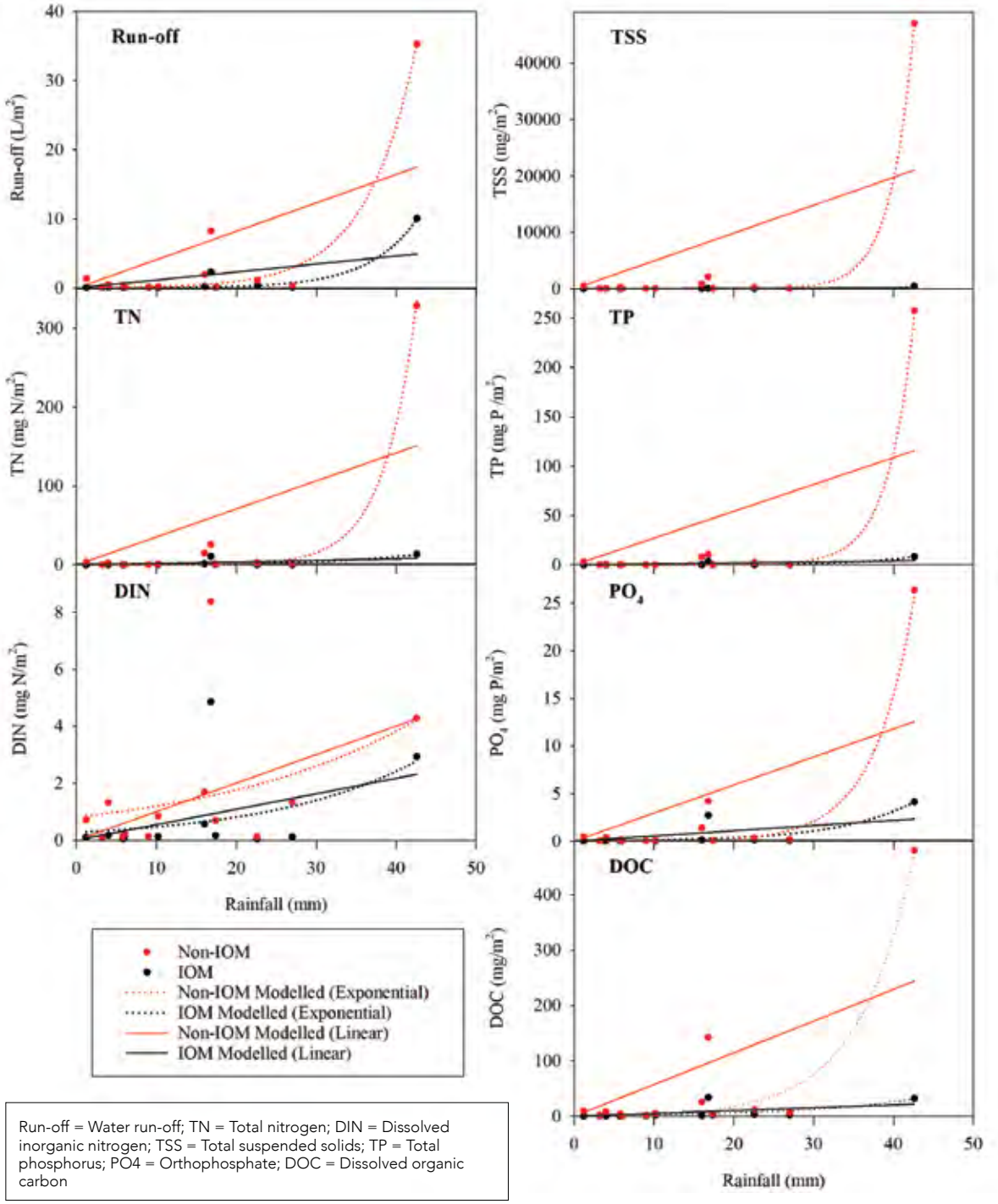
The research update also showcased research comparing three different nutrient treatments and how they affect orchard production, environmental sustainability and fertiliser costs.

The treatments being trialled include:

- inorganic fertiliser
- organic matter amendments
- a combination of organic matter amendments and inorganic fertiliser at varying rates

The CCC team is monitoring a range of variables in the trees and soil to compare tree health, soil health and productivity differences resulting from the various treatments.

During the field day DPI research physiologist, Suzy Rogiers and horticultural consultant Scott Hill explained the results so far. Scott also demonstrated how he collects total non-structural carbohydrate (TNSC) samples from the trees. The TNSC samples reflect tree energy reserves and give an indicator of tree health.




Run-off = Water run-off; TN = Total nitrogen; DIN = Dissolved inorganic nitrogen; TSS = Total suspended solids; TP = Total phosphorus; PO4 = Orthophosphate; DOC = Dissolved organic carbon

***Figure.*** *The graphs show the amount of water run-off, total suspended solids (TSS), and total nitrogen and phosphorus lost from the IOM and Pre-IOM orchards at CTH during different levels of rainfall. The dots show the data collected from the IOM site (black dots) compared with the adjacent site that did not use IOM techniques (red dots). The red and black lines show projected values under different levels of rainfall. (Graphs supplied by Mitch Call).*



*Scott Hill demonstrates nutrition measurement techniques in a macadamia orchard at the Centre for Tropical Horticulture. The Clean Coastal Catchments Research team is using nutrient data to assess the benefits of organic soil amendments for tree health and productivity.* Photo: Meg Strang, NSW DPI

Discussion then followed into the benefits of organic matter including:

- soil structure: how organic amendments can increase cation exchange capacity, water holding capacity and pH-buffering ability
- benefits to soil microbiology
- improved tree resilience
- reduced nutrient run-off
- reduced erosion
- environmental benefits.

## Ag tech demonstration

The CCC Macadamia Research Update ended with a presentation by Tom Flanagan from the NSW DPIRD Farms of the Future Program about cutting edge ag-tech devices installed at the CTH research site. Devices such as dendrometers, sap flow sensors, soil moisture probes and weather monitoring tools, are helping to reveal what's happening inside the trees and in the soil beneath the orchard floor. Data from these devices is used to inform CCC research at the site, while also demonstrating new technology solutions for growers, and how the information they gather can be used to support better management decisions.

Macadamia farmer, Andrew Auld, was also on hand to explain how macadamia yield monitoring sensors can be used to determine yield variability across an orchard. Andrew and his father, James Auld, have developed a yield monitoring prototype that will enable growers to implement more targeted nutrition management strategies.

The core message of the CCC Macadamia Research Update was that better orchard management saves growers money. It helps growers produce more nuts and stops expensive fertilisers from going to waste and potentially ending up as nutrient pollution in coastal creeks, rivers and ocean estuaries.

Growers at the event were asked what treatments they would like to see in future side-by-side IOM trials. Suggestions from the crowd included a herbicide strip vs non-herbicide strip trial and research comparing the impact of applications of different forms of nutrition.

If you have ideas to contribute to future research plans, you can contact me at email Jeremy.bright@dpi.nsw.gov.au or phone 0427 213 059.

The CCC Research project is delivered through the NSW Department of Primary Industries and Regional Development and is funded by the NSW Government through the Marine Estate Management Strategy (MEMS).

The ten-year Marine Estate Management Strategy was developed by the NSW Marine Estate Management Authority to coordinate the management of the marine estate.

To find out more about IOM techniques, scan the QR code right to take a look at the Macadamia *Integrated Orchard Management Practice Guide*.

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# Building on the National Macadamia Map – your help needed for futureproofing the macadamia industry

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

*With the macadamia industry rapidly expanding, understanding the crop we produce on diverse farms presents both a challenge and an opportunity. Additional information and good planning can help us make better decisions to support on-farm activities and target high-value sustainable markets for our diversifying crop. The AMS needs your help to future-proof Australian macadamias.*

Globally, macadamia production is expected to increase at an average annual rate of 9% to 2029. With the continued rapid expansion of the macadamia industry, both in Australia and internationally, accurate industry data is critical. Orchard data to support and improve existing crop forecast models is crucial to maintain market confidence and support industry-wide infrastructure and resource planning.

Researchers at the University of New England's Applied Agricultural Remote Sensing Centre (AARSC) have been working with the AMS to update and extend the national map of macadamia orchards. This map, developed under Phase 1 of the *Multi-scale Monitoring Tools for Managing Australian Tree Crops* project, includes all tree crops greater than 2 ha. It has proven crucial to the AMS in better planning and preparation.

The AMS now needs your support to collate orchard details to help understand what crop we produce annually. Phase 2 of the National Macadamia Map involves a higher level of data collection and collation, which will produce a powerful analysis tool for fact-based decisions.

## Secure data the foundation

The AMS needs grower help to complete this phase of the project and realise its significant benefits to individuals and the industry. The AMS has invested in the development of a special tool called **Macadamia Block Builder.** This tool allows the AMS to edit the national macadamia map in-house and assign block-level information using a simple secure web application. What we need is your data to include in the map to ensure it is complete.

## Industry benefits: National Macadamia Map

Accurate data on macadamia orchards across Australia will ensure the industry is well-prepared to respond to various scenarios and make informed contributions to a range of industry-wide initiatives, including:

| | |
|---|---|
| **Tracking and management of biosecurity outbreaks** | This will improve industry preparedness in the event of an incursion (such as varroa mite, fire ants and other emergency plant pests), enabling a rapid and targeted response |
| **Tracking emergency responses to natural disasters** | This will help alert affected orchards to bushfires and floods and will aid planning during recovery |
| **Yield forecasting** | This will allow for better forecasting and modelling for future yields, including for specific cultivars, and for improved industry planning to reflect the increase in new cultivars and their processing and storage requirements |
| **Export opportunities and finding high-value homes for future crops** | Examples include satisfying export certification requirements for global markets, planning to strengthen emerging markets like India and more calculated kernel vs nut-in-shell market allocation |
| **Resource management** | Planning and development to support supply-chain infrastructure and labour |
| **Industry advocacy** | Advanced data will support applications for government funding to meet the needs of an expanding industry |
| **Sustainability initiatives** | Providing data for carbon tracking, water use and best practice land management |

For each farm, we need the following information:

- farm geolocation
- cultivar/s per block
- tree and row spacing
- year of planting (to compare with planting year predictor tool)
- whether irrigation is used (1) or it is supplementary (2) or the orchard is dryland (3)
- irrigation source: on-farm surface, e.g. dam (1), on-farm groundwater bore (2), surface licence from a river (3) or a scheme system (4)
- whether the farm is owner operated or managed
- whether the farm is organic or conventional.
- grower name, phone number, email address (this is optional but will be valuable in the event of a natural disaster or pest incursion).

**Privacy has been a key consideration in this development. The ATCM is built to meet national privacy standards with no personal or commercial information to be published or shared. The National Macadamia Map is owned and managed by the AMS and is secured under strict sign-in for AMS access only. Your data is protected and stored on secure servers based in Australia.**

## How to submit data

Growers can visit the AMS website australianmacadamias.org and follow the link from the home page to the online survey. Alternatively you can email data to your AMS team (see below) and attach a KML file from your farming or mapping app. Please include the additional information listed in the previous column. If this is not possible, we can assist with alternative direct input methods for submitting data. We are also happy to answer any questions about the purpose of the map and data security.

1 Visit the AMS website: australianmacadamias.org/industry and follow the link from the home page to the online survey **OR simply scan the QR code on the right with your mobile phone to go to the survey.**

2 Contact your state-based AMS staff member (see below) and attach a KML file from your farming/mapping APP. Please also include the additional information listed above. If this is not possible, contact the AMS for an alternative method.

**NSW**

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**QLD/WA**

**Emily Grieve** (Industry Development Officer)
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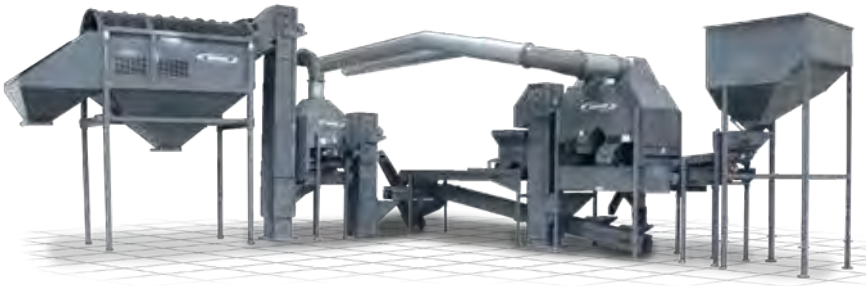
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# Predicting macadamia planting dates using remote sensing and deep learning

**Dr Andy Clark, Senior Research Fellow, Applied Agricultural Remote Sensing Centre, University of New England, Armidale, NSW E: Andrew.Clark@une.edu.au**

*Researchers at the University of New England's Applied Agricultural Remote Sensing Centre (AARSC) have been working with the AMS to improve the accuracy of planting-year predictions for macadamia orchards. They are using advanced satellite imagery and AI to provide more accurate and useful information to growers and industry professionals.*

## Key findings

- **Industry applications:** The Predicted Planting Year Dashboard provides information about orchard age distribution within the different AMS regions. This information helps improve the accuracy of yield forecasting as well as harvesting logistics, labour and forward selling.
- **Advanced methodology:** The research used satellite images and advanced AI computing models to predict the age of all macadamia orchards identified in the Australia Tree Crop Map.
- **Accurate predictions of planting year achieved:** The top-performing model could accurately predict macadamia planting years.
- **Challenges with earlier plantings:** The model's accuracy decreased for planting years before 2000 as a result of limited training data for those periods.
- **Future improvements:** We plan to collect additional calibration data, which will help us improve the tree age models.

The Australian Tree Crop Map (ATCM) provides valuable data about the location and size of commercial macadamia orchards. The map now covers more than 41,000 ha. At the industry's request, AARSC has used the map to accurately predict the planting year of all mapped orchards. Previous methodologies relied heavily on manual surveys and less advanced analytical techniques, which had limited ability to predict the most recent plantings.

## Using AI to analyse satellite images

We used time-series satellite images from the Landsat satellites, spanning from 1986 to the present, to track changes in orchards over time. These images are ideal for this purpose, as they provide a consistent and comprehensive view of the Earth's surface. We then tested various AI models in handling time-series data, which is crucial for predicting planting years based on the progressive growth patterns of orchards captured in the satellite imagery.

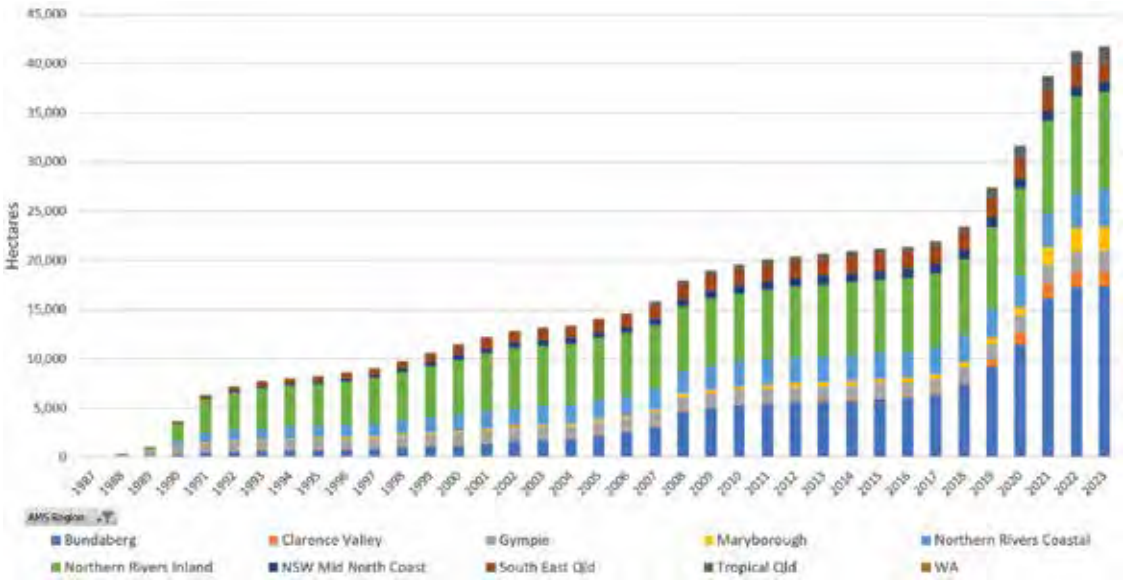



***Figure 1.*** *Cumulative macadamia planting areas by growing region, as predicted by the GRU model*

One model, the Gated Recurrent Units (GRU) model, performed particularly well for recent planting years (from 2000 to 2023); however, its accuracy decreased for planting years before 2000, mainly because of the limited availability of training data for earlier periods.

Nevertheless, the model provides valuable insights. For instance, the temporal patterns detected by the model can help identify trends in macadamia planting practices over recent decades. This information is crucial for understanding how the industry has evolved across different regions and for planning industry expansions as more orchards come into production.

Figure 1 illustrates the cumulative macadamia planting areas by growing region over time, as predicted by the GRU model. The plot highlights the large increase in planting areas, particularly from the mid-2000s onward. This is especially noticeable in Bundaberg, the Clarence Valley and Maryborough. This information about where macadamias are being planted and the planting trends over time provides valuable insights for growers and industry stakeholders.

## Data available in interactive map

This information is also shown in a map on the AMS Predicted Planting Year Dashboard, which is available on the AMS website. Users can interact with the map to view the data by AMS region, including area breakdown of bearing and non-bearing trees.

Figure 2 shows a detailed map of the planting year predictions for macadamia orchards in the Bundaberg region. The map clearly distinguishes between older and newer orchards using a colour gradient, with darker colours representing older plantings and lighter colours indicating more recent ones. This visual representation allows growers and industry stakeholders to easily identify the age distribution of macadamia orchards within the region, facilitating better planning and management practices.



***Figure 2**. Map of the predicted planting years for macadamia orchards in the Bundaberg region. Darker colours represent older orchards, while lighter colours indicate more recent plantings.*

## Applications and future work

Accurately predicting planting years is important for the macadamia industry. Knowing when trees were planted helps us make more accurate yield forecasts, as older trees produce more than younger ones. Additionally, this information aids in market access decisions, as it helps verify the age and production capacity of orchards. The data layer also helps with biosecurity by identifying older trees that might be more susceptible to pests and diseases.

Future work will continue to improve the model accuracy and to include new plantings each year. We are also considering including other data sources, such as production information, geographical location, variety, surrounding land classes, management and weather data, and exploring AI techniques to better understand seasonal variations in growth characteristics, yield and quality.

## Conclusion

This research is a big step forward in the field of remote sensing and agricultural analysis. By using modern technology, we've created a robust methodology to predict macadamia planting years. This information will help make the macadamia industry more sustainable and profitable. The insights from this study will help growers make more informed decisions, leading to better management practices and increased productivity.

**Information.** Readers are invited to explore the mapping tools discussed here on the AMS website: https://bit.ly/3LnPGyO.

Your feedback is always welcome. Simply use the ATCM Survey to let the mapping team know about new plantings or missing orchards. Continued collaboration and industry engagement are essential to ensure the best mapping is delivered for the AMS.

For more information, visit the AARSC web applications gallery: www.une.edu.au/webapps.

**Acknowledgments.** This research was funded by the Future Food Systems CRC, Hort Innovation, UNE, and industry partners including Avocados Australia, Australian Banana Growers Council, Citrus Australia, and the Australian Macadamia Society.

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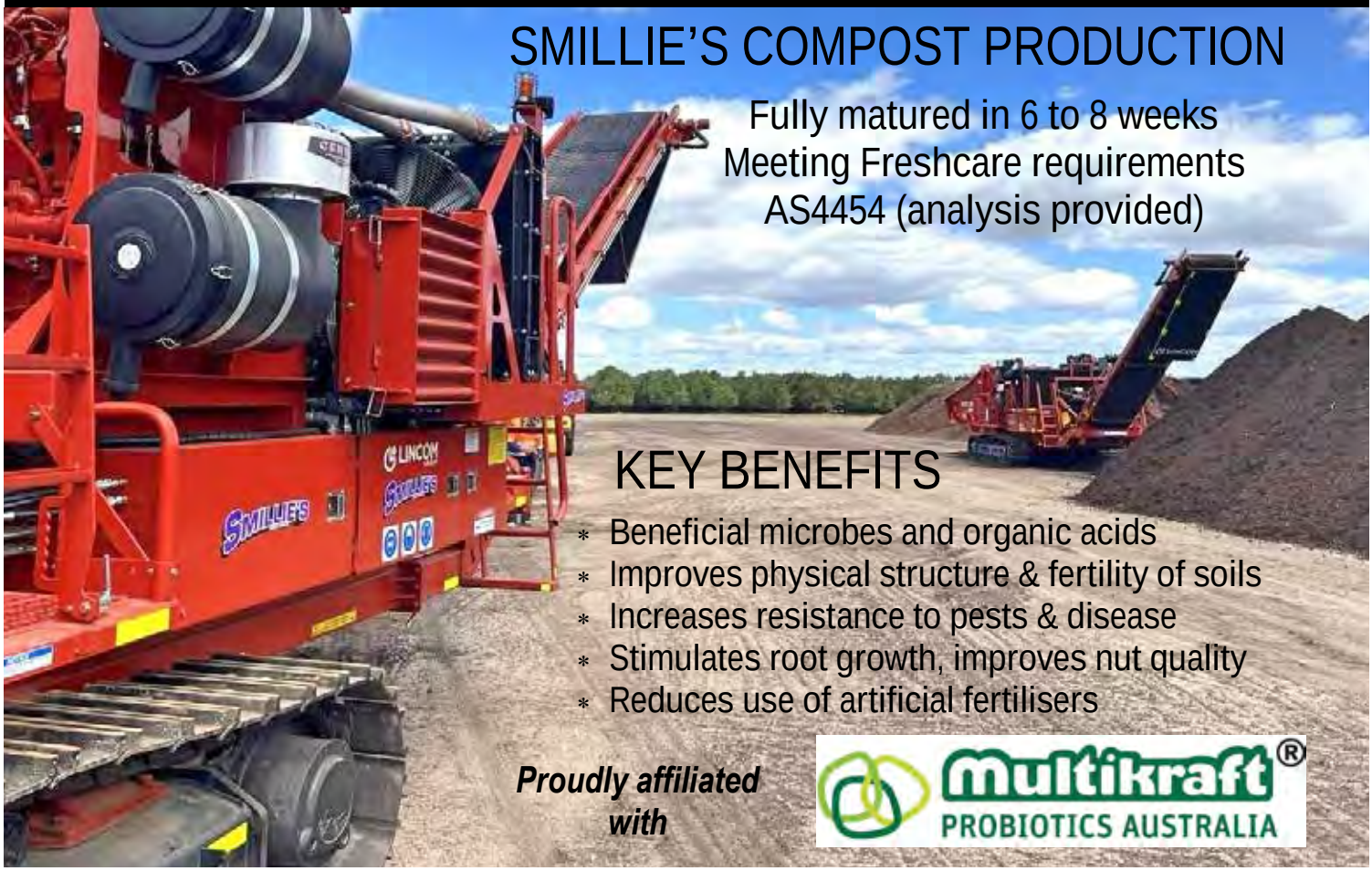
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# Monitoring and managing flower diseases in macadamia

**Vivian Rincón-Flórez, Xiaoxue Xu, Hariharan Ganeshamoorthy, Theophilus Mensa and Femi Akinsanmi**
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The University of Queensland, Centre for Horticultural Science, Queensland Alliance for Agriculture & Food Innovation, Brisbane

## Project snapshot

Macadamia Integrated Disease Management (IDM) research project MC 21001 has identified the importance of all stakeholders sharing a clear understanding of the phenology of raceme development as this will underpin successful management and risk assessment of flower diseases.

The most important flower diseases in macadamia are grey mould (Botrytis blight), green mould (Cladosporium blight) and dry flower disease (Pestalotiopsis blight).

When assessing the risk of flower blight disease, the three key factors to consider are host phenology, climatic conditions, particularly ambient temperatures and the likelihood of rainfall, and the history of severe flower diseases in the affected cultivars and orchards.

The project team has developed four tools for managing flower blight complex in macadamia: pre-season assessment, a disease forecasting tool that uses seasonal weather forecasts and the disease history of the orchard, disease monitoring and disease abatement.

*Understanding the different stages of nut development such as matchhead and pea size stages has been pivotal for managing husk spot effectively. Similarly, a clear understanding of the phenology of raceme development will support management decisions, monitoring and risk assessment of flower diseases.*

We have noticed, however, that growers and consultants seem to vary in how they classify macadamia flower phenological phases. To help with this, in this article we clarify the difference between these stages. For disease management discussions, 'raceme' refers to the entire inflorescence with flowers attached to the rachis, and 'flower stages' includes the descriptions of the development of the flowers on the rachis (see Figure 1).

Floral development is influenced by temperature changes, which initiate bud growth from the axial region of the leaves, breaking dormancy. Raceme development becomes visible from bud break, early elongation and the late elongation phase,

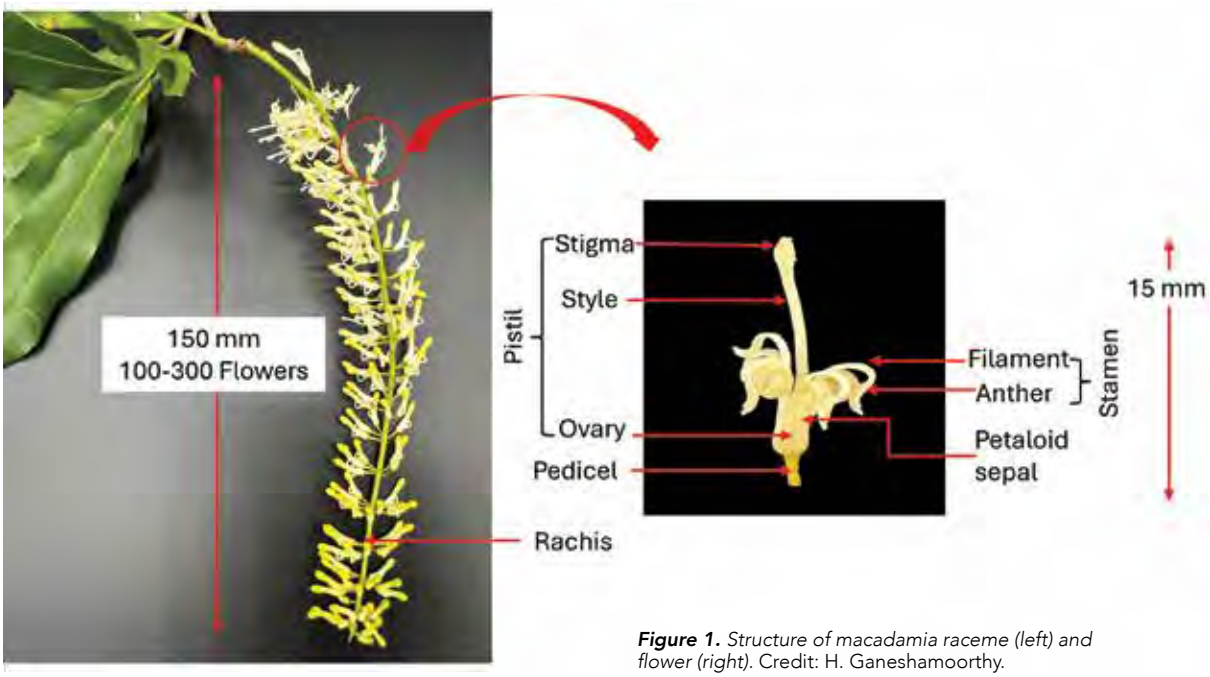



***Figure 1.*** *Structure of macadamia raceme (left) and flower (right).* Credit: H. Ganeshamoorthy.

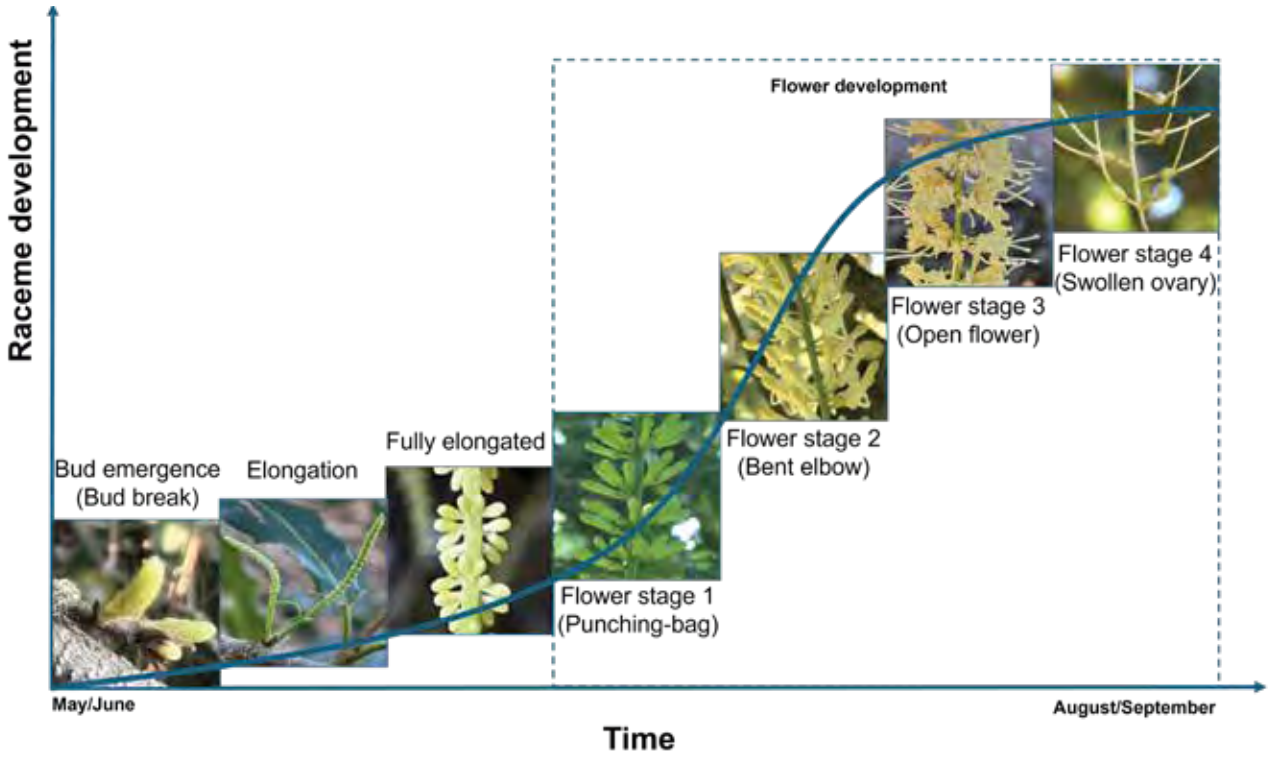



***Figure 2.*** *Progression of raceme development from bud break to petals fall with ovary swelling in macadamia.*

when individual florets can be identified. Flower development passes through four distinct stages, all with well-defined characteristics. These stages are: 'punching-bag, 'bent elbow', open flower and swollen ovary (see Figure 2).

## Flower diseases

There are three different fungal flower blight diseases in Australia:

- grey mould (Botrytis blight)
- green mould (Cladosporium blight)
- dry flower disease (Pestalotiopsis blight).

Macadamia racemes with or without flower blight diseases may also exhibit rachis tip dieback (RTD) symptoms, also known as rat tail. Our recent study suggests that RTD could be a distinct disease of the macadamia raceme. Besides the flower blight pathogens, other fungal genera can cause RTD and not infect flowers. Research is currently ongoing to understand the influence of RTD on flower blight epidemics, so it is essential to monitor RTD incidence as it reflects flower blight risk. Another issue with RTD is that it might damage the raceme from the early elongation phase when it is less than 10 mm long, resulting in a significant loss of raceme.

## Monitoring and diagnostics

Diagnosing flower blight diseases in macadamia orchards requires attention to detail. Different pathogens with different lifecycles cause flower diseases in macadamia. As well, the factors that influence severity and spread vary with each type of flower disease.

When assessing the risk of flower blight disease, three key factors that should be considered, as follows:

- host phenology, i.e. a visual inspection to identify the raceme phenological stage
- climatic conditions, particularly ambient temperatures and the likelihood of rainfall, which could change the relative humidity and vapour pressure in the orchards and the canopy (see Figure 3)
- history of severe flower diseases in the affected cultivars and orchards.

**Dry flower** disease pathogens *(Neopestalotiopsis and Pestalotiopsis* species) can infect macadamia racemes at all growth stages, depending on climatic conditions and, to some extent, the history of the diseases in the preceding seasons.

The fungal spores are dry spores because they preferentially spread in relatively dry conditions. The spores produced by dry flower disease pathogens are spread by wind and rain splash and are the primary inoculum. The spores germinate and penetrate the tissue within a few hours of contact with the flowers or any part of the raceme. Infected tissues are destroyed within 48 hours of infection, and the fungal pathogens

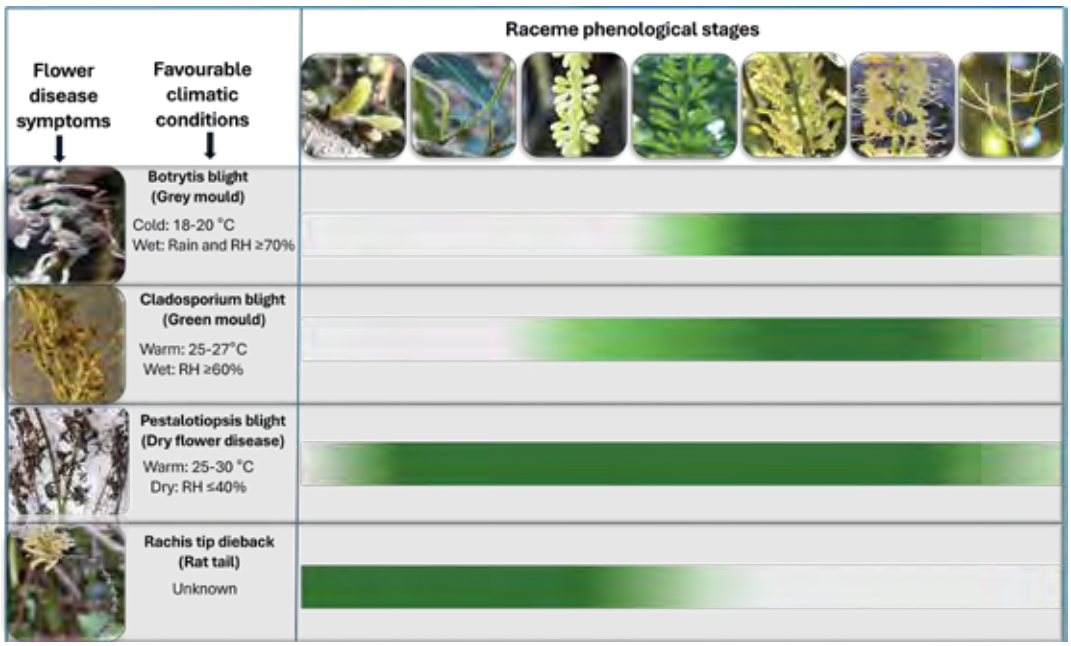



***Figure 3.*** *Risk levels based on conditions promoting flower diseases at the various raceme phenological stages.*

progress to colonise the entire raceme and the disease spreads to other racemes. Diseased racemes look dry, and the flowers may easily dislodge from the rachis.

**Grey mould** pathogens (*Botrytis cinerea* and *Botrytis macadamiae*) thrive below 20°C and the disease spreads quickly in cooler conditions, particularly from the bent-elbow flower stage, and is more severe at the open flower stage.

Orchards with closed canopies in Northern New South Wales and South East Queensland are at a high risk during periods of spring rainfall. Managing grey mould at the open flower stage is challenging because, after the primary infection, more spores are produced within two days, damaging the entire raceme. This means it is important to target grey mould management before the bent-elbow flower stage.

Unlike grey mould, many species of *Cladosporium* cause green mould. The pathogens are early spread by wind and are favoured by warm and humid conditions. Infection can occur from the punching bag stage, resulting in total collapse of the racemes, which become covered in olive-green spores.

## Tools for managing flower blight complex in macadamia

**Tool 1: Pre-season assessment. This tool targets pre-season actions based on the macadamia disease management philosophy, Start Clean, Stay Healthy and Stay Safe.**

Orchard hygiene and cultural practices aimed at removing raceme remnants from the dense canopy should be considered. Higher numbers of spores of dry flower disease pathogens overwinter in remnant racemes in tree canopies compared with those of grey and green mould pathogens. The spores from old racemes contribute significantly to the primary inoculum source of the pathogens between seasons. The widespread nature of dry flower disease in all the growing regions may be attributed to the predicted vapour pressure deficit (VPD) range of between 0.9 and 1.1 kPa.

In high-risk orchards with a severe history of dry flower disease, proactive management is recommended to reduce the risk of infection from the primary inoculum sources in tree canopies. This proactive approach reduces the risk of disease in your orchard.

**Tool 2: Disease forecasting tool. This tool is based on seasonal weather forecasts and the disease history of the orchard.**

Orchards with minimal or no history are at a lower risk of severe dry flower disease than orchards with history of severe disease. The MacDisease Tool for forecasting risk and action threshold based on potential economic damage is being evaluated (See Figure 4).

**Tool 3: Disease monitoring.**

Visual inspection for the presence of RTD from the early elongation stage may indicate the risk of infection of flowers at different growth stages in the season. The monitoring interval may coincide with each stage of raceme development, determined by when a large percentage of racemes are at a similar stage.

**Tool 4: Disease abatement.**

Actions to reduce disease progression and potential pathogen spread during the season are critical to successful nut set. Disease management actions such as applying registered fungicides and using alternative control options are needed when the risk of economic damage due to flower diseases is high.

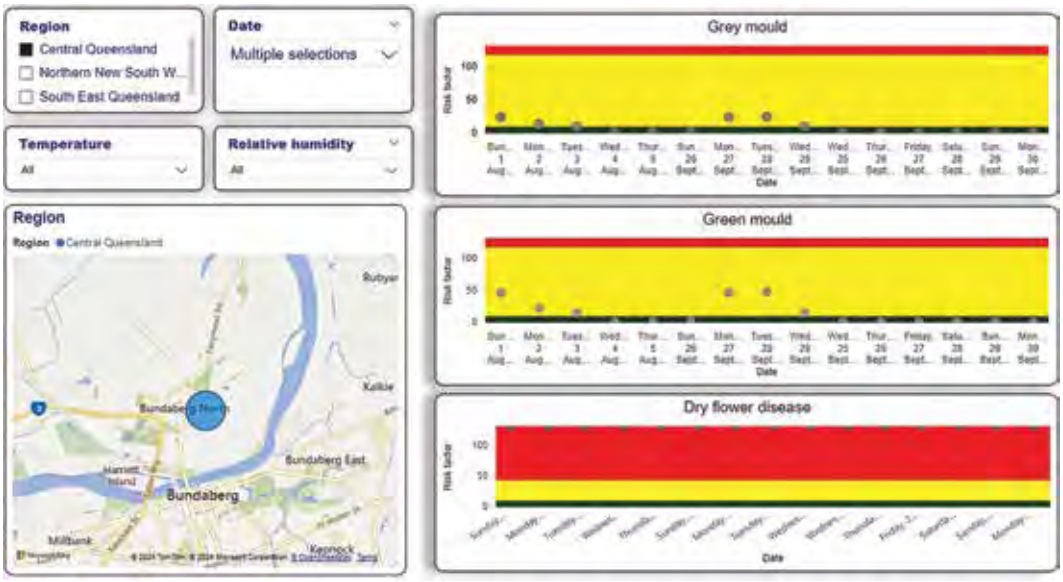



***Figure 4.*** *A screenshot of the MacDisease Tool under development and validation process.*

Research to further evaluate and support decisions for economic loss assessment is underway. Evidence from growers about severe economic losses from dry flower disease and green mould reinforces the importance of monitoring and controlling flower diseases in macadamia.

## Timing of spray applications essential

The Macadamia Integrated Disease Management (IDM) project has successfully partnered with agricultural chemical companies to develop two fungicides for flower diseases in macadamia. Fontelis (Penthiopyrad) and Merivon (Pyraclostrobin + Fluxapyroxad) are now registered to manage the flower blight complex in macadamia.

Timing spray application timing is critical, i.e. generally before the open flower stage. To prevent fungicide resistance in the pathogen population that could lead to early loss of efficacy of the product in macadamia, it is highly advisable not to apply more than two consecutive treatments of the same product or mode of action per year, and maximum of three applications per year, if used to also control husk spot.

It is also important that fungicides from an alternative chemical group are included in the spray program each season.

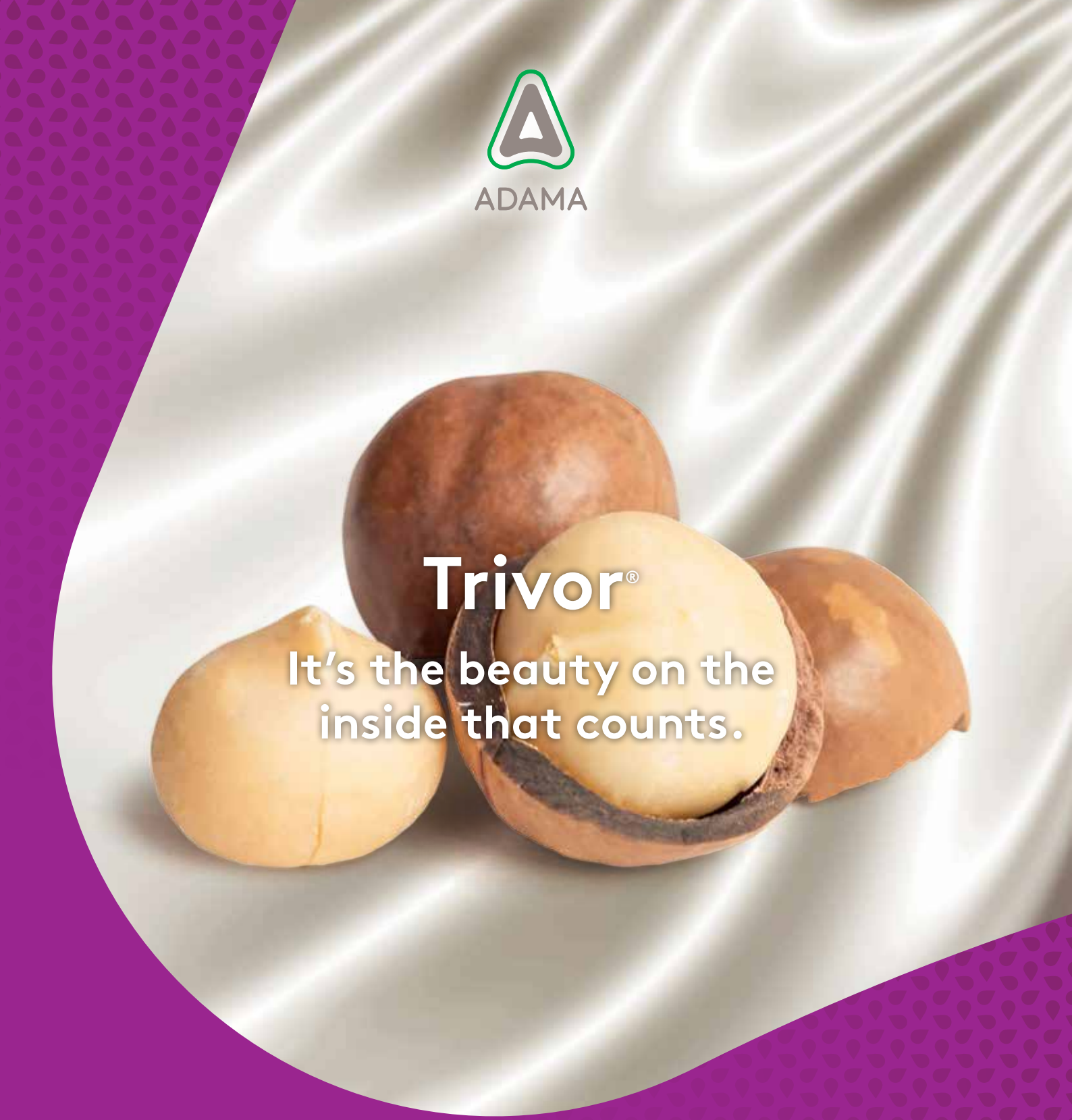
The development of biological control options is underway. The use of alternative and biological products is expected to support the building of a disease resilience system in macadamia orchards.

**Information**
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**Acknowledgments.** This research (Project No. MC21001) was funded by Hort Innovation using the macadamia research and development levy and funds from the Australian Government.



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# Improving fruit and banana spotting bug control using pheromones

**Ian Newton, Donna Chambers, Stefano De Faveri, Kempsy Adams, Department of Agriculture and Fisheries, and Andrew Hayes, University of the Sunshine Coast**

## Project snapshot

Fruit spotting bugs (FSB) and banana spotting bugs (BSB) are significant pests of macadamia crops in eastern Australia.

Current pest management practices rely heavily on pesticides and often employ a calendar-based spray strategy, which is not aligned with integrated pest management (IPM) principles.

A new project aims to develop a more effective BSB trap and create a pheromone lure for FSB.

The researchers have tested a range of traps, adhesives, and tapes, and have identified one product that shows promise for a longer-lasting BSB trap.

Efforts to develop an FSB pheromone lure involve bioassays and advanced laboratory techniques to identify and formulate the pheromone compounds, with initial field cage tests already underway.

The goal is to enable more targeted pesticide applications, reducing pesticide use, improving nut quality, and helping control pest populations more effectively

Fruit spotting bugs (FSB) *Amblypelta nitida* and banana spotting bugs (BSB) *Amblypelta lutescens lutescens* are significant pests of macadamia crops in eastern Australia, causing substantial economic losses annually. Current pest management approaches rely heavily on pesticide usage, often employing a calendar-based spray strategy due to the lack of efficient pest-monitoring systems. This practice contradicts integrated pest management (IPM) principles and may contribute to issues like pesticide resistance and the proliferation of secondary pests such as thrips, mites, scale insects and various lepidopteran (moth) pests.

The project "Improving Fruit and Banana Spotting Bug Control MT21017" is supported by the Department of Agriculture and Fisheries, the University of the Sunshine Coast and Hort Innovation through the macadamia and avocado R&D levy. It has two primary objectives:

1. To develop an improved BSB trap with enhanced longevity and effectiveness.
2. To create a pheromone lure to attract and trap FSB.

## Improving traps for banana spotting bugs

The existing commercialised BSB pheromone trap from Organic Crop Protectants (OCP) demonstrates short-term effectiveness in trapping BSB. However, it loses efficacy over seven to ten days, or even shorter periods in direct sunlight, as the sticky pad deteriorates. Replacing the sticky pads every two weeks is cumbersome and time-consuming, discouraging many growers, consultants and crop scouts from using these traps. Alternative trap types and adhesives have been tested, but none have proven effective in trapping BSB, which can escape most traditional sticky traps and other trap types. Thus, there is a critical need to develop a trap that lasts up to six weeks to match the lure's lifespan.



*Part of this project involved testing 33 different traps, adhesives and tapes from a range of product types and manufacturers.*



*Solid phase microextraction (SPME) aerations to collect potential FSB pheromone compounds*

In this project, we tested 33 different traps, adhesives and tapes from a range of product types and manufacturers. Each adhesive product was tested in the laboratory using live cultured BSB. The products were evaluated for trapping efficacy compared with the existing trap adhesive. Promising products that demonstrated effective trapping abilities were further subjected to sunlight degradation tests to assess their durability.

Field testing focused on evaluating UV stability and trap longevity by exposing adhesive products to full sunlight. The strength of adhesion required to trap BSB was reassessed every seven days over a four-week period for each product. One product exhibited promising results, showing comparable effectiveness to the current commercial trap while maintaining adhesive integrity over the testing period. We are currently conducting further field testing of this product against the standard commercial trap from OCP.

## Developing a pheromone lure for fruit spotting bugs

No effective pheromone lure currently exists for FSB. Previous collaboration with the United States Department of Agriculture yielded inconclusive results despite identifying potential chemical compounds involved in FSB communication. The second objective of this project, which comprises two stages, is to develop an effective pheromone lure to attract and trap FSB.

The first stage involves conducting bioassays of FSB using unmated adults to determine if a natural pheromone exists, if it has significant natural attraction (the degree of attraction) and if it is an aggregation or a sex pheromone. This work will also determine bioassay techniques to be used for the second phase of the research, which will attempt to determine the exact pheromone chemical compound(s) and chemical ratios. Further work will include formulating a lure, as the compounds are thought to be highly volatile.

To date, we have conducted two large field cage bioassays. We are also investigating the bug's chemical communication compounds using laboratory techniques such as solid phase microextraction (SPME) aerations to collect potential compounds, and electroantennogram detection to test recognition of the compounds by the bugs.

The successful development of pheromone traps for both BSB and FSB is expected to help macadamia growers implement more targeted pesticide applications, thus reducing pesticide use, increasing nut quality and reducing reject rates. Additionally, an improved BSB/FSB trap design could contribute to population control, further reducing growers' reliance on pesticides for pest management.

**Information**
For further information contact Ian Newton at Ian.Newton@daf.qld.gov.au

**Acknowledgments**. This research was funded by Hort Innovation using the macadamia research and development levy and funds from the Australian Government.

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R&D UPDATE

# Research investigates new methods for macadamia plant supply

## Project snapshot

Traditional methods of producing macadamia plants, which rely on mainly on grafting and root cuttings, can be slow and result in supply issues for growers, especially when demand for trees is high.

Researchers at the University of Queensland are investigating methods of accelerating plant production as well as preserving germplasm of Australia's unique macadamia species.

The research is primarily focussing on developing high-throughput tissue culture methods to accelerate plant production and ensure uniformity as well as cryotechnology methods for long-term macadamia germplasm storage.

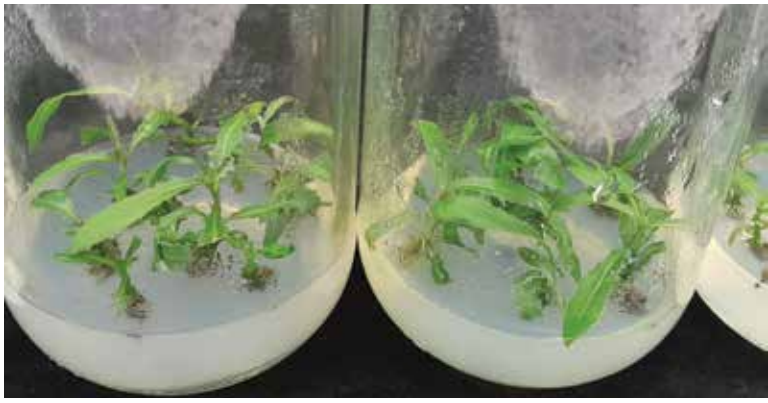
This project aims to support a sustainable industry into the future by enabling long-term preservation of important genetics and the rapid uptake of improved varieties suited to future fields and markets.

Australia's macadamia industry is booming, but with rapid growth come challenges. The industry in Australia relies largely on grafting varieties to seedling rootstocks for clonal variety propagation. This comes with time and resource inefficiencies that impact plant supply, plus the inherent genetic variability of seedling rootstocks. Compounding this is a lack of technology for long-term germplasm banking of commercial cultivars and risk of extinction faced by Australia's unique wild macadamia germplasm, crucial for future crop breeding.

## Project aims

To address these challenges, a collaborative project brings together researchers and industry experts to revolutionise macadamia propagation and conservation through two broad aims:

- Develop a novel high-throughput tissue culture system for clonal propagation of industry-desired macadamia trees
- Develop the world's first cryotechnology for long-term storage of germplasm



*Regenerated* Macadamia *cv. Beaumont plants after cryopreservation in liquid nitrogen. Starter cultures were provided by The Australian Plant Bank, Royal Botanic Gardens Sydney.*

## Overcoming propagation challenges

A hurdle in the macadamia industry is the slow and costly process of producing plants. Traditional methods of grafting or rooting cuttings can attract high labour costs and inconsistent success rates, as well as limitations to through-put. To combat this, the project is focusing on developing a tissue culture system for clonal propagation.

Tissue culture offers a resource-efficient, pest and disease-free method of plant propagation. Unlike traditional methods, tissue culture can produce large volumes of uniform plants from very small amounts of starting materials. This project builds on the successful application of tissue culture by the team in other woody plants, such as avocado. By leveraging this expertise, researchers aim to establish a robust system for macadamia, ensuring high-quality plant production at scale.

As part of the tissue-culture process, the team will explore the next step-change in grafting through production of an entire grafted plant in tissue culture (*in vitro micrografting*). This technique, which has been tested in avocados, has potential to overcome variable success rates of traditional macadamia grafting in the nursery. The tissue-culture technology also opens the door to commercially efficient production of cultivars on their own roots to avoid the grafting step completely.

## Cryotechnology for conservation

Another innovative aspect of this project is the development of cryotechnology for the conservation of macadamia germplasm, which cannot be stored



*Macadamia shoots from mature trees in tissue culture multiplication and rooting optimisation. Photo: Albert Wong and Chris O'Brien.*

using conventional seed-banking techniques. All species of macadamia are threatened in the wild, and commercial germplasm is held in field collections, which can be impacted by environmental stress.

Cryopreservation is the storage of living tissues in stasis at ultra-low temperatures. It requires tissue culture as a source of clean material for banking, as well as to regenerate 'frozen' plants. With this method, the genetic diversity of an entire species can be maintained cost-effectively in compact liquid nitrogen containers.

The process begins with treating small amounts of plant tissue (in this case 2 mm shoot tips) with a cryoprotectant solution, which helps prevent ice crystal formation that can damage cells during freezing and thawing. Once adequately treated, the plant tissue is carefully frozen in liquid nitrogen, ensuring rapid cooling to ultra-low temperatures (-196 °C). The shoot tips can then be regenerated into plants using tissue culture. By storing plant material at ultra-low temperatures, researchers can preserve genetic diversity and safeguard against future threats.

## Research progress

The tissue culture trials have progressed for four different cultivars and rootstocks with plants under multiplication and rooting optimisation to enable future transition from the lab to the nursery. The next step will be to conduct trials of the tissue-cultured plants in commercial nursery conditions and in the field. The researchers are also currently working on optimising the cryopreservation methods.

## Future prospects

This project expects to break down barriers to industry expansion and address the industry need for sustainable high quality plant supply. This should support Australia's 800+ macadamia growers and whole value-chain growth as well as uptake of new cultivars from breeding programs for the farms of the future. Field-free propagation would also greatly reduce the need for land, water and chemicals for propagation and minimise the industry's environmental footprint.

The project is led by Prof Neena Mitter and Dr Alice Hayward at The Queensland Alliance of Agriculture and Food Innovation (QAAFI) at The University of Queensland (UQ), in partnership with the Royal Botanic Gardens & Domain Trust (RBG), the Queensland Government Department of Agriculture and Fisheries (DAF), Australian Macadamia Society (AMS), Macadamia Conservation Trust (MCT), macadamia nurseries and growers. This research was funded by the Australian Research Council Linkage Scheme with contributions from partners.

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R&D UPDATE

# Rapid assessment of brown centre and rancidity in macadamia

**Shahla Hosseini Bai, Michael Farrar, Steven Lee, Nick Nikzad, Thomas Chen, Kourosh Khoshelham, Griffith University**

## Project snapshot

As part of a research project funded by an Advance Queensland Industry Fellowship (AQIRF092-2021RD4) and the macadamia industry, the potential of hyperspectral imaging is being assessed to identify brown centre and rancidity level in kernel.

Colour sorters used in the industry currently use the visible light spectrum so are not always able to identify when brown centre and rancidity are present.

The Griffith University research team imaged kernel halves with and without brown centre and with and without rancidity to test the accuracy of hyperspectral imaging. Results are encouraging with a 95% accuracy being achieved for detecting brown centre and 85% for rancidity.

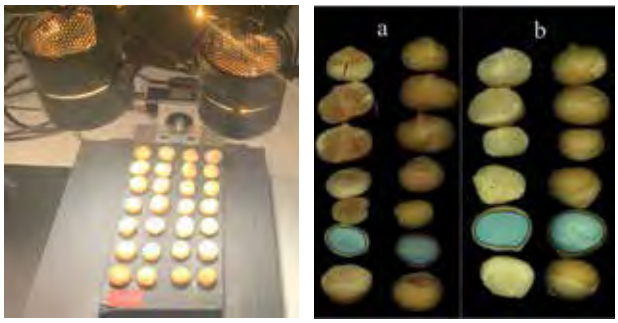
Given these results, the team is now looking at ways of automating the assessment process.

Macadamia growers and processors rely on producing high quality kernels to maximise productivity and profit. Two important measures of quality that are used to assess kernel are internal discolouration (brown centre) and rancidity level (peroxide value: PV), both of which, however, can remain undetected in modern processing. This is because brown centres are not always visible on the kernel surface and rancidity is not visible at all, meaning they are not always detected by colour sorters, which rely on information from the visible spectrum only.

Our team at Griffith University are developing a non-destructive method for assessing brown centre and rancidity that uses hyperspectral imaging. Hyperspectral images incorporate both visible and near-infrared (VNIR) information and can detect subtle changes in chemical and physical composition of nuts. As part of our project, we examined whether hyperspectral imaging could predict brown centre and rancidity from the outer layer of kernels where it cannot be detected by traditional colour sorting machines.

## Classifying brown centre disorder in kernel halves

We imaged 489 kernel halves with and without brown centre disorder, in face-up and face-down orientations, to assess if direct or indirect detection using VNIR hyperspectral images was a viable method (see photos). Spectral data was extracted from the visible kernel surface area and used to develop classification models.




*Imaging macadamia kernels using a VNIR hyperspectral imaging camera (left) to classify brown centre kernels (a) and premium kernels (b); the blue shaded areas represent regions where spectral data was manually selected and extracted and use during model development and testing.*

Models developed using artificial neural networks (ANNs) classified brown centre in face-up image with 100% accuracy as was expected given the human eye and colour sorting can achieve this result. Interestingly, our model also predicted brown centre disorder with 94% accuracy using spectra extracted from the outside kernel surface of face-down images, and 95.4% after combination of the face-up and face-down images.

## Classifying high rancidity kernels (best before labelling)

To develop PV classifiers we imaged fresh, aged and rapidly aged (incubated) whole kernels collected from processors in Queensland and NSW. The PVs for 448 individual kernels were determined using chemical analysis, and classification models were developed using classes for 'best before 12 months' based on the recommendation given by AMS kernel quality standard. Kernels were classified with total accuracies ranging between 83% and 85% (see table).

| Kernel orientation | Total accuracy (%) | Precision[2] BC (%) | Precision[2] PK (%) | Recall[3] BC (%) | Recall[3] PK (%) |
|---|---|---|---|---|---|
| **Brown centre classification models** | | | | | |
| Face-up | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| Face-down | 93.9 | 90.0 | 100.0 | 100.0 | 86.7 |
| Combined images | 95.4 | 91.7 | 100.0 | 100.0 | 90.6 |
| | | **Precision <3PV (%)** | **Precision ≥3PV (%)** | **Recall <3PV (%)** | **Recall ≥3PV (%)** |
| **PV classification models** | | | | | |
| Base-up | 84.7 | 83.6 | 89.5 | 97.2 | 55.9 |
| Base-down | 83.4 | 82.5 | 87.4 | 96.7 | 52.8 |
| Combined images | 85.0 | 83.5 | 91.7 | 97.8 | 55.2 |

**Combined images model matrix**

| | | Predicted | |
|---|---|---|---|
| | | BC | PK |
| Reference | BC | 33 | 3 |
| | PK | 0 | 29 |

| | | Predicted | |
|---|---|---|---|
| | | <3 PV | ≥3 PV |
| Reference | <3 PV | 131 | 26 |
| | ≥3 PV | 3 | 32 |

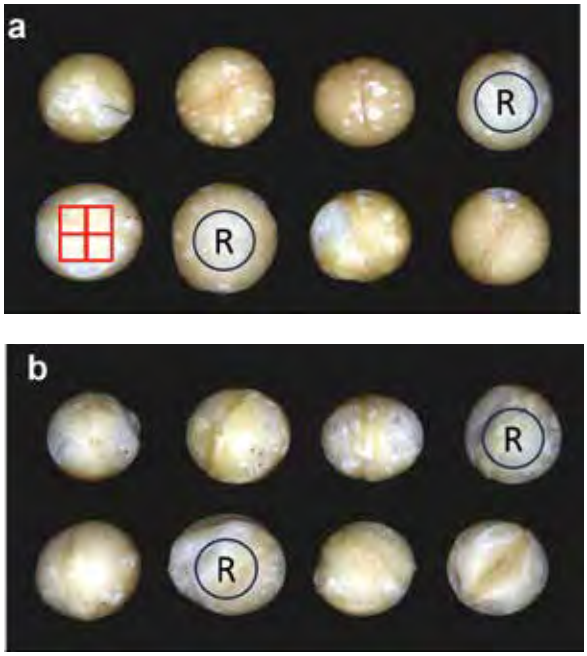
***Table.*** *Accuracy metrics for brown centre and rancidity level (peroxide value: PV) classification models using test dataset1 and comparing models developed with images of kernels in different orientations.*

VNIR: Visible near-infrared spectral region (400–1000 nm); BC: Brown centre; PK: Premium kernel: PV: Peroxide value

[1] Independent test dataset for: BC contained 32 kernels (50% BC and 50% PK); PV contained 96 kernels (80% <3 PV and 20% >3 PV meq/kg).

[2] Precision measures the model's ability to identify instances of a particular class correctly.

[3] Recall measures the model's ability to identify all instances of a particular class.




*Kernels imaged in (a) base-up and (b) base-down orientations and showing reject samples with high PV (≥3 PV meq/kg) that cannot be detected by the human eye or colour sorting machines; the red squares in (a) represent the regions where spectral data was automatically detected using computer vision for use in model development and testing and the kernels marked 'R' represent kernels with high PV unseen by the human eye.*

## Where to from here?

Rapid identification of a brown centre or a rancid kernel would help to improve processing efficiency and maximise kernel quality assessment by our growers and processors. Our study has shown that hyperspectral imaging has great potential to accelerate kernel quality assessment in the macadamia industry. The next step is to work on automating the assessment, and we are currently investigating the shortwave infrared region (SWIR). We hope that the technology will be adapted for convenient use on hand-held devices in the near future.

**About the authors**

Shahla Hosseini Bai, Michael Farrar and Nick Nikzad are based at Griffith University in Brisbane, Australia. Kourosh Khoshelham and Thomas Chen are based at the University of Melbourne. Steven Lee is employed by Marquis Macadamias, Australia.

For information about the project, contact Associate Professor Shahla Hosseini Bai (E: s.hosseini-bai@griffith.edu.au) and Dr Michael Farrar (E: m.farrar@griffith.edu.au).

**Acknowledgments**

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# Australian macadamia minor use permits

Current at August 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<br>• 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<br>• Product containing 440 g/L maldison: 1.4 or 1.9 L/ha<br>• Product containing 500 g/L maldison: 1.2 or 1.7 L/ha<br>• Product containing 1000 g/L maldison: 600 or 850 mL/ha<br>• Product containing 1150 g/L maldison: 520 or 750 mL/ha<br>• Ground application | Chlorpyrifos: 30<br>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<br>• Product containing 720 g/L ethephon: 55–165 mL/100 L water<br>• Product containing 900 g/L ethephon: 44–132 mL/100 L water<br>• Do not spray stressed trees<br>• 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<br>• 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<br>• Spraying ground mulch/soil surface up to treelines only<br>• 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<br>• Do not apply a spray volume exceeding 1500 L/ha<br>• Do not apply by aircraft or to plants in flower<br>• 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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