AUSTRALIAN MACADAMIA SOCIETY

News Bulletin

VOLUME 53 | NUMBER 3

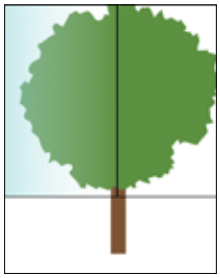


Spring 2025



Making sense of a difficult season

P 14



Getting sprayer calibration and coverage right

P 19



MCT and AMS - driving macadamia conservation for 18 years

P 38



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AUSTRALIAN MACADAMIA SOCIETY

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Front cover image. *Trichogramma parasitic wasp laying eggs in macadamia nutborer egg. See the MacTrix release checklist on page 32.* Photo: BioResources.

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Hort Innovation MACADAMIA FUND

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CEO's Report

As the 2025 Australian macadamia season formally draws to a close, the narrative across industry is consistent - a season that promised so much, but for the majority delivered very little. The crop result has been devastating for most growers, with the impact extending through the supply chain to impact handlers, processors, customers, and ultimately our end consumers. The mid-season forecast released in early July revised the Australian crop down from 60,000 t, to 40,000 - 45,000 t in-shell at 10% moisture; a final crop figure will be released in December.

The recent round of AMS MacGroups presented an opportunity to reflect on the season, to discuss the factors impacting the crop, to review what we might have done differently and to consider how the outcome might have been better foreseen. That feedback, combined with direct input from growers, consultants, processors, and researchers, has enabled us to build a season picture and set priorities, both in immediate support and in longer-term planning. The Industry Development report on page 14 provides a detailed update.

Joint Commonwealth-State disaster recovery funding to support businesses impacted by the severe weather events in NSW was finally announced in early June. Thank you for helping the AMS to help you. Completing the Primary Industries Natural Disaster Damage Assessment (PiNDDA) survey is the crucial first step in any natural disaster response, and in this instance provided a strong foundation for our subsequent advocacy and ongoing engagement with the NSW Government.

A Grants Workshop co-hosted by AMS and NSW DPIRD was well attended and provided valuable assistance to members in better understanding eligibility and the grant application process. Our conversation with the NSW Government regarding Primary Producer definition and eligibility for non-bearing orchards is ongoing.

Other valuable and well supported AMS events in recent months have included the series of AMS calibration workshops, grower liaison and pest scout meetings, the July MacGroups and the final workshops for the 2024-25 cohort of macadamia masterclass participants. In the most difficult of times the value of industry connection and support cannot be underestimated, and as we plan activities for 2026 we encourage you to reach out and assist in setting the agenda to continue to deliver for members and wider industry.

In early August, I had the privilege of representing the Australian macadamia industry at the China International Tree Nuts Conference, providing an overview of our 2025 season and an outlook for 2026 and beyond. Whilst little consolation, it's clear that our experience is not unique, with 2025 reported as a challenging year for nut crops globally. From almonds in California to walnuts in Chile and macadamias across much of Africa; many producing regions facing similar challenges of weather extremes, shifting pollination patterns and pest and disease pressures, and economic challenges and global market uncertainty.

Speculation on the final impacts of the US tariffs was obviously a key topic of conversation at the Chinese conference, with the immediate effects on US-China trade already clear and creating opportunities for other origins (including Australian almonds). Regardless of the final tariff outcomes, the impact on long-established nut industry trade flows will be significant, and a critical consideration in planning our own Australian macadamia market development strategies moving forward.

In June, AMS concluded its role as trustee for the Macadamia Conservation Trust, transitioning this valued organisation to Wild Macadamia Conservation. Their mission to protect and preserve wild macadamia genetics remains critical, and we look forward to maintaining a close working relationship.

Thank you if you have already renewed your AMS membership for 2025–26. Your support enables the AMS team to continue to deliver both levy-funded projects and the vital activities that levy funds cannot cover, such as strong advocacy and representation, practical support on-farm and in business when challenges arise, industry services and strategic partnerships, and targeted market engagement activities.

By renewing, you're not just securing these benefits for yourself. You're also helping to keep our industry strong, united, and ready to respond to the challenges ahead. Every membership counts in giving AMS the voice and weight needed to influence decisions and unlock opportunities.

This season has tested us all, but it has also reinforced the importance of staying connected and working together. Your resilience, insights, and continued engagement – through MacGroups, events, and direct feedback – ensure we can learn from 2025 and move forward with greater knowledge and confidence.

Clare Hamilton-Bate
CEO

Vale Geoff Garratt



It is with great sadness that we share the passing of Geoff Garratt.

Geoff was a former AMS President, pioneering macadamia grower, and a much-loved figure in our industry who passed away peacefully on 6 June 2025 at the age of 102. We extend our heartfelt condolences to his wife Ursula and the Garratt family during this time.

Geoff was a passionate advocate for the macadamia industry for nearly fifty years. His leadership, generosity, and unwavering commitment helped lay the foundations for the strong, united industry we know today.

After serving as a Lancaster bomber navigator during World War II, Geoff returned home to settle in Grafton where his strong sense of community and natural leadership saw him elected Deputy Mayor.

After moving to Sydney, Geoff's entrepreneurial spirit flourished. He developed a lasting connection to macadamias through his friendship with Paul Mendels from The Nut Shop — a family business that still roasts and sells macadamias to this day.

Never afraid to take risks, Geoff pursued ventures from prawn trawling to a brewery project in Timor, which ended abruptly with the Indonesian invasion. His resilience shone through as he recovered losses by selling the brewery plant to the Philippines.

In Gympie, Geoff dedicated 18 years to Skill Centred, an organisation supporting disadvantaged individuals through employment and training. He went on to serve as Board Chairman, and in recognition of his service, a new section of the organisation was named in his honour.

In 1976, convinced of the potential of macadamias, Geoff purchased 'Macadamia Integrifolia' from Bernie Mason in Gympie — an orchard of 1,000 trees originally planted by Italian internees after World War II. In the late 1950s and '60s, it was among the largest macadamia-producing orchards in the country. Geoff topworked many of the trees, embraced organic farming methods, built a processing facility using equipment he designed himself, and successfully marketed his own kernel. He actively worked the orchard well into his late 90s, only stepping back in 2020 at the age of 98.

Geoff's contribution extended far beyond his orchard. He joined the AMS in its early days and was elected to the Management Committee in the late 1980s. In 1994, he stepped into the role of President, guiding the Society through a particularly difficult period.

Known affectionately as the People's President, Geoff led with wisdom, humility, and a deep commitment to unity. He helped professionalise and stabilise the organisation, ensuring it represented the entire industry and was well-positioned for future growth.

He served on the AMS Board for nearly a decade and remained an engaged and valued member of the macadamia community long after his formal leadership ended.

His quiet strength, wisdom and kindness made him a respected leader and true friend. In Gympie, he was fondly known as "Gentleman Geoff" for the warmth and integrity he brought to all he did.

Geoff's passion for the macadamia industry never faded, and his influence continues to be felt across the orchards, businesses, and people he inspired. He will be deeply missed and remembered with great respect and gratitude.





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Crop setbacks in Australia and South Africa reshape 2025 outlook



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Global supply

This year is proving to be a difficult one for major production origins, with Australia and South Africa making major mid-season forecast adjustments. The 2025 Australian macadamia crop has been significantly revised, with the forecast now sitting between 37,300 and 41,970 t in-shell at 3.5% moisture (40,000 to 45,000 t at 10% moisture), down from an initial estimate of 55,960 t in-shell at 3.5% moisture (60,000 t at 10% moisture). The reduction is mainly due to prolonged wet weather in New South Wales and yields falling short of pre-season expectations. Growers are describing 2025 as one of the most challenging seasons in recent memory.

Other major macadamia-producing origins are forecasting a mixed supply outlook. South Africa has revised its 2025 crop forecast down from 93,433 to 85,166 t in-shell, a 9% decrease attributed to unfavourable climatic conditions. In contrast, China is forecasting a crop of 74,500 t in-shell, up 7% on 2024, while Kenya is also expecting growth, with a forecast of 47,500 t.

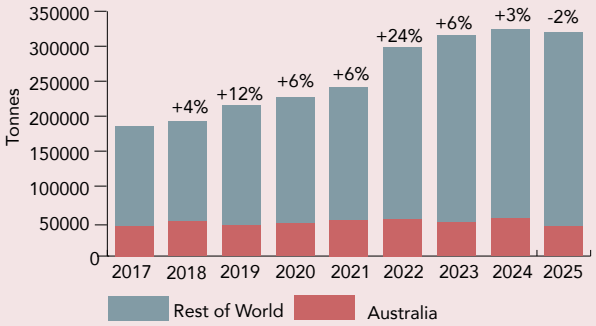

Figure 1. *Global macadamia crop volumes 2017-2025 (tonnes)*
Source: AMHA, INC, SAMAC. All volumes are at 3.5% MC

Global demand

In the 12 months to May 2025, macadamia kernel imports across the top five markets increased 5%. USA and Japan experienced strong growth, while China and Europe's kernel imports fell. The domestic market performed well, up 9% on prior period. Uncertainty around tariffs continues to cause concern.

Nut-in-shell imports reported by China Customs for the period June 2024 to May 2025 reduced by 18% from 95,406 to 78,056 t. South Africa retained market leadership supplying 52% of the imports, followed by Australia (23%) and Kenya (12%).

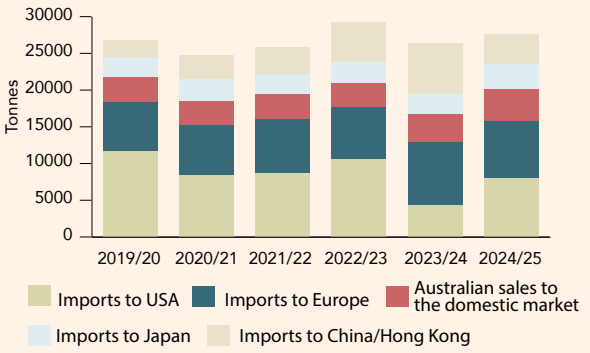

Figure 2. Global macadamia kernel imports from all origins to top 5 markets (tonnes) MAT June-May
Sources: USDA, Eurostat, Japan Customs, China Customs, Hong Kong Census & Statistics Department via S&P Global, AMHA

Australian sales

With the global kernel market showing signs of strengthening, Australia increased its focus on kernel sales this season. This shift is reflected in higher kernel sales and a reduction of in-shell exports.

In the 12 months to May 2025, Australian kernel sales were close to 12,000 t, up 11% on the previous year. Strong growth was recorded in the domestic market (+9%), which remains the largest kernel market, now accounting for 36% of total kernel sales. South Korea (+11%), Japan (+7%), and Taiwan (+44%) also posted year-on-year increases. The overall uplift is particularly notable given it was achieved despite sales to the USA and China falling by 24% and 22% respectively.

Australia's in-shell sales for the same period were 19,543 t, down 17% from the previous year's record of 23,569 t and reflected the increased focus on kernel sales.

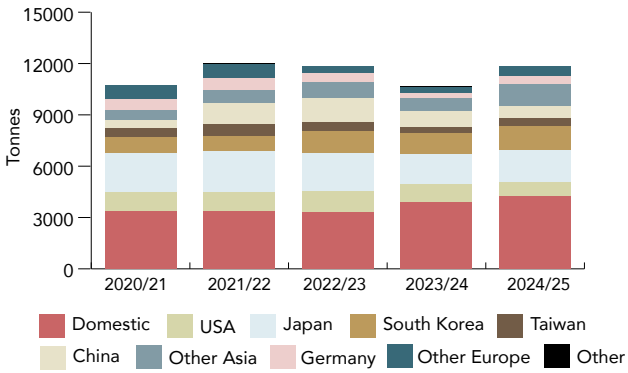

Figure 3. *Australian macadamia kernel sales (tonnes) MAT (June to May)*
Source: AMHA. Represents 90% production, sales are adjusted to represent non-AMHA members.

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Momentum across markets: Mid-year marketing update

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

The uniquely creamy taste, satisfying crunch and health credentials of Australian macadamias continue to resonate with consumers and trade alike. Around the world, more people are discovering their versatility as a snack, an inclusion in home cooking, or a premium ingredient that adds value across a wide range of food and beverage products.

The Australian Macadamias marketing program continues to amplify that story in six key markets: Australia, Japan, China, Taiwan, South Korea and India. The aim is to engage health-conscious consumers, inspire food manufacturers and forge new connections in-market. By delivering a co-ordinated mix of consumer and trade activity, the program is helping to drive global demand for our crop. Below is a selection of recent highlights from this diversified and strategically targeted marketing effort.

Japan: Macadamia brands in the spotlight



A Happy New Year with Meiji

To ring in the New Year, we partnered with iconic Japanese chocolate brand Meiji for a festive Instagram giveaway. Consumers were invited to answer the question: "Which New Year's dish would you like to make with macadamias?" with four options on offer - grilled shrimp with macadamia sauce, sweet mashed macadamia purée (shirokinton), salted macadamia beans, or burdock root tossed with macadamias.

The activity inspired new usage ideas and showed how easily macadamias can be incorporated into Japanese cooking. Meiji's macadamia chocolate is a long-standing favourite among Japanese consumers, and the giveaway helped boost engagement and Instagram following while promoting macadamias in a culturally relevant, festive context.



Brookfarm giveaway

A collaborative giveaway was run on our Japanese Instagram account in partnership with Brookfarm to showcase the delicious pairing of macadamias and muesli, and demonstrate macadamias as a versatile, health-forward ingredient in a premium food product. The giveaway was designed to grow our Japanese Instagram following and provide a valuable platform to spotlight Brookfarm's rainforest regeneration efforts - a tangible example of the sustainability commitment shared by many Australian macadamia growers.



Australian Nut and Dried Fruit Seminar Osaka

Our industry was represented by grower and MacField Farms MD Henrik Christiansen at the Australian Nut and Dried Fruit Seminar hosted by Austrade in Osaka in June. Henrik spoke about the benefits of Australian macadamias, and MWT's Andrew Waring joined a Q&A panel alongside the presidents of leading Japanese importers, Toyo Nuts and Shoei Foods. The event raised awareness of Australian nuts and encouraged their use as premium ingredients in Japanese food manufacturing.

China: Driving inspiration from gelato to energy snacks

Gelato World Cup China Selection



Macadamias proved to be a medal-winning ingredient at the Gelato World Cup China Selection, held at the world expo for foodservice excellence, SIGEP China 2025 in Shenzhen. As a silver sponsor, Australian Macadamias was proud to support the event and see our native nut featured in both the gold and silver medal-winning creations. Embraced for their creamy flavour, soft crunch and golden hue when roasted, Australian macadamias added premium appeal to some of China's most exciting new gelato concepts.

Energy-boosting snack campaign



In April, we partnered with 10 influencers across career, lifestyle and student-life categories on RED - a popular Chinese social media platform for lifestyle and product discovery - to promote macadamias as a natural energy-boosting snack. Each influencer created content showing how Australian macadamias power them through long days of work or study.

Perspectives from China's food industry leaders



To deepen our connection with the Chinese trade audience, we conducted a six-month interview series with some of the country's most respected chefs, brand managers and food media professionals. These interviews explored their views on Australian macadamias, from their rich flavour and texture to their potential in elevating both traditional dishes and innovative food products. The conversations also touched on broader food and health trends, offering valuable insights into the evolving Chinese culinary landscape. Published on the Australian Macadamias trade WeChat channel, which now has more than 10,000 followers, the series helped reinforce macadamias' relevance and value to China's foodservice and manufacturing sectors.

China Nut and Dried Fruit Exhibition



The China Nut and Dried Fruit Exhibition in Hefei - the world's largest trade event for the global nut industry - drew more than 100,000 visitors in April. Jacqui Price joined a well-attended macadamia roundtable that discussed evolving consumer preferences, long-term global production forecasts and the role of innovation, quality and health messaging in driving demand. Young Chinese consumers are increasingly interested in bold flavours and customisation, with new coated macadamia flavours like Coriander Beef, Coconut Latte and Cucumber on show. The Australian industry was also represented by Michael Waring, Brian Loader and Steve Mackinlay.

Taiwan: Connecting with consumers through culture and cuisine



Lunar New Year giveaway

A festive giveaway campaign celebrated Lunar New Year, tapping into the spirit of sharing and good fortune. Participants were asked to tag friends and answer the question "Where are macadamias grown?" - a fun way to reinforce their Australian origin. Macadamia gift boxes were offered as prizes, linking their rich, buttery flavour with the themes of abundance and celebration.



520 Day love competition

Marking Taiwan's 520 Day - a social media-driven celebration of love on May 20 - a giveaway campaign connected the theme of love with macadamias' heart health benefits. The activity encouraged followers to share the benefits of eating macadamias for a chance to win prizes, reinforcing the nut's nutritional value on a day associated with heartfelt expression.

TIQ Trade Mission and Taste of Queensland Showcase



Australian Macadamias representatives attended trade events in Taipei in June as part of Austrade and TIQ's Taste of Queensland Showcase. A delegate briefing covered market trends and regulatory updates, followed by a product showcase where Australian macadamia marketing materials were displayed alongside products from Marquis, Nutworks, Freedom Fresh and Australian Premium Macadamias. The event provided an opportunity to meet with several of Taiwan's nut importers. Guests at the networking function enjoyed desserts featuring macadamias, including Orange Australian Macadamia Cheesecake, Cocoa Puff with Australian Macadamias and Pistachio Cake with Australian Macadamia Nuts.

Australia: Expanding reach at home

Testing the waters on TikTok



Australian Macadamias launched on TikTok in January with platform-tailored videos supported by paid amplification. While still in its early stages, the channel is already delivering strong engagement on several posts and valuable insights into this fast-evolving platform. It is playing an important role in broadening our reach and relevance among younger consumers.

Regional media outreach



A PR campaign focused on regional media outreach saw core brand messages - including origin, taste and versatility - picked up by titles such as *The Byron Wave*. This helped extend our reach to important regional audiences and reinforced everyday usage ideas.



Competitions continue to perform

Our February consumer competition drew more than 8,000 entries and added 3,000 new subscribers, growing our domestic database to more than 30,000. Competitions remain an effective way to drive engagement and build our email list.

Grower stories strike a chord



Grower profiles continue to perform well across our digital channels. This year, we developed six new stories featuring growers from the Bundaberg region, showcasing the people, passion and expertise behind our premium product.

India: Food creators spark growth and engagement

Inspiring new ways to cook with macadamias



A partnership with top Indian Instagram creators - Karan Sawhney, Culinary Chaser and Savoury Tales highlighted macadamias in both traditional Indian and global recipes. From macadamia and pea vegan risotto to macadamia rabri (a traditional Indian dessert), the content reached millions of food lovers and drove strong engagement.

Following climbs past 13,000

Our India Instagram account hit a significant milestone in March, surpassing 10,000 followers - a strong signal of growing brand traction. That momentum has continued, with the account now exceeding 13,000 followers as more Indian consumers discover the delicious taste, versatility and health benefits of Australian macadamias.

South Korea: Successful brand partnership drives product development



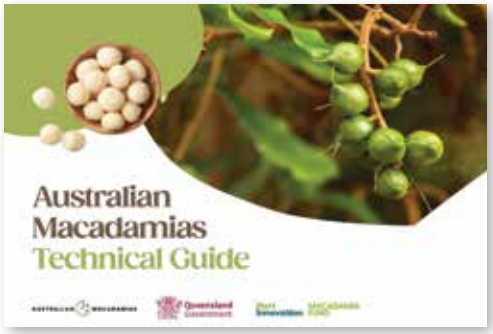
An exciting development in our collaboration with popular South Korean dessert brand Kokorokara has seen new Australian macadamia products launch in CU, South Korea's largest convenience store chain.

The partnership began in September 2024 with limited-edition macadamia desserts, which were extended due to strong consumer demand. The Macadamia Brittle Pudding has now been adopted by CU and launched as a limited-edition product

in its 19,000-store network, alongside a macadamia chocolate cookie product. A macadamia ice cream bar will launch soon, with more innovations under discussion.

This outcome is helping bring premium macadamia products into the hands of more South Korean consumers and stands as a compelling example of how consumer-facing campaigns can drive trade uptake of macadamias as an ingredient.

Technical Guide helping to drive global ingredient innovation



The Australian Macadamias Technical Guide is a comprehensive resource designed to support food industry professionals in understanding the features, benefits and technical attributes of macadamias as an ingredient. Launched in May, the guide brings together up-to-date technical knowledge and best-practice insights to help unlock macadamias' full potential in food product development.

Available in English, Simplified Chinese, Traditional Chinese, Japanese and Korean via the Australian Macadamias trade website, the guide is being downloaded by food professionals around the world. A highly targeted LinkedIn campaign is helping drive awareness of the resource among food innovation and procurement specialists, encouraging downloads and fostering ongoing connection via LinkedIn and the trade e-newsletter *The Macadamia Review*. The Guide represents a significant milestone in our trade marketing efforts, driving deeper knowledge of macadamias as an ingredient and growing demand for their use in manufactured food products. You can find it at trade.australian-macadamias.org/technical-resources/technical-guide

Want to know more?

If you would like to know anything more about these activities or the Australian Macadamias international marketing program, please feel free to reach out to Jacqui Price on jacqui.price@macadamias.org.

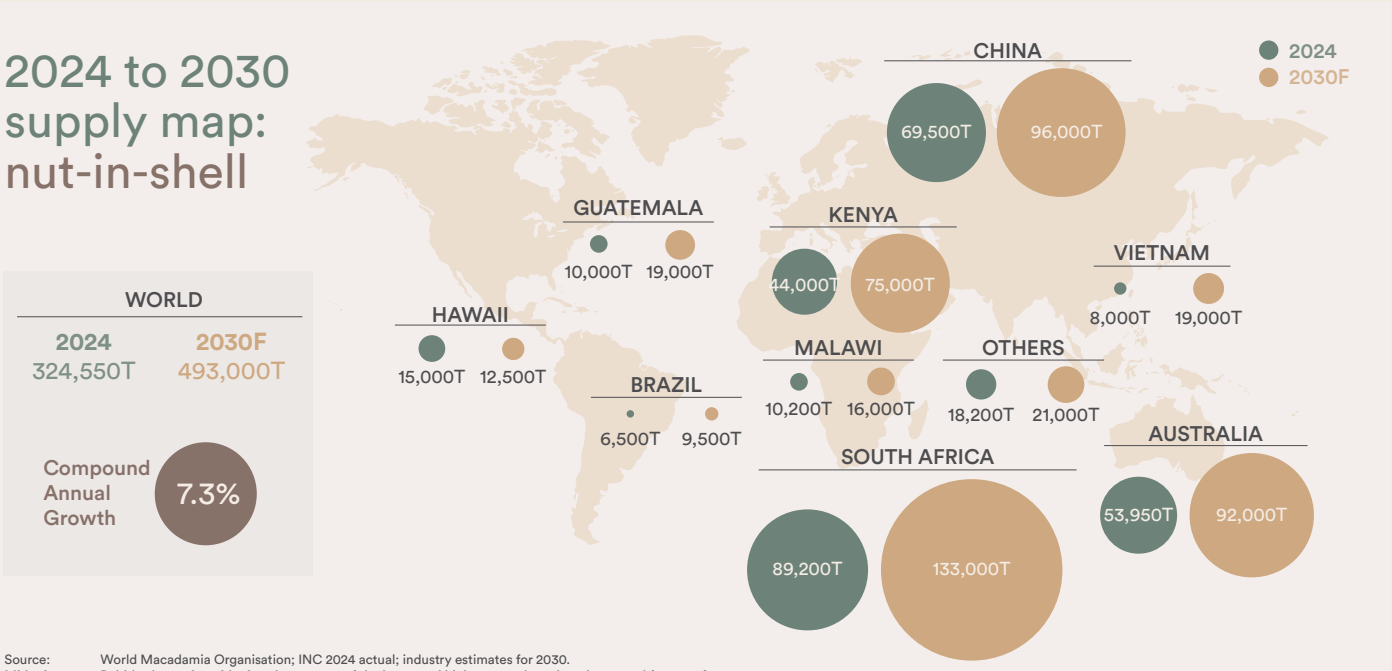


wmo world macadamia organisation

Growing supply, need to grow demand

Global macadamia supply is increasing and ensuring there is sufficient future demand is critical to the sustainability of the industry. The global 2024 crop was reported by INC as 325,000MT (nut-in-shell @ 3.5% moisture). Industry projections currently have the 2030 production at 493,000MT, over half of the current crop size again and a compound annual growth rate of 7.3%.

2024 to 2030 supply map: nut-in-shell



WORLD	
2024	2030F
324,550T	493,000T

Compound Annual Growth: 7.3%

Source: World Macadamia Organisation; INC 2024 actual; industry estimates for 2030.
Midpoint: Bubble shows the midpoint, the average of the lower and higher range based on the agreed forecast for 2030.
Note: This information is an estimate only and there is no guarantee of accuracy. Estimates are at May 2025 and expected to be updated in October 2025.

Work is underway to map the demand picture in 2030, including breaking down both supply and demand into styles. This will help shape future industry demand generation activities.

Strategic Foundations Committee oversees foundational industry activities

The Strategic Foundations Committee is a committee that advises the WMO Board on foundational activities that are important to the whole macadamia industry. These include co-ordinating the industry strategy, data collection and insights dissemination, creating product standards, evolving nutritional messaging, and developing industry-wide sustainability positioning. Co-ordination of these activities ensures that the activities of the WMO and also non-WMO members work in a cohesive way.



Australia is involved in the Strategic Foundations Committee

Australia's participation in the Strategic Foundations Committee is funded through voluntary contributions from members of the Australian Macadamia Handlers Association. This enables Australia's ongoing participation in and contribution to core foundational pillars of pre-competitive activity, and recognises the contribution already made by the Australian industry to support the Australian Macadamias marketing program. The Australian representatives at the Strategic Foundations Committee are Ben Adams of Marquis Macadamias and Clare Hamilton-Bate of Australian Macadamia Society.

WMO has new membership options

The WMO has now been operating for four years, and the membership structure has evolved to make it easier for companies to join directly, to offer options to organisations in the wider value chain, and to have more representation at decision making forums. Thirty-one processors and handlers, across eight countries, are now full members of WMO. And organisations representing the wider value chain for macadamias have joined as well. Australian companies who would like to be full members of the WMO are welcome to enquire through info@worldmacadamia.com.

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Making sense of a difficult season



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After two tough years of low prices and farm-gate price bouncing back around $4/kg in-shell, many growers were looking to the 2025 harvest as a turning point where they could begin to recover financially, and where the industry could realise its growth potential from new plantings. Unfortunately, that hasn't been the case.

The crop forecast has been revised from 60,000 t in-shell at 10% moisture to between 40,000 and 45,000 t, which has contributed to a general sentiment that this has been one of the hardest years in decades.

What went wrong this season?

Yields are down across the board. NSW has been hit the hardest, with yields down roughly half and many orchards producing a fraction of their usual crop. In Queensland, the crop is down between 20 and 30%. Production has varied greatly between orchards and within blocks; even where growers maintained input programs, yields were below expectation and harvest ended early. The decline was more evident in Hawaiian cultivars, most notably 741 and 344. Nuts were slightly smaller than average and kernel recovery across cultivars is about 1.5% lower, although with A203 and 741 it is lower still.

This wasn't just a macadamia problem. Crops across our growing regions such as lychees, avocados and citrus also reported yield decline, pointing to broader environmental factors at play. Following is a summary gathered from growers, consultants, processor representatives and MacGroup sessions in recent months.

Tree age and resilience

Some people have questioned whether reduced orchard inputs after low prices contributed to the outcome, but most growers maintained fairly standard input programs. The exception was canopy management, which was more often than not deferred.

Its notable how well young orchards performed compared to older orchards, something not explained simply by juvenile vigour. In general, young orchards had better light, airflow and pollinator activity, and dried out quicker after rain, while older orchards struggled. Their denser canopies were more vulnerable to fungal issues, less attractive to bees, and less able to photosynthesise. It's a pattern that's hard to ignore.



Young orchards produced well in a tough season.

Many old orchards seem to be nearing their end of life. The gap in performance between old and new cultivars is widening, and it may be time to replace underperforming old blocks with newer cultivars, particularly where tree architecture has become structurally unfunctional. In these cases, no amount of canopy management can return trees to full productivity.

Seasonal cues and extreme weather

Macadamias set a good crop when the right weather signals align, such as a rest period after harvest, cooler conditions for flower initiation and to interrupt pest cycles, adequate soil moisture into flowering, flushing outside of resource intensive periods like flowering and nut set, and favourable conditions through nut development with adequate sunlight.

Signals have been less reliable in recent years. Warmer autumn and winter temperatures, especially minimums, and a shifting rainfall pattern from one that is summer dominant to one of increasing winter and spring rainfall have resulted in less distinct natural signals. Not only is tree recovery after harvest compromised when this happens, but the window for orchard floor reset and canopy management is smaller.

In the 2024-25 season, growing regions experienced these shifting signals differently. In 2024, the NSW Northern Rivers set a new record - the most rain days in a year since records have been kept (208 days). Bundaberg recorded 100 mm of rain in August 2024, an unusual event for the typically driest month of the year. In NSW and South East Queensland, unseasonal heat was an issue, with temperatures above 30°C for several days during flowering. These are conditions we dread as much as hail as they hinder pollination and nut set. It wasn't a year to miss preventative fungicide application if there was a history of fungal flower/nut disease in orchards.

The wet summer experienced in all regions, which resulted in long grass and soggy conditions,

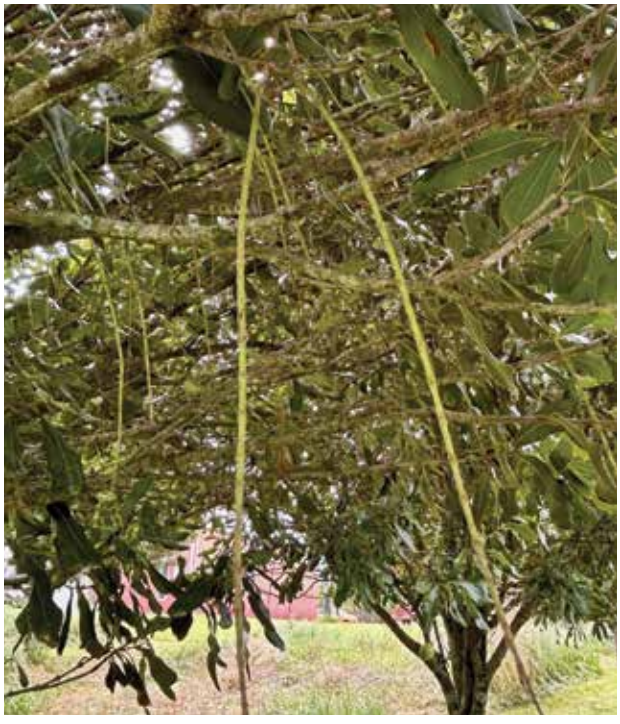
hampered orchard clean up, and then with preparations for early harvest underway in February, Tropical Cyclone Alfred brought damaging wind and rain. While this was bad enough, a bigger challenge was near-constant rain across South East Queensland and NSW in the months after, meaning that many growers were still waiting to begin harvest in June.

Wet harvest conditions are now a recurring problem, and growers are rethinking their machinery strategy, balancing using light gear to enable access and protect the orchard floor with the efficiency of larger equipment.

Pollination pressure

Pollination in 2024 was poor, and the causes were complex. Grower reports of limited bee activity were echoed by beekeepers. Usually you cannot miss the buzz of bees at flowering, but orchards were silent last year, and to make matters worse, flowering was short and sharp. Bud break and raceme elongation came early and looked promising but open flower and petal fall happened rapidly. This meant the window for cross pollination was narrow, and many trees were left in late September-early October with bare racemes and patchy set.

In the future, varroa mite will worsen this situation as it's expected to weaken commercial hives and ravage feral honey bees. This means increased challenges and higher costs for managed pollination and underlines the importance of planning for these changes by making orchards pollinator friendly and securing beekeeper agreements. The research on cross pollination is well established and has shown that managed pollination is worth the investment as it consistently improves yield, kernel recovery and nut retention.



Empty racemes on a 344 in early October 2024.

High pest pressure and late season activity

Last season featured high pest pressure, particularly late in the season. Prominent issues were as follows:

- High spotting bug pressure, notably in the late season when it's hard to detect damage. This is supported by modelling by the integrated pest management project, which has shown that FSB populations were significantly higher in the last two wet seasons. The impact was worst for growers who stopped monitoring or managing this pest at Christmas.
- Pressure from macadamia nut borer extended later, and control was required into January. Fortunately, control remains effective with Mactrix releases and timely sprays (if needed).
- The emergence in Bundaberg and Gympie of citrus blossom bug. While this flowering pest is known to attack avocados, its impact on macadamia is unclear but some orchards lost almost all flowers.
- The impact of broadmite, signs of which were bronzing on flowers and husks. While usually minor, this husk damage can affect the developing kernel as husks respire and support the kernel to maturity.
- Growers who did heavy "clean-up" sprays with broad-spectrum or cheap products removed all beneficial insects and flared secondary pests like aphids, thrips and felted coccid. These early-season choices need careful consideration. The move to selective chemistry supports good IPM but requires better monitoring because we aren't using broad disruptive controls.

Ignoring vertebrate pests

Vertebrate pests - rats, pigs and cockatoos - continue to cost growers. The impact from vertebrate pests is probably greater than from any other pest, yet insect management gets far more attention. Rat populations have surged after wet years and many view it as an unavoidable "tax" on production, but the tax is getting steeper. Growers who manage rats all year round with proactive baiting and orchard hygiene see a dramatic reduction in populations and damage.

Baits are most effective when kept dry, replenished regularly, and placed where activity is highest. Reducing rat harbours such as rubbish piles in and around the orchard and opening up headlands also makes a big difference.

A pattern in yields?

Along with underperforming older orchards, a broader trend is evident, that is, a biennial yield pattern. Over the last decade, "off years" have landed on odd-numbered years, and "on years" on even-numbered years. While this sawtooth yield pattern is most obvious in Queensland, it does affect the whole industry. The silver lining? Trees often bounce back



Rat bait in a station with an unexpected occupant.

the year after producing a light crop, using unspent reserves. If this seasonal pattern holds true, there's great hope for 2026.

Understanding crop forecasts

Forecasting is important for many reasons, including grower and processor planning and cash flow management, reliable sales contracts, market confidence, levy investment planning and Australia's contribution to global forecasts. It is a collaborative process involving the following:

- A levy-funded, science-based model from the Crop Forecasting project led by Queensland DPI. This uses weather indices, flowering assessments, crop intake history, tree census data and price trends. While it can't predict extreme events or harvest decisions, it does provide a valuable starting point. The model is currently under review to include more seasonal ground-truthing.
- Seasonal insights and mapping data from the AMS, including planted and bearing hectares, yield history, and orchard age data complemented by long-term yield curves in line with benchmarking. Seasonal insights are gained from grower feedback, industry consultation, and the AMS's established role in managing emerging issues.
- Forecasts from processors and handlers through the Australian Macadamia Handlers Association (AMHA), which are based on grower consultations, field observations and crop history. The AMHA aggregates these inputs and provides an initial forecast, mid-season updates as intake progresses and then releases the final crop in December each year.

This forecast is shared with the International Nut & Dried Fruit Council (INC) and the World Macadamia Organisation, which build the global crop outlook, something that is essential given the rapid expansion of plantings in Africa and Asia and the need to develop markets for this growth.

Forecasting macadamias isn't easy. The crop is hard to see, flowering doesn't always reflect yield, mid-season weather is unpredictable and bias creeps in. Still, the four-year average variance since 2021 is only 6.4%. This year that variance will be larger and reflects an exceptional season.

Looking forward

This season has tested everyone. There are no quick fixes but there are takeaways.

The season showed that orchard performance can't be taken for granted, even in blocks that usually do well. We've seen how younger orchards perform with the benefit of sunlight, ventilation and the IOM pillars of orchard floor, canopy and drainage management. We've seen how poor pollination can undo early promise and how pest pressure can steal crop at the final hurdle.

We can't control the weather, but we can improve our preparation through better canopy structure, improved ground cover and orchard floor condition, pest and disease monitoring, smarter inputs, more productive cultivars and understanding how individual farms respond to seasonal pressures.

Take a look below at some of the orchard priorities highlighted at the recent MacGroups. I look forward continuing this conversation about how we strengthen for the seasons ahead.

Priorities for the months ahead

At the July 2025 MacGroups, grower and consultant panellists from across the regions shared their orchard priorities for the next six months. Here's what they said:

Orchard floor condition and soil health. Repairing the orchard floor, focussing on improving soil health, building organic matter and maintaining groundcover.

Canopy management. Prioritising light and airflow for next season's crop but not pruning during the peak demand of flowering or early nut development.

Pest and disease monitoring. Engaging a professional to help monitor the orchard, planning chemistry choices with the whole season in mind and applying preventative fungicides if at risk.

Pollination preparation. Early planning for managed hives and prioritising the cost, making the orchard conducive to natural pollinators and avoiding sprays at flowering.

Rat control. Keeping up proactive baiting and orchard hygiene.

Phytophthora management. Assessing the impact in blocks, managing drainage, improving soil health and well-timed phosphoric acid applications.



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Getting sprayer calibration and coverage right

Theunis Smit, OmenAg, Bundaberg M: 0423 394 468 | E: theunis@omenag.com

In this feature, Theunis Smit goes through the practical steps for achieving accurate calibration and more effective coverage, highlights common mistakes and provides worked examples for calibrating sprayers.

Ever found yourself wondering why your best chemical mix just didn't get the job done? Or why your neighbour's orchard seems to thrive while yours lags behind, even though you're both using the same inputs? The answer might not be in the drum, but in the delivery. In macadamias, smart spraying isn't about more product, it's about getting it where it counts, every time, and this means paying attention to sprayer calibration and coverage.

Sprayer calibration is one of the most powerful tools in a grower's toolkit. It's not about fancy gear or ticking a box, rather it's about how droplets, air and timing work together to reach every part of your trees.

A properly calibrated sprayer ensures every leaf gets its fair share, every pass counts, and every dollar stretches further. Conversely, a poorly calibrated sprayer can cost far more in lost yield, ineffective pest or disease control, and repeat applications. Worse still, repeated poor coverage or sub-lethal dosing can contribute to the development of chemical resistance making future problems harder and more expensive to manage.

Getting it right means pausing long enough to measure, test and think. Because no two orchards are the same, no sprayer setup should be either. A few small adjustments can mean the difference between average control and excellent results. Watch how the canopy moves. And if you're not sure — ask. That's what good advisors are for.

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Calibrating for precision, step by step

Sprayer calibration can seem complex at first glance, but it's about aligning your equipment with the needs of your orchard. Calibrating your equipment includes canopy measurement through to nozzle checks to ensure that your spray reaches the target. With a few calculations, simple tools and a systematic approach, you'll have everything needed to make every spray count.

Step 1. Measure the canopy and calculate tree row volume (TRV)

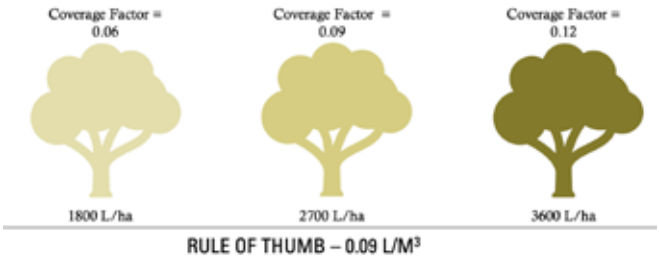
Start by measuring tree height and average canopy width for each block. Use the TRV formula:

TRV = (Height × Width × 10,000/Row Spacing) × Coverage Factor

Typical coverage factors are:

- 0.06 for sparse canopies
- 0.09 for standard macadamia canopies
- 0.12 for dense canopies.

This gives you the dilute spray volume (L/ha), which is the volume required to achieve full coverage to the point of runoff. This is an important figure as it forms the basis for calibration. It's what most chemical labels refer to when they talk about application rates. Many growers calibrate from memory, not measurement, and that's where mistakes begin.



Canopy factor is used to calculate tree row volume.

Step 2. Measure tractor ground speed

Lay out a 100 m track and time how long the sprayer takes to travel it at operating RPMs.

Speed (km/h) = (Distance in m ÷ Time in seconds) × 3.6

Travel speed directly affects flow rate and airflow. Go too fast, and your spray-laden air won't replace the canopy air as droplets miss the target and drift or settle too early. In dense orchards, travel speeds often need to be as low as 3 km/hr, and in some cases under 2 km/hr, especially when using sprayers with smaller fans or less powerful blowers.

Step 3. Measure sprayer air displacement

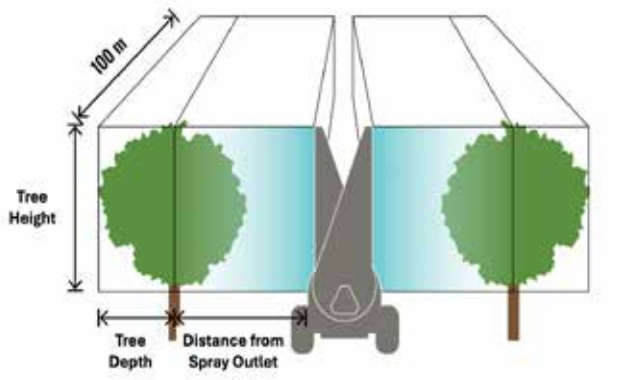
Use an anemometer to measure air speed at the fan outlet and calculate the spray air volume:

Spray Air Volume = Air Speed (m/s) × Fan Outlet Area (m²) × 3600

This tells you how much canopy air can be displaced per hour, critical for ensuring droplets penetrate the canopy. If you don't replace the air within the canopy, droplets won't make it to the target. The canopy may look wet on the outside but be bone-dry inside.

Step 4. Estimate canopy air volume

Now estimate how much air volume your sprayer must displace to fill the canopy space.



Canopy Volume = Tree Height × Distance from sprayer to mid-tree × Row Length (typically 100 m)

This is **not** the same as TRV. TRV is about wetted surface area, while canopy air volume is about replacing the actual air inside the canopy with spray-laden air. In young or narrow-canopy orchards, this volume can be much larger than the TRV. Matching your sprayer's airflow to this volume is essential to avoid under-spraying.



Step 5. Check that your sprayer can deliver the required air and water volumes

Before changing nozzles or pressures, make sure your pump and fan can physically deliver the air and water volumes you calculated. A surprising number of sprayers simply can't do the job at higher speeds or on larger trees. This is a great time to check manufacturer specifications or talk with a technician.

Step 6. Verify pressure and flow rate

Check that your flow rate controller can deliver the required volume consistently and accurately, and then match nozzle output to the set pressure using a calibrated gauge. Compare pressure at the pump and at the nozzle to ensure minimal loss. Nozzle wear, blockage, or incorrect sizing can all cause major issues.

Step 7. Measure nozzle output at correct pressure

Once pressure is set, measure each nozzle's output for one minute and compare it to manufacturer specifications. Nozzle mismatches and wear are one of the most common reasons for uneven or ineffective application.

Step 8. Conduct a coverage check

Set the sprayer to the dilute rate. Place water-sensitive paper or use a kaolin/dye mix throughout the canopy. A well-calibrated spray should hit nuts, flowers and leaves. For nuts (especially spherical ones), full surface coverage is essential. Tools like the SnapCard app can help you assess coverage using your phone.

Step 9. Adjust for concentrate spraying

If you're using less water than the calculated dilute spraying volume (based on TRV and a coverage factor), you're doing concentrate spraying so you must adjust chemical rates:

Concentration Factor = TRV ÷ Actual Water Volume

Multiply the label rate by this factor - but only if the label permits concentrate use. Neglecting to do this is a major reason sprays fail.



Calibration brings consistency

When contemplating the steps to effective calibration, it's worth remembering that it isn't a chore; it's a system check that brings precision to everything that follows and allows for you to bring consistency to your spray program.

Common mistakes to do with calibration.

Mistake	Why it matters	Fix
Assuming TRV = Air canopy volume	Tree Row Volume (TRV) estimates the water needed to wet the canopy, not the physical space the sprayer needs to fill with air and droplets. Mixing the two can result in underpowered sprays and patchy coverage.	Always calculate both TRV (for water volume) and canopy air volume (for airflow requirements).
Travelling too fast	At higher speeds, spray-laden air may not penetrate the canopy. Instead, it rebounds or deflects, especially in large or dense trees.	Use a stopwatch and calculate your real travel speed. Most growers overestimate how slow they need to go. Under 3 km/hr might be necessary in denser orchards.
Not verifying nozzle output	Even if your pressure gauge reads correctly, worn or blocked nozzles can throw off your flow rate. That means your chemical rate per hectare may be completely wrong.	Measure nozzle output at the correct pressure and replace or clean where needed.
Not adjusting rates for concentrate spraying	Spraying at 300 L/ha when the label rate is based on 1000 L/ha, without adjusting the concentration, delivers only a third of the intended chemical and trees get under dosed.	Always calculate your concentration factor and confirm label support for concentrate use.
No need to check coverage every time	False sense of performance.	Use water-sensitive paper + SnapCard app.

Coverage matters

A properly calibrated sprayer still needs real-world confirmation. The easiest and most effective way to check coverage is with water-sensitive paper placed throughout the canopy, from the outermost tips to the hidden inner zones. A good spray leaves even, round droplets across each surface.

How to tell If you're hitting the mark

Use kaolin clay or a dye to visually inspect coverage during calibration runs. Nuts and flowers are the key infection and damage points of macadamia trees, so if you cannot see residue on them, your spray isn't reaching the target. This is especially critical for nuts, which are spherical and notoriously hard to coat.

If you're getting poor coverage, it's usually not the product, rather it's the application. Don't assume that because the trees look wet from the outside, the job is done.

Airflow and coverage

Coverage failure is often tied to one issue: airflow mismatch. If airflow isn't sufficient to penetrate the canopy and replace the air inside with spray-laden air, droplets won't reach internal surfaces.

To assess airflow distribution, use the flagging tape test, that is attach strips to various heights in the canopy and on your sprayer's fan. If the tape barely moves or flaps inconsistently it's a sign your airflow needs work. Fan speed, nozzle angle, and travel speed can all be adjusted to improve this.

Growers often overestimate what their sprayer can deliver at speed. Always match travel speed with fan capacity. A slower pass with good displacement is far more effective than a quick one that only wets the leaves.

What to watch with contractors

Even if you're not doing the spraying yourself, your reputation and profitability still rides on it. When working with contractors:

- ask what TRV and canopy factors they're using,
- request their calibration data,
- confirm whether they're spraying dilute or concentrate,
- observe coverage with water-sensitive paper or use the SnapCard app to check results,
- reconfirm that chemical rates are being adjusted for concentrate spraying where needed.

Many spraying failures in macadamias come down to assumptions and missed questions, not bad intentions.

Common mistakes to do with coverage.

Mistake	Why it matters	Fix
Overlooking airflow direction and distribution	Uneven air distribution leads to uneven coverage, even at the right speed and pressure.	Use flagging tape in the canopy and on the sprayer to visualise airflow. Adjust fan vanes or nozzle positions as needed.
Relying on the contractor's settings	Many growers assume their contractor's setup is 'close enough'. But settings for one block or orchard might not match your trees.	Ask what **coverage factor** they're using. Insist on regular **coverage checks** and ground speed testing per block.

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Doing the maths: Worked examples for calibration and coverage

TRV and dilute volume calculation

Tree Row Volume (TRV) helps you calculate how much spray is needed to cover the canopy to the point of runoff, the dilute volume referred to on most chemical labels. This base volume is essential for calibrating your sprayer and adjusting chemical rates correctly. In this example, we walk through how to measure TRV using real orchard dimensions, helping you set a solid foundation for accurate spray application.

Scenario

- Tree height = 7 m
- Canopy width = 5 m
- Row spacing = 8 m
- Coverage factor = 0.09 (standard for macadamias)

Formula

TRV = (Height × Width × 10,000/Row Spacing) × Coverage Factor

= (7 × 5 × 10,000/8) × 0.09 = 3,937 L/ha

Interpretation

This is your dilute spray volume, the theoretical water volume needed per hectare to reach the point of runoff. It forms the base spray volume to calibrate your sprayer and aligns with most label recommendations.

Matching airflow to canopy volume

Spray coverage isn't just about water; it's about moving enough air to carry droplets deep into the canopy. To achieve this, your sprayer's airflow must displace the actual volume of air inside the trees, not just blow across the surface. By calculating and matching your sprayer's air output to the size of your orchard canopy, you ensure that every spray reaches where it needs to go.

Canopy volume formula

Canopy Volume = Tree Height × Distance to Mid-Tree × Row Length (usually 100 m)

Sprayer air volume formula

Air Volume = Air Speed (m/s) × Fan Outlet Area (m^2) × 3600

Goal

Match sprayer airflow with the volume of air inside the canopy. This ensures spray-laden air replaces canopy air for maximum penetration.

Chemical concentration: Are you under-dosing?

Many growers unknowingly apply less chemical than needed by switching to lower spray volumes without adjusting their chemical rates. This happens when you move from a dilute spray (to the point of runoff) to a concentrate spray but forget to multiply the rate by the correct factor. If the label doesn't allow for concentrate spraying, this can result in poor pest and disease control and potentially contribute to resistance.

Example

- TRV (dilute spray volume) = 1,000 L/ha
- Actual water applied = 250 L/ha

Concentration factor

1,000/250 = 4X

Why it matters

You must increase the chemical concentration by this factor (4X in this example), but only if the label allows concentrate spraying. Failing to adjust chemical rates risks poor pest control and contributes to chemical resistance.

Matching sprayer air output to canopy volume

To achieve good spray coverage, your sprayer needs to push spray-laden air through the entire tree canopy, not just blow it around. This worked example shows you how to check whether your sprayer is up to the task and what speed you should be travelling to make it happen.

Example orchard setup

- **Tree height:** 7 m (how tall the trees are on average from the ground to the top of the canopy)
- **Distance from sprayer to mid-tree:** 4 m (how far the spray has to travel to reach the middle of the tree)
- **Row length:** 100 m (a standard measurement block often used when calculating spray rates)
- **Row spacing:** 8 m (the space between the centres of each tree row)
- **Fan air speed:** 35 m/s (how fast the air is moving as it leaves your sprayer's fan)
- **Fan outlet area:** 0.6 m^2 (the size of the air outlet on your sprayer, measured in square metres)
- **1 hectare:** 10,000 m^2 (the standard unit area we use to express spray volumes [litres per hectare])

Step-by-step calculation

Step 1: Canopy air volume per row. First, work out how much air the canopy in one row can hold. This is what needs to be replaced by spray-laden air to get proper coverage.

Volume = Height × Width × Row Length
= 7 m × 4 m × 100 m = 2,800 m^3

This means every 100 m row has 2,800 m^3 of canopy air to displace.

Step 2: Canopy air volume per hectare. Now we calculate how much canopy air exists in one hectare of orchard.

- Each 100 m row occupies 800 m^2 (8 m × 100 m)
- 10,000 ÷ 800 = 12.5 rows per hectare

2,800 m^3 x 12.5 = 35,000 m^3/ha

Your sprayer needs to displace 35,000 m^3 of air per hectare to reach all the leaves.

Step 3: Sprayer air displacement rate

Now calculate how much air your sprayer is actually pushing out each hour:

Air Volume = Air Speed × Fan Outlet Area × 3600
= 35 m/s × 0.6 m^2 × 3600 = 75,600 m^3

This sprayer is moving 75,600 m^3 of air per hour.

Step 4: How many hectares can the sprayer treat per hour? To find this, divide the sprayer's air output by the canopy volume per hectare:

75,600 ÷ 35,000 = 2.16 ha/hr

The sprayer can properly cover 2.16 ha/hr at this air output.

Step 5: What travel speed does that mean?

Each hectare has 1,250 m of tree rows (10,000 ÷ 8). So:

2.16 ha/hr × 1,250 m = 2,700 m/hr

2,700 ÷ 1000 = 2.7 km/hr

You should travel at 2.7 km/h or slower to fully displace canopy air at this setup.

Why this matters

This example shows that to get spray right into the canopy, not just onto the outside leaves, you need enough airflow, and you often need to **go more slowly** than expected. Many growers overestimate how far their airflow reaches, especially when travelling above 4 or 5 km/hr.

By matching sprayer air output to the real canopy volume, you give your spray the best chance of doing its job.



Champion of organic macadamias retires

After 40 years in the macadamia industry, Vince Collins is hanging up his boots.



An integral player in the certified organic nut business, Vince is proud of what has been achieved at Macnuts to support organic growers and promote the product.

Vince started his nut journey, not through farming, but through computers. As the IBM specialist for the Stahmann processing plant in Moree in the 1980s, he was approached to oversee the installation of similar equipment in the newly built Toowoomba plant. In 1982, he was given the role of business manager for Stahmann Toowoomba, which processed pecans and macadamias and value-add products.

At the start of the 2000s, Macadamia Exports Australia lured Vince to assist with exports of processed nuts. Part of his role was sourcing nuts to fulfil orders, including from Nambucca Macnuts.

'The nuts from the mid-coast of NSW seemed to have a creamier taste and better quality, so when the opportunity came to be general manager, I jumped at the chance.

'The nuts here are harvested later than other areas, so the oil content develops more with the extra time on the tree,' said Vince.

Going organic

The volumes processed at the time were a tenth of some of the bigger operations, making it hard to compete. The Macnuts co-op board looked at their options, and with two board members being organic growers, decided to focus on servicing the small, niche organic market.

Nuts are sourced from certified organic growers. The NSW mid north coast regional growers are small land holdings, and isolated from each other by distance, which means that pest and disease pressure is less than for northern growers. In Vince's time the number of growers has gone from five to 10, with more growers looking to attain organic certification. Vince and the board work with growers to share the latest news and innovations for organic production.

As a co-op it means that most growers are shareholders, so they can be small operations and still have a voice and a market. Macnuts acts as a consolidation point processing and distributing nuts on their behalf, to companies such as Stahmann Webster or to retail.

A number of improvements have been made to the facility over time.

'When I started, the equipment was getting quite old. We sold that to a start-up in Kenya and upgraded to equipment that would suit the 700 tonne capacity we were doing at the time.

'Since then, we have installed multi-scan colour sorters for the nuts and kernels, and air separators to remove the shells. As a consequence, we are more efficient, and better able to compete,' said Vince.

As well, a packaging filler machine for small packs of nuts (100 and 250 g and 1 kg) has just been installed, and these products will go on the market soon.

The organic market is feeling the pinch with the reduced harvest as a consequence of weather events and consumers tightening their financial belts. Competition from imported nuts is also clouding the opportunities for genuine Australian organic nuts.

Significant achievements

As Vince heads into retirement, he reflected on his achievements in the macadamia industry, saying that while he may not have made big impacts across the whole industry, he is proud of what has been achieved for the organic market and Nambucca Macnuts.

'I have enjoyed being part of the Macnut story and am grateful to the support the company has had from the board.

'I would like to also thank the people I have had the privilege to work with over the years including buyers, processors, growers and staff,' he said.

Macnut Chairman Peter Ranking paid tribute to Vince, who he said took the company from a small operation to one of the largest organic processors in the country.

'MacNuts is well known for its high-quality processing of kernels, and this is due to the excellent quality control and attention to detail Vince has given it. He is very much a "jack-of-all-trades" across our company and is always quick with a smile,' he said.

And Vince's favourite product? Dry-roasted salted nuts!

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On-farm autonomy: Lessons from a grower's trial

Macadamia grower Henrik Christiansen has been trialling autonomous tractor technology to improve efficiency, reduce labour reliance and boost safety. Here's how he made it work on his farm – and what other growers should know before taking the leap.

The evolving technology

Autonomous agricultural technology is no longer just a concept for the future. While still in its early stages, more horticulture producers are trialling systems that take on repetitive or high-risk tasks, freeing up labour and improving efficiency. In macadamias, the focus is on jobs like slashing, mowing and spraying, where safety, accuracy and consistency matter.

Cam Clifford, CEO of Agri Automation, says the shift from operator-assisted equipment to fully autonomous platforms has been remarkable.

"Retrofit systems can now automate existing tractors, while others provide fully autonomous electric platforms. These tools reduce labour needs, improve precision, and in some cases cut input costs through better-targeted spraying," he said.

Cam believes the main benefits are labour savings, reduced downtime from operator error, and in some cases fuel or chemical reductions. However, he notes that choosing the right system and integrating it into existing operations is key.

Case study: Henrik Christiansen, MacField Farms

Henrik's six key tips for autonomous agtech

1. Choose compatibility over complexity – work with your current tractors and implements.
2. Map once, benefit for years – accurate mapping is a one-off per task.
3. Plan for staff ownership – appoint a "technology champion".
4. Check your connectivity – reliable GPS/mobile coverage is essential.
5. Know your layout limits – can't reverse, needs navigable headlands, must be off public land.
6. Track your ROI – hours used, downtime, R&M, labour saved.

"Staff ownership is critical. We identified a champion to oversee it."

Henrik has been trialling GoTrack autonomous tractor technology for inter-row slashing and orchard spraying. His decision was based on several practical considerations.



"It's not just about moving the tractor, it's about completing the task."

Choosing the right system

Henrik chose GoTrack because it worked with his standard tractor models and existing implements, avoiding the need for a specialist machine. GPS and RTK integration provide precise steering, with built-in safety features, remote monitoring and control.

"The team behind GoTrack have strong orchard knowledge and a commitment to a complete solution – not just moving the tractor but completing the task," Henrik said. "It's simple, robust and repeatable."

Overcoming adoption challenges

Mapping the farm for each task was time-consuming but only needs to be done once per operation type. Planning work so the autonomous tractor is first to start each job helps maximise its value.

Connectivity is another factor – the system needs clear satellite access and reliable mobile coverage. Starlink is an option where 4G is patchy.

Quick benefits at a glance

- Long-term labour savings.
- 24/7 operation with consistent results.
- Reduced wear and tear on machinery.
- Potential for variable-rate spraying.
- Lower WH&S risks.

Questions to ask before you buy

- Is the system compatible with my current machinery?
- How many hours a year will I realistically use it?
- Is my farm layout suitable for autonomous operation?
- Does the supplier have orchard experience?
- What level of local support and training will I get?

Key benefits for growers

Henrik sees long-term labour savings and the ability to run operations 24/7 without breaks. Jobs are completed consistently and on time, with less wear and tear on machinery.

"For tasks that aren't fully autonomous yet, the steering function is still valuable. We can also set up variable-rate spraying based on tree size, avoiding wasted inputs," he said. WH&S risks are also reduced.

Limitations to consider

Not all orchards are suited – the system can't reverse, requires suitable headlands, and must operate entirely on private land. There's an upfront cost to weigh against the payback period, and Henrik recommends considering how to lock out specific areas for safety.

Measuring performance

Henrik monitors utilisation hours, downtime, repair and maintenance needs, and calculates ROI by comparing costs against labour hours saved.

Advice for other growers

"Look at all the options, and make sure the supplier has orchard experience," Henrik said. "Check your farm layout, think about how many hours a year you'll use it, and plan how it fits into your workflow."





Henrik Christiansen, MacField Farms is trialling autonomous tractors for efficiencies and labour.

Industry investment in automation

Hort Innovation has recognised the need for autonomous operations in orchards and initiated the project *Automating the Nuts Industry in Australia: A pathway to smarter orchards and labour optimisation (AS23008).*

This multi-year initiative will use advanced AI to accelerate the adoption of precision autonomy in Australia's almond, macadamia and pistachio industries, automating labour-intensive processes to boost productivity and reduce reliance on manual labour.

The technology, developed by US company Bluewhite, has already delivered strong results in major nut, citrus and vineyard operations in the United States, improving productivity, crop consistency and operator safety. The project will adapt Bluewhite's Pathfinder autonomous tractor system for Australian conditions, ensuring it suits our orchard layouts, machinery and connectivity requirements.

For macadamia growers, the trials will focus on compatibility with existing equipment, safety in orchard environments, and reliable operation under varying terrain and canopy conditions. The aim is a scalable, smart farming solution that supports both efficiency and sustainability, with practical case studies to help growers plan their adoption pathway.

Hort Innovation Frontiers

More floods on mid north coast affect orchards

Jeremy Bright, Development Officer Macadamia, NSW Department of Primary Industries and Regional Development M: 0427 213 059 | E: jeremy.bright@dpi.nsw.gov.au

In the wake of TC Alfred, the mid-north coast of NSW was impacted by flooding, causing widespread damage, particularly to the region's macadamia farms



Strong winds and prolonged wet weather caused significant damage to orchards.

The latest flooding comes on the back of prolonged wet weather, and occurred just as conditions had begun to improve for harvest. An additional 600 mm of rain fell, halting orchard operations.

Harvesting was disrupted, grass growth became unmanageable, and rodent populations surged. During 2025 many growers in the mid-north coast region have been unable to start harvesting until June.

This latest setback follows a difficult few years for the industry in this region. After devastating floods in 2022, poor market prices in 2023 and 2024, and further challenges from weather events in 2025, continue to strain the region's growers.

The heavy rain has led to soil erosion, loss of nuts, soil nutrition and root exposure. because of the relatively small number of macadamia farms located on low-lying land between Macksville and Taree, widespread tree submergence was limited. The volume and intensity of rain over a long interval has led to significant damage on many farms. Many growers are still dealing with waterlogged fields, which can lead to long-term issues such as tree stress, root damage and increased susceptibility to plant pests and diseases.

Many growers are mindful of soil compaction impacts from entering sections of the orchard before they dry out. When machinery enters still-wet zones, particularly areas with underlying springs or poor drainage, it can cause significant soil compaction and leave deep wheel ruts. This type of damage is difficult and labour-intensive to repair, and can negatively impact soil structure and future productivity.

Orchard clean-up priorities

Immediate orchard clean-up is a priority as it is essential to prevent long-term damage and pest infestations. Key tasks are:

- **Removing and disposing of fallen limbs and trees.** Fallen branches and trees are being removed to allow access for harvest operations. These branches can be either chipped or burnt. . Avoid leaving them in burn piles for long periods, as they can become breeding grounds for bark beetles. These pests may spread to stressed or recovering trees, compounding damage.
- **Clean cutting of damaged trees.** When cutting damaged limbs from trees, ensure the cut is clean. A clean cut encourages healthy regrowth below the wound and reduces the risk of disease entering the tree.
- **Orchard floor management.** Overgrown vegetation under trees should be mowed to improve orchard hygiene and access. While this may result in the loss of some crop in the ground cover, it is a necessary step. After harvest has finished, , re-profiling may be necessary in areas where erosion has exposed tree roots and improve the orchard floor conditions for future harvest seasons.
- **Controlling rats.** Wet conditions have led to a surge in rat populations. Continue intensive monitoring and baiting across all stations. Continued vigilance is key - do not ease up on control efforts once harvest is finished.

Soil health and nutrient management

These weather events have likely leached vital mobile nutrients such as nitrogen and calcium from the soil. This depletion can significantly affect crop health and yield.

Growers should:

- **Soil and leaf test.** A comprehensive soil and leaf analysis should be conducted to determine any deficiencies or toxicities; particular attention should be given to soil pH levels. The soil pH is especially critical for farms on NSW floodplains, where low pH can result in high aluminium levels, which are toxic to plants and can inhibit root development, leading to long-term decline.
- **Restoring soil fertility.** Replenishing lost nutrients and organic matter is essential. Timely intervention will support plant recovery and maintain long-term soil health. Use the soil and leaf test results to guide any program.

Looking ahead: building resilience

While the current focus is on recovery, it is equally important to plan for future resilience. Strategies such as improved drainage systems, enhanced flood forecasting, and adaptive farming practices will be vital in safeguarding the macadamia industry against future extreme weather events.

These insights, along with findings from simulated research trials, will be detailed in this year's *Macadamia Plant Protection Guide*, which summarises lessons learned from the 2022 floods and Tropical Cyclone Alfred in 2025.

Financial setback

The accumulation of a number of challenging years as a result of poor weather conditions and low prices has compounded the effects of this disaster on growers, both physically and financially. The loss of crop and potential long-term damage to trees means that growers are facing significant financial setbacks. The cost of recovery, including, in some cases replanting and addressing exposed roots through the intensive washouts, adds to the burden on these growers.

Funding. If your macadamia orchard was impacted by TC Alfred (March 2025) or the May 2025 floods, you may be eligible for grants of $25,000 or $75,000 under the Disaster Recovery Funding Arrangements. More info can be found here: www.raa.nsw.gov.au/grants/storm-flood/natural-disaster-relief-grants

The AMS website www.australianmacadamias.org/industry has more information, including a list of macadamia-specific examples of eligible expenditure and evidence requirements under the grants. Examples for claims include tree replacement, pruning and orchard profiling.

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Farming with friends: Building biodiversity through better pest management

James Altmann and Stephanus Malherbe, BioResources

MacTrix (Trichogramma cryptophlebiae) *is now a trusted, proven tool for managing macadamia nutborer (MNB) in Australia - but it hasn't always been this way. Just 25 years ago, MNB was the most significant pest threatening the industry. Today, large-scale Integrated Pest Management (IPM) programs have made Australia a global leader in MNB control.*



Macadamia nutborer moth

Timing is everything

The first main MacTrix releases should begin early in the season (October or November, depending on your region). They don't need to be at full rates straight away, but early releases help establish beneficial insect populations before MNB numbers climb. Mature orchards that had higher pest pressure last season may benefit from higher release rates.

Guideline rates: Release 1,000 wasps per hectare per week for at least eight weeks. This can be reduced in larger orchards where hotspots are well known. Where late-season MNB activity has been a problem, consider low-level releases throughout the season in those blocks. If weather prevents field placement, wasp emergence can be slowed by storing them in a cool room (5°C–15°C).

Plan ahead and tailor your program

If you're thinking of changing your IPM program from previous years, speak with your consultant first. For young plantings that are ready for MacTrix, contact your insectary by September so production can be planned in advance.

Consider releasing MacTrix into surrounding natural vegetation and swamps that border the orchard. These areas are known breeding grounds for MNB, so targeting them early helps reduce orchard pressure. Small, off-season releases may also help keep populations in check year-round.

Grower takeaway: *Think beyond the orchard - pest pressure often starts in surrounding habitats.*



The first main MacTrix releases should begin early in the season (October or November, depending on your region).
Photo: BioResources

MacTrix release checklist – Season at a glance

✔ Pre-season (August–September)

- Discuss the whole season's IPM program with your consultant.
- Contact insectary by September to place new orders for young plantings or higher release rates.
- Ensure cool storage availability (5°C–15°C) for weather delays.

✔ Early season (October–November)

- Begin first releases before MNB numbers build up.
- Use standard rates initially: 1,000 wasps/ha/week as a guide.
- Target mature blocks with prior high pest pressure at higher rates.
- Consider early releases into natural vegetation/ mangroves near orchards.

✔ Peak season (November–January)

- Continue weekly releases for minimum eight weeks.
- Avoid broad-spectrum sprays during this window.
- Maintain low-level releases in late-season hotspot areas if needed.

✔ Off-season (February–April)

- Consider small releases to keep beneficial populations active.
- Record data on pest levels, release timing and rates for program refinement next year.



Trichogramma parasitic wasp laying eggs in macadamia nutborer egg.
Photo: BioResources

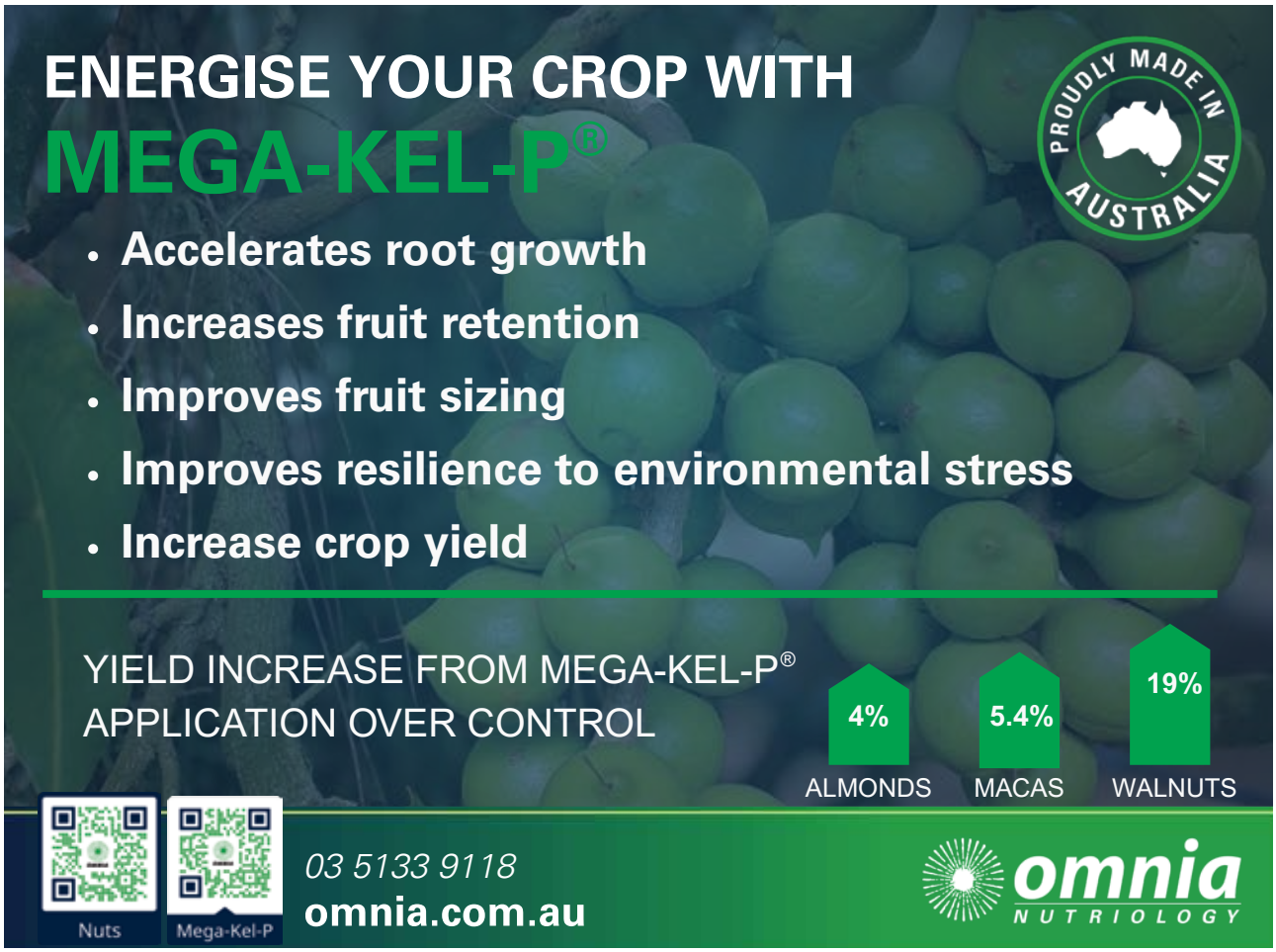
Avoiding setbacks from sprays

New broad-spectrum and persistent insecticides are now available in Australia and being promoted for tree crops. While they have their place, these products can harm beneficial insects if applied at the wrong time.

A critical IPM window is from November to January. Avoid broad-spectrum sprays during this period to ensure protection of natural enemies. "Protecting natural enemies and encouraging diversity on your farm is key to maintaining a resilient agroecological system," says James Altmann, Director at BioResources. Jake Byrne from Biological Services adds: "We must look after the beneficials on our farms - it doesn't happen by itself. One poorly timed spray can undo years of progress. If you're unsure, speak with your IPM consultant or reseller before applying any treatments."

Grower takeaway: *One spray at the wrong time can undo years of work — check before you act.*

Information. For more details on IPM programs for macadamias and other tree crops, contact:
Jake Byrne, Biological Services – 0419 199 123
Rebecca Cassidy, BioResources – 0492 247 176
office@bioresources.com.au



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New post-harvest facility opens in Gympie

A new post-harvest facility has opened in Gympie, giving growers in South East Queensland more options for crop handling.

The new facility, called Gympie Sort, was officially opened in July by industry processor CL Macs. With the capacity to process up to 2,000 t of nut-in-shell (NIS) per year, it represents a significant investment in the region, with construction costs of $4 million (excluding land costs). Gympie Sort can handle around 50 t of NIS a day, which equates to roughly 90 t of freshly harvested macadamias sourced from local farms.

Meeting a regional need

The impetus for the facility was the need for third-party post-harvest services in the Gympie area. Unlike larger growing regions such as Bundaberg and the NSW Northern Rivers, Gympie has fewer processing options and fewer contractors available to growers.

For smaller farms in particular, Gympie Sort offers a viable alternative to making large capital outlays on post-harvest infrastructure. CL Macs hopes the facility will not only improve nut quality but also increase the viability of macadamia farming for a broader group of growers.

While the idea initially began as a solution to meet the post-harvest needs of farms managed by CL Macs, strong demand from the wider grower community led to its expansion.

Gympie Sort is part of the growing Gympie Farm Services business, which aims to ultimately provide a full suite of farm support — from dehusking, drying and sorting to harvesting, spraying and management services — from next season.

Smart infrastructure, streamlined flow

The facility design incorporates an efficient processing flow, underpinned by a mix of proven engineering and new technology including shaker tables with aspiration for trash removal of rocks, leaves and sticks; two triple-wheel de-huskers from Keba Engineering and a sizing trommel.

The nuts are then stored in six ventilated bunkers (50 t total capacity) for a short period before final sorting, which is done using AI-enabled x-ray technology. Once sorted, the nuts are dried in eight 50 t, temperature- and humidity-controlled drying bins. Husks are either composted or reclaimed by growers.

The site is designed for operational efficiency, requiring only three or four full-time staff when fully operational, along with some seasonal workers.











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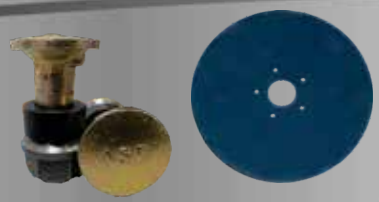



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MCT and AMS – driving macadamia conservation for 18 years

Denise Bond, WMC Executive Officer, M: 0488 432 226 | E: denise.bond@wildmacadamia.org.au

Macadamia conservation timeline

1980s
- Less than 2.2% of Queensland is National Park and rainforests are still logged
- Little is known about wild macadamias and where they grow
- AMS has 300 members
- Production is under 8,000 t
- A levy is being developed to fund research and marketing

1990s
- National Macadamia Germplasm Conservation Project initiated

2000s
- Macadamia gene banks planted at Tiaro and Alstonville

2004
- Work starts on Macadamia Species Recovery Plan

2007
- AMS establishes Macadamia Conservation Trust

2021
- Macadamia habitat surveyed and distribution of genetic diversity assessed

2025
- Macadamia Conservation Trust becomes an independent organisation: Wild Macadamia Conservation

From the 1980s AMS showed great leadership in its support of macadamia conservation, recognising that identifying and preserving wild macadamia genetics would be crucial to the industry's development. In 2007 AMS formed the Macadamia Conservation Trust and in 2016 included an object in the AMS constitution: T*o promote and facilitate the conservation of wild species of Macadamia*. As trustee for MCT over the last 18 years, the AMS facilitated important conservation initiatives and grew potential for an independent organisation.

Wild Macadamia Conservation EO, Denise Bond reflects on the history of the trust and the role the AMS has played.

The Australian macadamia industry was still small in the 1980s. Fewer than 300 members produced less than 8,000 t, but there was a great deal of enthusiasm for this unique Australian nut. We owe much to the advocacy and actions of Norm Greber, Calvin Winks and Ian McConachie in these early days, who understood the importance of wild macadamias both as Australia's natural heritage and as a resource for breeding productive trees.

We should also acknowledge the role of CSIRO plant scientists in the 1990s, including Julia Playford and Craig Hardner, who had the foresight to develop the National Macadamia Germplasm Conservation Project. Supported by AMS, Horticulture Australia Ltd, World Wildlife Fund and local councils, this project created three "gene banks" at Tiaro, Caboolture and Alstonville, two of which survive and are a valuable resource for the macadamia breeding program today. As well as being the first important step towards macadamia conservation, the project identified many more actions needed to secure a future for macadamia species.

An informal Macadamia Conservation Committee formed in 2004 to continue this work, with members from industry, research and conservation. The next important advance was development of a Threatened Species Recovery Plan, the only Recovery Plan ever sponsored by a horticultural industry body.

A trust was established in 2007 by AMS to raise capital to implement the recovery plan. Since then, the Macadamia Conservation Trust has been the main driver for macadamia conservation. Its primary roles were to determine the distribution of genetic diversity,



Participants celebrating the launch in November 2009 of the Macadamia Species Recovery Plan.

increase the level of protection for key macadamia habitat, expand living collections and educate people on where wild macadamias grow and how to look after them.

While managing the trust has largely been undertaken by a small team of dedicated volunteers, this could not have happened without the support of the AMS as trustee. The AMS also helped channel valuable support from the macadamia industry through levy funds for initial conservation and research projects, governance oversight, the innovative "NIS Donation" program and by providing opportunities to share conservation progress through industry forums.

In return, MCT contributed to the macadamia industry by:

- working to protect the gene bank and the capacity of wild macadamias to survive and evolve
- supporting research into macadamia genetics and ecology (pollinators in the wild, climate change response, soil microbiome of natural habitat)
- taking on the risk of commercialising a new cultivar for the industry (around $100,000 to provide DNA-verified scion wood of MCT1) thus encouraging the concept of a return on investment for breeding improved cultivars, standard practice in other horticultural industries.
- publishing and publicising the first comprehensive history of macadamias and the global industry they support.

In 2024, the AMS and MCT decided to form an independent entity to continue the trust's conservation work. MCT has now evolved into **Wild Macadamia Conservation,** an independent charity and registered environmental organisation dedicated to *supporting and conserving Australian wild macadamia trees and their native habitat.*

Wild Macadamia Conservation is very thankful for the vision and support of the AMS and looks forward to working together to achieve our shared macadamia conservation objectives.

Plans for the future

Most remaining wild macadamia habitat is threatened by weeds and fire, particularly the narrow remnants along waterways that provide critical stepping stones for cross-pollination between wild trees. A strategic approach has been taken to maximise conservation efforts based on the location of remaining genetic diversity, tenure and threats. Areas we are currently targeting are in Mount Cotton, Amamoor, Bulburin and the Northern Rivers.

Mount Cotton, south of Brisbane, has the largest remnant habitat for the lost Brisbane clade of *M. integrifolia* (the Walter Hill tree and its relatives). WMC is working with Redland City Council and interested landholders to protect and expand this habitat to make Mount Cotton a permanent wild macadamia refuge.

Amamoor is the largest remaining habitat, the original source of most industry cultivars and home to the *Walk with Wild Macadamias*. Although the National Germplasm Collection contains samples from Amamoor, untapped genetic diversity may remain due to the area of connected habitat. Much of the area is protected from clearing, but still threatened by cat's claw. MCT supported Gympie Landcare to remove it and other weeds from sections of Amamoor Creek, and WMC plans to build on this work, including discussing options with Hancock Queensland Plantations to combat these weeds in Amamoor forestry areas.



BMRG Project Officer Ben Hoekstra provides weed control training to Gidarjil Development Corporation rangers in March 2025.

At the Bulburin site, invasive vine species, one of the biggest threats to macadamia habitat, is one focus of activities. WMC is part of a consortium managing a $500,000 grant from the Australian Government's Saving Native Species Program. Partners Burnett Mary Regional Group and the Gidarjil Development Corporation are tackling the challenging task of controlling cat's claw and pigs.

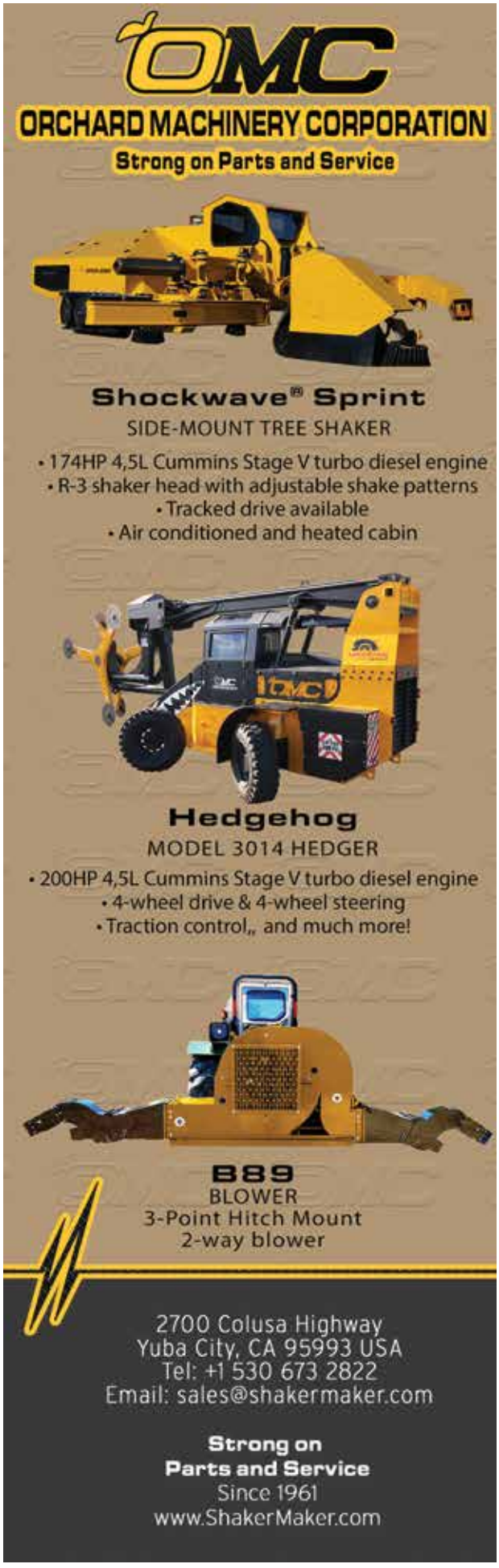
In the Northern Rivers, the focus is on *M. tetraphylla,* which has the least amount of habitat in protected areas and the smallest, least connected remnants. This variety requires significant input to survive. WMC has been able to add to our database of healthy populations, but they are all small, disconnected and threatened by weeds. WMC is in the process of developing partnerships with Northern Rivers First Nations communities to work together to protect *M. tetraphylla* habitat on Bundjalung land.

Investing in the future

The popularity of MCT1 has provided an undreamed-of source of income for macadamia conservation. To honour the growers who buy MCT1, WMC plans to invest a portion of these funds into research on all aspects of the macadamia genus. This research will be a foundational resource for the industry as well as conservation. Beaumont is one of two main root stocks for the industry, a 50/50 hybrid of *M. tetraphylla* and *M. integrifolia.* One of the projects we currently support is investigating the soil environment that *M. tetraphylla* grows in naturally. Research into soil type, microbiome and presence/absence of arbuscular mycorrhizal fungi may lead to a better understanding of soil nutrient requirements for macadamia.

Information. For more information contact WMC, which has a new email and website, but the same phone number.

M: +61 488 432 226
E: denise.bond@wildmacadamia.org.au
W: wildmacadamia.org.au



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Macadamia genetic diversity research crucial to industry

We are all aware of the importance of genetic diversity in any crop as a way of ensuring a capacity to maintain high levels of production and resistance to environmental and other threats.

Diversity is certainly crucial for the macadamia industry, which has a relatively short history of developing new cultivars and a limited bank of wild genetic material when compared to other horticultural industries with much longer commercial traditions, such as apples, almonds and stone fruit. This underscores how essential it is that we maintain a focus on identifying macadamia varieties in the wild and preserving a gene bank for future research. While this work may seem academic at present, it could prove a saviour in future, for example, by providing information on resistant wild varieties if a disease or insect pest threatens a current cultivar and as the industry develops cultivars with different properties to the ones we currently grow.

Two new projects will focus on identifying and preserving genetic resources, with WMC involved in both as a minor but enthusiastic stakeholder. The first project, led by Ass. Prof. Craig Hardner (University of Queensland) and funded through Hort Innovation, aims to develop cheaper and quicker ways of genotyping trees in the field (allowing growers to confirm what cultivar they're growing and helping researchers to screen new cultivars). The second is led by Dr Alice Hayward (University of Queensland) funded by the Australian Research Council, to develop bio-technologies to accelerate plant biodiversity conservation with a focus on *M. jansenii*.

We asked Craig and Alice to describe their projects and identify the benefits that they see for the macadamia industry.

Developing a rapid low-cost method for genotyping by sequencing

Craig's project, *Developing a rapid low-cost method for genotyping by sequencing,* aims to develop a platform for reducing the cost of determining the genetic identity of individuals for use in identity validation and genomic breeding in apple, blueberry, macadamia and strawberry. It builds on work initiated by Dr Mobashwer Alam at The University of Queensland

For macadamias this can be used to validate the genetic identity of cultivars and native populations.

'Currently, there is no standard low-cost platform for validating the genetic identity of a cultivar to replace the method developed by Dr Cathy Nock (previously of Southern Cross University),' said Craig. 'To fill this gap, this project will build a reference population of cultivars to establish a standard for new material to be compared against.'

In addition, this project will develop specific genetic markers for identifying the ancestral wild origin of individual macadamia trees. The aim is to deliver a method for determining genetic identity that costs around $20/sample, or lower, within three years.

This larger project is a research collaboration between University of Queensland, Diversity Array Technologies (genotyping commercial partner), West Australian Department of Primary Industries and Regional Development, Murdoch University, and Mountain Blue and is funded through Hort Frontiers with additional contributions from Wild Macadamia Conservation, Australian Nurserymen's Fruit Improvement Company, CiderAus, and Mr Sheng Wei.

Benefits. Craig explained that the main benefits of this project will be an accessible, Rapid and Cost Efficient (RACE) platform for determining the genetic identity of individual macadamia trees for the industry, conservation and breeders. The platform uses an established genotyping method used in many crops for breeding and is flexible and scalable. The reference population will be the first established for macadamia to ensure standardisation across the Australian and international industry. Standardisation of methods for understanding the structure of wild population will help conservation efforts to become more targeted.

'The expected outcomes of this project are improved confidence in the use of macadamia cultivars (which could be extended to develop a quality assurance program for nurseries), faster, more efficient breeding of new cultivars, and improved use of new genetic material from the wild,' he said.

Bio-technologies to accelerate plant biodiversity conservation

According to Alice, this project responds to Australia's urgent biodiversity crisis, where many native plant species, including critically endangered *Macadamia jansenii,* are facing significant threats in the wild.

While traditional seed banking provides an insurance policy against species loss, it is ineffective for around 30% of threatened plants (classed as 'exceptional'), including all macadamias.

'This project will accelerate the conservation banking of six of Australia's exceptional priority plants including *M. jansenii* using advanced tissue culture and cryo-techniques, enabling their long-term conservation. It also aims to develop a pioneering framework to fast-track in vitro conservation globally, addressing a major bottleneck in protecting plant biodiversity,' said Alice.

The research is a collaboration between The Queensland Alliance for Agriculture and Food Innovation, Curtin University and Griffith University with Wild Macadamia Conservation, Botanic Gardens of Sydney, Kings Park and Botanic Garden (Department of Biodiversity Conservation and Attractions), Native Plants Queensland, Limpinwood Gardens and Nursery, Cedar Grove Landcare and Wedgetail Foundation.

Benefits. Alice explained that she and her team hope to provide new knowledge into *M. jansenii* propagation biology and cryopreservation, as well as safeguard the genetic diversity of this and other species at The Australian PlantBank.

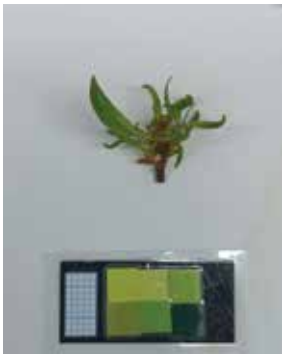
'This will provide a resource for future research programs as well as on-ground use for industry or recovery plantings in suitable locations,' she said.

Biodiversity is critical to the ecosystems and food systems of the future. Wild crop relatives including *M. jansenii* provide a rich resource for macadamia breeding, bringing in new traits such as short tree stature of high value for Australia's industry.

M. jansenii is critically endangered, and with its home-grown advantage, Australia has a custodial responsibility to protect the genetic diversity of this and other *Macadamia* species and preserve its ecosystems. And this is not just the case for industry as *Macadamia* species are connected to the cultural heritage of first nations peoples as well as the ancient ecosystems of Eastern Australia.

'This project will equip industry and conservation practitioners with the safest, long-term method to bank the genetic diversity but also facilitate propagation for use in industry and wild plantings,' said Alice.





Macadamia jansenii *shoots initiated into sterile culture by Dr Albert Wong at The University of Queensland.*
Photo Credits: Dr Albert Wong (recipient of Australian Flora Foundation Ian and Janet McConachie Macadamia Conservation Grant)

WMC: Benefits of research

WMC's interest in the RACE project is initially to be able to test if trees belong to the lost Brisbane clade (a sub-population of *M. integrifolia* now on the brink of extinction).

'Ultimately, we hope RACE will provide a core reference population for the full known range of wild genetic diversity, and this will help us to assess which trees hold rare DNA (some of which only exists in old trees in parks and gardens) and where conservation actions from sections of Amamoor to maximise diversity of the gene bank,' explained Denise Bond.

WMC support for *Biotechnologies to Accelerate Plant Biodiversity Conservation* is to address the challenge of long-term storage of macadamia germplasm. If a pathogen or wildfire wiped out a significant proportion of wild macadamias, genetic material stored in a seed bank could be the only surviving source of the lost genetic diversity. This would be invaluable to either restore habitat or grow in new areas, protected from the original threat.

According to Denise, this is not idle speculation as myrtle rust, first seen in NSW in 2010, now threatens many Australian species including eucalyptus, willow myrtle, turpentine, bottlebrush, paperbark, tea tree and lilly pilly.

Many plant species can have their seeds stored in cool, dry conditions for decades, but large fatty seeds like macadamia loose viability after several years. Finding alternative ways to store germplasm from such species is a global conservation challenge. This project is developing novel techniques such as extracting the tiny growing tip as it emerges from seed and preserving it in such a way that it can be frozen for long periods and then de-frosted and grown into a viable plant through tissue culture.

'This is a hi-tech process, but results in a cost-effective long-term storage option, as the material stored is tiny and stable compared with whole nuts,' said Denise.

One of the six species in this project is the critically endangered *M. jansenii* which, despite our best efforts, will remain at risk from catastrophic fire until global warming is controlled. Long term germplasm storage is an important addition to WMC's habitat protection and living collection projects, and techniques developed for *M. jansenii* should be adaptable for safe storage of the other three macadamias species.

Nuts and weight: Communicating the science

Nuts support a healthy body weight, yet unfounded fears around nut calories and weight gain are major barriers to their consumption. Nuts for Life has been working to change this narrative.

We supported a PhD project, through the University of Wollongong, to explore the relationship between nut consumption and body weight, focussing on metabolisable energy, defined as "the amount of energy our body can absorb when we eat food".

The lower-than-expected metabolisable energy of nuts – up to 26% less – may help explain why nuts do not increase body weight.

The project explored whether the "true" calorie content of nuts should be included on food labels, a change requiring regulatory approval by Food Standards Australia New Zealand (FSANZ).

The research uncovered challenges to this approach, including a low likelihood of success (together with a high application cost and a lengthy approval process), and potential minimal impact on consumer behaviour. The research team instead suggested exploring alternative strategies to promote nut consumption.

As a result, Nuts for Life have developed an evidence-based communications toolkit that distils and translates the key scientific literature on nuts and body weight. This consists of three distinct communications stories.

Using powerful stories to talk about nuts and weight

Story 1: The weighty truth. When it comes to nuts and weight, there's a big gap between perception and science. Contemporary research convincingly shows that nuts do not cause weight gain in the short term and likely supports improved weight maintenance in the long term. Yet, both the public and health profession express concerns about nuts increasing the risk of weight gain.

This story demonstrates that nuts support healthy body weight in the following ways:

- referring to convincing evidence across 19 systematic literature reviews that shows nut consumption does not increase body weight or related measures
- showing that in long-term studies (prospective cohort studies), nuts are associated with lower weight gain
- referring to dose-response analyses that indicate higher nut intakes are linked to modest reductions in weight and fat mass.

Story 2: The vanishing calorie. Not all calories are created equal, especially when it comes to nuts. Current research shows that nuts reduce feelings of hunger, leading to fewer calories being consumed later in the day, and that the true calorie content of nuts may be up to 26% lower than what is listed on the nutrition information panel. This helps to explain why nuts do not increase body weight in short-term studies.

This story provides explanations for the finding that nuts do not lead to short-term weight gain despite being energy-dense:

- People tend to eat fewer calories after nut consumption. In general, about 75% of the calories from nuts are offset, though this varies greatly between studies.
- The metabolisable energy of nuts is between 5 and 26% lower than described on the nutrition information panel.
- Larger nut doses appear to increase satiety and reduce metabolisable energy.
- Increases in energy expenditure have been reported, though long-term effects are generally minimal.

Story 3: The metabolic advantage. Our understanding of body weight regulation is evolving. Contemporary science highlights metabolic function as a key player, and nuts emerge as foods that support metabolic function, in part because of their unique matrix. While still early days, the complex relationship of nuts across multiple aspects of metabolism may explain the inverse associations between nut consumption and body weight in long-term studies and flips the script on nuts and weight - from perceived enemy to powerful ally.

This story proposes a mechanism for why nuts might support lower body weight in prospective cohort studies, although a causal relationship is not established:

- nuts nourish the gut microbiota, with the most established effects for butyrate-producing genera
- nuts may reduce markers of inflammation, with significant reductions seen for a glycoprotein known as Intercellular Adhesion Molecule 1
- nuts improve insulin sensitivity and lower fasting blood insulin
- these mechanisms are closely linked and together may create a more favourable metabolic environment for long-term weight regulation.

New resources: Everything you need to know about nuts

We recently launched a new suite of resources designed to help health professionals encourage their clients to develop a daily nut habit. Titled Everything you need to know about nuts, these free, downloadable resources include a fact sheet, infographic, and poster.

Access the resources here: https://www.nutsforlife.com.au/resource/fact-sheet-everything-you-need-to-know-about-nuts/



Real world implications

Nuts for Life will be working to share these science-backed stories with health professionals and bring nuts to the forefront of food policy reform discussions.

We want health professionals, a key group, to feel confident correcting misconceptions on nuts and weight, and to champion nuts as a simple, accessible food to support weight management. For example, we teamed up with Dietitian Connection in late July to host a free webinar, attended by 400+ health professionals, titled Reframing the calorie equation.

As far as policy is concerned, we want to drive an update to the Health Star Rating for nuts, to be more reflective of the science, and to better align with dietary guidelines. This includes educating food policy influencers and food policy makers. For example, we represented the nut industry at the Food Standards Australia New Zealand (FSANZ) Health Star Rating preparatory work webinar held in mid-August.

Efforts to change energy labelling regulations will remain a long-term consideration, especially as the concept of metabolisable energy gains traction across other whole foods.

About Nuts for Life

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



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

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

For further information visit www.nutsforlife.com.au, follow us on LinkedIn, or contact:

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Are current macadamia production practices increasing soil acidity on kraznozems?

Terry Rose, Jordyn Bond and Abe Gibson (Southern Cross University)
P: 02 6620 3457 | E: terry.rose@sce.edu.au

Project Snapshot

Topsoil pH is generally higher in orchards than native soils

Current macadamia best practice, adding organic amendments, indicates that there is no evidence of subsoil acidification

The consistent addition of organic amendments likely buffer soil acidification in macadamia orchards where organic amendments are added.



Southern Cross University student Jordyn Bond sampling soils to a depth of 1 m on macadamia farms across the Lismore region.
Photo credit: Jordyn Bond

Macadamias evolved on mildly acidic soils in the subtropical rainforests of the east coast of Australia, and in commercial orchards the trees are still relatively productive when soil pH (measured in a 1:5 soil: water extract) is around 5. However, from the point of view of nutrient availability and biological function in soils, maintaining pHwater above 5 (in the range of 5.0-6.5) is optimal.

The use of nitrogenous fertiliser can speed up the process of soils becoming more acidic. Macadamias have been grown commercially on the ferrosol (kraznozem) soils in the Lismore region for almost half a century. Over recent decades inputs of nitrogen have increased but what impact it has on soil pH is unknown.

To investigate whether soils are becoming acidified in commercial macadamia orchards under current practices, Southern Cross University student Jordyn Bond measured soil pH to 1 m depth in the tree line and in the inter row of 10 commercial paddocks in the Lismore region and compared the pH to that of soil under remnant rainforest. The 10 commercial paddocks were sampled from five farms on the Alstonville plateau and five farms near Clunes/ Dunoon.

Six soil cores were taken to a depth of 1 m across a transect in the tree line and another six in the inter row in each farm paddock and six cores were taken from randomly selected locations in a 1 ha area under remnant vegetation near Alstonville. The soil cores were separated into eight depth increments then the pH was quantified in each sample after drying in a 1:5 soil:water extract in the laboratory at Southern Cross University.

What did we find?

The pH in the topsoil (0 to 15 cm) was generally higher in macadamia orchards than in the native site, and typically higher in the topsoil of the tree line than the inter-row. The pH profile of one farm (Farm 8) is shown in Figure 1 that typifies these results. The soil pH at the native site was around 5.4 in the top 0 to 2.5 cm layer, and around 5.0 in all layers below that. At Farm 8, soil pH in the top 15 cm is around 6.5 in the tree line and around 5.5 in the inter-row. The pH in the tree line and inter row declines to around 5 in the lower soil horizons (50 to 100 cm), but this is similar to the pH in the native site.

Depth (cm)	Farm 1 Tree Line	Farm 1 Inter-row	Farm 2 Tree Line	Farm 2 Inter-row	Farm 3 Tree Line	Farm 3 Inter-row	Farm 4 Tree Line	Farm 4 Inter-row	Farm 5 Tree Line	Farm 5 Inter-row
0-2.5	+	ns	ns	ns	ns	+	+	+	+	+
2.5-5	+	ns	ns	ns	ns	+	+	+	+	+
5-10	+	ns	ns	ns	ns	+	+	+	+	+
10-15	+	ns	ns	ns	ns	ns	+	+	+	+
15-20	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
20-30	ns	ns	ns	ns	ns	ns	ns	ns	ns	+
30-50	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
50-100	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Depth (cm)	**Farm 6 Tree Line**	**Farm 6 Inter-row**	**Farm 7 Tree Line**	**Farm 7 Inter-row**	**Farm 8 Tree Line**	**Farm 8 Inter-row**	**Farm 9 Tree Line**	**Farm 9 Inter-row**	**Farm 10 Tree Line**	**Farm 10 Inter-row**
0-2.5	ns	ns	ns	ns	+	ns	ns	ns	ns	ns
2.5-5	+	+	+	+	+	+	ns	ns	+	+
5-10	+	+	+	+	+	+	+	ns	+	+
10-15	ns	ns	+	+	ns	ns	ns	ns	+	+
15-20	ns	ns	+	+	ns	ns	+	+	+	+
20-30	ns	ns	+	+	ns	ns	+	+	+	+
30-50	ns	ns	ns	ns	ns	ns	+	+	+	+
50-100	ns	ns	ns	ns	ns	ns	+	+	+	+

Table. *Significant changes in soil pH for each soil layer between farm paddocks (tree line and inter-row) and the native site near Alstonville. '+' indicates the soil pH of a particular layer at a particular farm was statistically higher than the corresponding soil layer at the native site, while 'ns' indicates no statistical difference.*

While Farm 8 is typical of what was observed, there was some variation across the 10 farms. Some farms had higher topsoil pH in the inter row, likely due to sweeping of organic material into the inter row before harvest, while one farm had pH in the tree line very similar to that of the native site. The results from all farms are summarised in the table, where the pH from the farm paddock is compared to the pH of the native site for each soil layer. If the soil pH at the farm site was statistically higher than the pH of the corresponding layer at the native site, this is indicated by a '+' sign. If there was no difference between pH of a given soil layer between the farm tree row or inter-row and the native site, this is indicated by 'ns'. Notably, no inter row or tree line showed statistically lower soil pH than the native site in any depth. This indicates that current best practice macadamia production, where growers apply a range of organic amendments and/or lime, are not leading to increased soil acidity in the topsoil or subsoil.

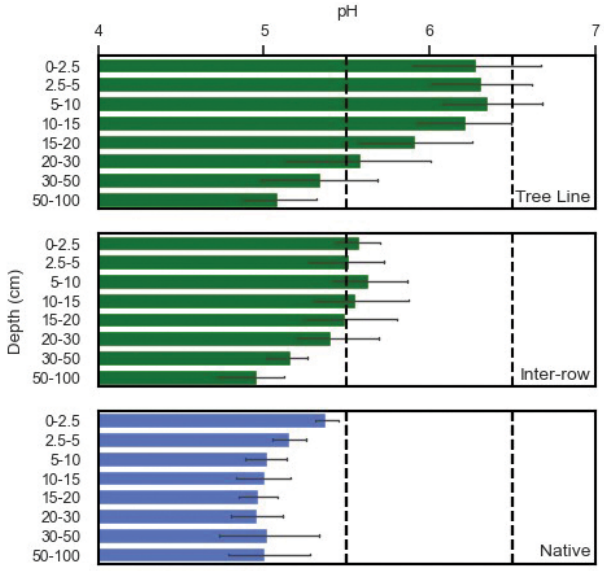

Figure 1. *Mean (average) soil pH in each depth layer in the tree line and inter-row on Farm 8 (green bars) compared to a native site (blue bars). The error bars indicate how much variability there is in the six replicate cores (standard error). The dotted lines indicate the pH range from 5.5 to 6.5, which is generally considered optimum for nutrient availability and soil biology.*

What does it mean?

The research showed no evidence of subsoil acidification under macadamia production in the paddocks tested. The increased soil pH (compared to native soil) in the top 0 to 15 cm is likely due to periodic lime application and/or the use of composts/manures. This might seem odd when most composts are generally slightly acidic (pH < 7.0). However, if the pH of a compost is 6.0 and that material is continually added to a soil with pH 5.0, then the pH of the soil will increase.

Acknowledgments. Thanks to the landholders who participated in the research project, and to Mark Whitten and Matt Weinert from Marquis Macadamias for their assistance.

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Tracey Steinrucken (Innovation Facilitator, CSIRO) and Hazel Parry (Project Leader, CSIRO) and Scott Wallace (Hort360 Manager, Growcom). Dr Tracey Steinrucken, M: 0409 937 377 | E: Tracey.Steinrucken@csiro.au

Managing pests and pathogens effectively across whole regions works best when growers, advisors, and industries work together. Sustainable integrated pest management (IPM) starts with informed decisions – using chemicals strategically and exploring other non-chemical options.



Integrated Pest Management (IPM) includes attracting beneficial insects to improve pollination services and reduce pest numbers

CSIRO has teamed up with Growcom's Hort360 team on the Pest READI project to build a practical tool for growers and advisors. This tool helps assess how prepared they are for pest and disease issues on-farm, how well they're using area-wide IPM strategies, and where their biggest risks lie.

What is Pest READI?

The Pest READI project is a $12 million, five-year collaboration working to transform how pests are managed at both farm and regional levels. Pest READI aims to bring together knowledge from landholders, advisors, Traditional Owners, and scientists to co-develop a digital platform to support healthier, more abundant landscapes

Right now, the team is working with growers in the Northern Rivers of NSW across a diverse mix of horticultural industries – including macadamia, avocado, berries, banana, coffee, and custard apple – to build tools that make pest management decisions easier and more effective. Many of these crops face the same challenges (like fruit spotting bug, or Phytophthora) and coordinated, area-wide IPM deliver stronger results when industries work together.

Helping growers plan for the future

The cost of chemical use in Australian agriculture has more than doubled since 1992, now costing growers around $3 billion each year. With growing pressure from resistance, regulation, human health and environmental impacts, there's never been a more important time to support strategic chemical use and provide practical information on other IPM options.

Hort360 IPM benchmarking tool for growers



Example output from the Hort360 module that gives you feedback about your risks and actions to takewhen it comes to IPM, and links you to verified information resources to find ways to improve.

Growers can access the IPM module as part of Hort360's suite of benchmarking tools. Based on your answers to a set of questions, the tool enables you to spot any gaps in your pest and disease management, build on what's already working, and create a simple action plan to support your farm's long-term sustainability.

The outputs will show:

- which areas of IPM can be improved, and what you're doing well,
- how you compare with others who have used the IPM tool,
- customised advice on risk, actions you can take to improve, and verified links to free online resources.



Fruit spotting bug, an important pest in the Northern Rivers on Mock Orange leaves.

Interested in testing the tool out?

The tool is in its beta phase, so we are looking for growers and advisors to get involved with the project and give their input on the tools we're developing.

We're actively taking feedback and would love to hear what you think! Get in touch with the team via email: pestreadi@csiro.au, or scan the QR code to visit our webpage https://research.csiro.au/pestreadi

Acknowledgement
Pest READI: Regionally Enabled Agroecological Decision Intelligence is funded through Hort Innovation Frontiers with co-investment from CSIRO's 'Catalysing Australia's Biosecurity' initiative, Macquarie University, NSW Department of Primary Industries and Regional Development, Queensland Department of Primary Industries, Growcom, Jagun Alliance Aboriginal Corporation and contributions from the Australian Government.

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Camera monitoring of predators in macadamia orchards

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Snapshot

- Cameras offer a potential new tool for monitoring predator-prey interactions in macadamia orchards, capturing around-the-clock footage.
- A recent study at Malua Farm, NSW, analysed 24 hours of footage to identify pest and predator activity and interactions.
- Early-season cameras on pre-flower racemes documented lace bug infestations and their natural predators, including Theridiidae spiders and brown lacewings.
- Findings highlighted that predator activity, particularly of spiders, was mostly nocturnal and focused on lace bug infestations.
- Camera monitoring offers valuable insights into pest aggregation, predator effectiveness, and potential crop damage, but faces limitations, such as restricted coverage and extensive data analysis requirements.

Using cameras could provide a new approach to monitoring predator-prey interactions in macadamia orchards, offering growers insights into predator effectiveness as part of sustainable pest management strategies. One advantage of camera surveys is their ability to capture around-the-clock footage of predator and pest activity. In a recent study conducted at Malua Farm in Northern Rivers, NSW, we analysed 24 hours of footage captured every five seconds to identify pests, predators, and their interactions. Here we outline the findings and discuss the implications for pest management in orchards.

Camera recording and analysis

In the early season, six Enduro Swift cameras were positioned 3 m above the ground on pre-flowers (racemes) to monitor lace bug infestations. In the late season, we set up three cameras on flowers, three on nuts, and three on nuts to which a macadamia seed weevil was tethered.

Camera captures

The cameras on flowers recorded interactions between several predators and lace bugs, while



Cameras were set up on: (a) pre-flowers; (b) flowers; (c) nut; and (d) nut on which macadamia seed weevil was tethered.

cameras monitoring nuts including nuts tethered with macadamia weevil showed no predator interactions.

Early-season flower cameras documented lace bug infestations and associated predator activity, notably spiders from the families Theridiidae, Araneidae, Salticidae, and Nephilidae, along with both larval and adult brown lacewings. Among the spiders, the Theridiidae were the most active, spending the most time associated with lace bugs (Figure 1). Such associations with lace bugs were recorded in four of the six cameras (Figure 2). Another unidentified species of spider was the second most active lace bug predator, appearing in three cameras. Predators were active during the night, starting from sunset (Figure 3). All the early-season racemes were covered with spider webs.

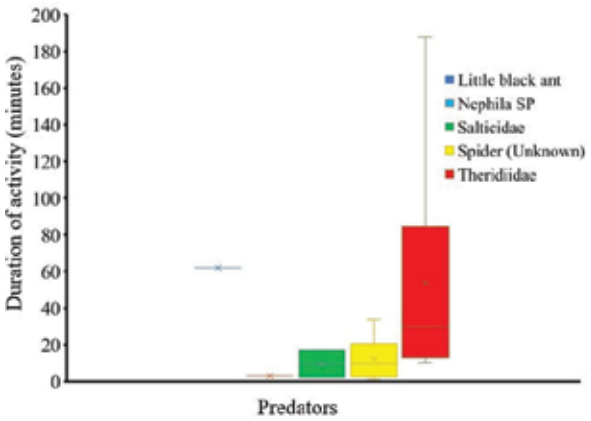

Figure 1. *Length of time the predators were active on the lace bug racemes during camera surveys.*

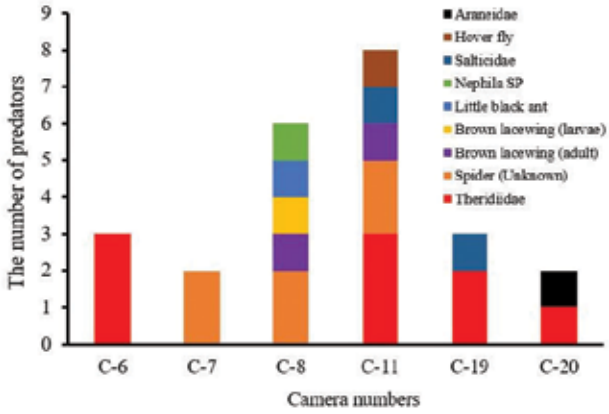

Figure 2. *The number of predators recorded by the six cameras.*

Takeaway message

Using cameras can be an effective way to monitor and understand predator-prey associations at different phenological stages of macadamia. For growers, this approach offers insights into:

- when are where pests appear and gather in their orchards
- predator activity against pests
- potential damage caused by pests.

However, camera monitoring has limitations, such as restricted coverage area, high data volume and analysis time, challenges in identifying fast-moving insects, and the need for manual review.

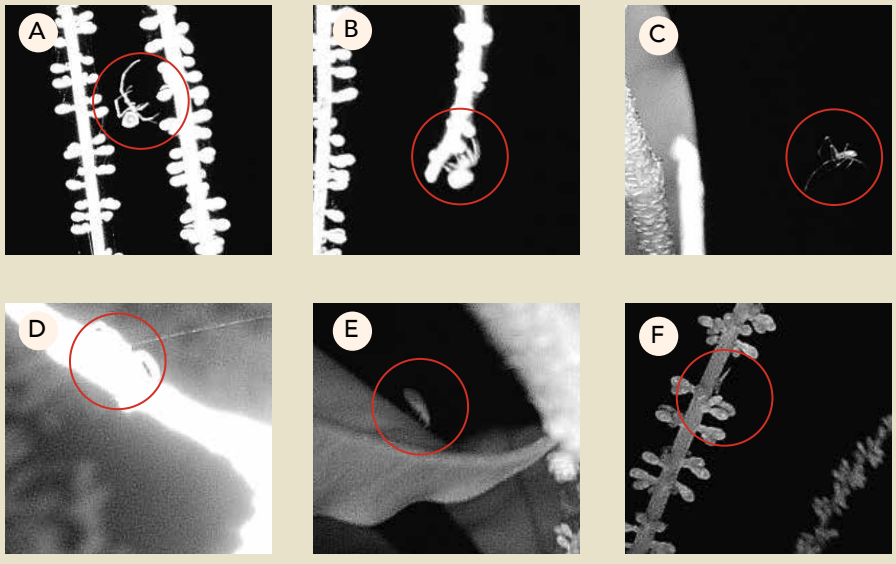

Figure 3. *Predators on lace bug from cameras: (a) Theridiidae spider; (b) Araneidae spider; (c) Nephila sp. (spider); (d) Salticid spider; (e) brown lacewing (adult), and (f) brown lacewing (larvae).*

Acknowledgement
The project *An integrated systems based approach for pest management in Australian macadamia* is funded by Hort Innovation using the macadamia research and development levy and contributions from the Australian Government.

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Macadamia phenology: Validating the model

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Project snapshot

The research team working on *An integrated systems based approach for pest management in Australian macadamia* is developing a model of the different stages in the macadamia growth cycle, such as flowering and nut set, particularly as they are influenced by climate.

Eight validation sites representing the climatic and geographical range of macadamia production have been identified for the model.

Rather than describe growth stages based on subjective assessment as is currently the case in the industry, the project has adapted a horticultural development scale making it easier to describe growth stages of trees in a consistent, objective manner.

As part of the project, *An integrated systems based approach for pest management in Australian macadamia,* the research team is developing a model of macadamia phenology, i.e. the different stages in the macadamia growth cycle, such as flowering and nut set, particularly as they are influenced by climatic factors such as heat, cold, rain and daylength. This model is a critical component of the project, as we ultimately need to link activity and impact of different pest species at different stages of plant phenology. For example, lace bug activity and impact occurs early in the season when racemes develop and flowering occurs, whilst spotting bugs only have an impact when nuts are present.

Any model is only as good as the data that is used to develop it, and with this in mind, we have spent a lot of time sourcing information to make it robust and useful. To begin, we completed an extensive literature review on macadamia phenology, which provided information from multiple locations in different years about tree performance and climate. By drilling down into some of this material to extract key information that related growth cycles to climatic factors, we were able to build a phenological model of flowering and nut production. As a final step, we validated the model against data excluded from the model construction.

The macadamia plant model is built using DYMEX, a modular modelling system originally developed by CSIRO. All the pest models in the project are also being developed using this platform, so that we can ultimately combine them to explore the interactions between the pests and the plant, and include economics with a view to identifying dynamic management thresholds.

Based on the literature review, we decided that eight validation sites ranging geographically from Alstonville to Bundaberg would cover the climatic gradient over which most of Australia's macadamias are grown. Because we used information from different cultivars to calibrate the model, it does not reflect any cultivar in particular. Rather it represents a generic macadamia tree. This is not a significant issue for the model as our simulations result in only minor misalignments of up to two weeks at some validation locations when run for the specific years with SILO weather data. SILO, a database of Australian climate data from 1889 to the present, provides daily meteorological datasets for a range of climate variables.

Objective measures needed

In the 2023-2024 season, we applied the terminology currently used in the industry to measure and record the different growth stages of macadamia trees in our study sites. We very quickly discovered that these descriptions, which depend on subjective assessment rather than being related to any objective benchmarks, could not be used in any of our modelling.

In the 2024-2025 season, we took a well-known horticultural plant development scale called the BBCH scale and modified it for macadamia, which made it easier to capture the growth stages of the trees in a consistent manner. This scale is based on assigning a numerical ranking and allows the assessor to record the most prevalent stage on the tree, as well as the minimum and maximum stages. For example, although a tree can mostly have open flowers, some racemes will still be elongating whilst others will already have small nutlets

Using the BBCH scale, a tree's growth stages can be visualised as a cumulative s-shaped curve, rather than as discrete events. Because the BBCH scale has numerous increments for each reproductive stage (inflorescence, flowering, nut development), it presents a simple curve of phenology advancing over time, whilst the current terminology only allows the discrete stages to be described. The scouts used a pictorial guide developed as part of the project so that classification of tree phenology was standardised

across all sites and scouts. We are continuing to use and refine the BBCH scale this season, aiming to make it standard for the macadamia industry.

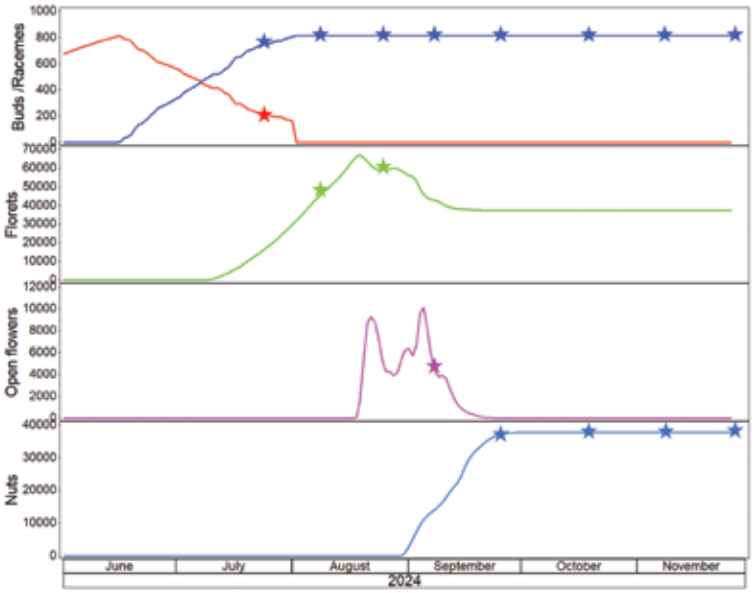
Field data confirms model

By measuring macadamia phenology in this way, we were able to validate our DYMEX macadamia plant model against flowering and nut formation data collected in 2024. Despite the fact that our model was calibrated for a generic macadamia tree, and not for the specific cultivars in the orchards we sampled, the model correctly captured macadamia growth stages as recorded by our field sampling. As shown in the figures, macadamia phenology differed across sites, depending mainly on temperature and latitude (daylength). The figures include data pooled for four trees at each site, capturing the phenology of different cultivars present at each site. The lines are the simulations; the stars indicate the phenological states recorded on that date. There is generally good agreement between observations and simulation at the sites. We will use macadamia phenology data collected this season in all our orchards to again validate the model.

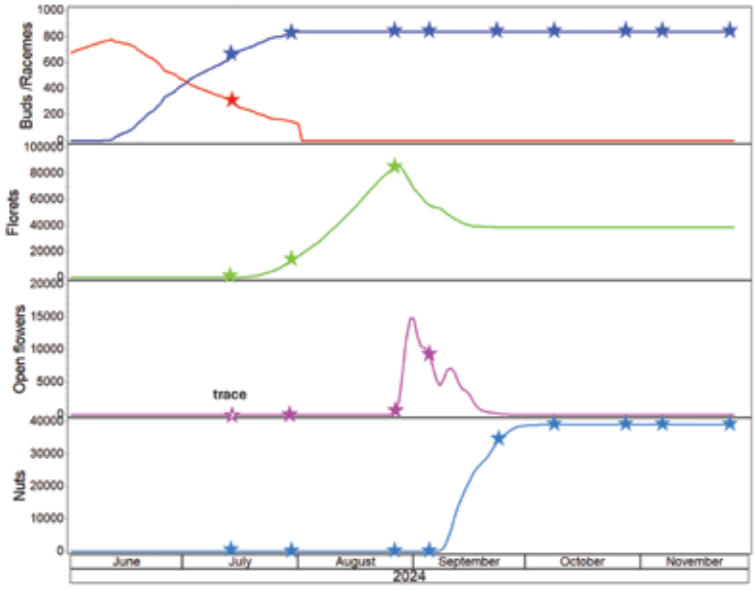
This project has already made some important advances in assessing and describing the growth stages of macadamias. While this doesn't mean the end of using common terms such as "match head", the new scale will help place them correctly within a seasonal timeline that will be relevant all year round and in every growing region, so watch this space for more information to come.

About the authors
Tania Yonow, Darren Kriticos and Carles Amat Gómez are from Cervantes Agritech; Jarrah Coates is from Coates Horticulture; Chris Fuller is from Nutworks; Chris Themsen is from Agreco Australia; and Bishwo Mainali is from Macquarie University, Applied BioSciences.

Acknowledgement
The project *An integrated systems based approach for pest management in Australian macadamia* is funded by Hort Innovation using the macadamia research and development levy and contributions from the Australian Government.



Site 1. Southeast Qld



Site 1. Northern NSW

Total Numbers
- Raceme Bud (BBCH 51 – 53)
- Raceme (BBCH 54 onwards; stays on tree)
- Floret (BBCH 56 – 59)
- Open flower (BBCH 60 – 66)
- Nut (BBCH 68 onwards)

lines: model simulation
y-axes: simulated numbers of each stage
stars: phenological states recorded
trace: stage was recorded as the minimum BBCH for one of four trees

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Laboratory evaluation of *Anastatus* sp. as a biocontrol agent of banana spotting bug

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Project snapshot

The research team managing the project *An integrated systems based approach for pest management in Australian macadamia* is evaluating the efficacy of a wasp, *Anastatus* sp, as a biocontrol for spotting bugs

While there have been some trials on *Anastatus* sp. These have mainly been to test the wasp's response to different temperatures (thermal biology). With this project, the research team is doing comprehensive laboratory studies into the developmental and reproductive biology of *Anastatus* sp., alongside ongoing investigations into its thermal biology.

One element being examined is how age of female wasps affects reproductive performance and the length of their parasitic activity in field conditions. This is important because it points to at what stage and for how long female wasps could parasitise spotting bug eggs.

Peak performance for parasitising spotting bug eggs has been observed for female wasps between 5 and 12 days of age, although on a positive note, it appears they can be effective even at an advanced age, suggesting they have considerable reproductive potential over time, which is advantageous for biocontrol applications.

After completing laboratory trials, the team is preparing to assess the field performance of *Anastatus* sp., with the aim of corroborating laboratory findings and evaluating its economic value as a tool for managing spotting bugs.

Spotting bugs, including the fruit spotting bug *(Amblypelta nitida)* and the banana spotting bug *(Amblypelta lutescens lutescens),* are major pests that affect the production of several horticultural crops, including macadamia, by reducing quality and yield. With increasing restrictions on pesticide use and significantly fewer effective chemical control options available, horticultural industries are actively seeking more sustainable and effective alternatives.

One of these alternatives, which is a key component of integrated pest management (IPM) strategies, is biological control using natural enemies of pests such as predators, parasitoids and entomopathogens.

Many growers are familiar with the biocontrol agent MacTrix, which has been used for the successful control of nut borer for some time. *Anastatus* sp. (Hymenoptera: Eupelmidae), an egg parasitoid of spotting bugs, has also been used by some growers to mitigate damage caused by spotting bugs, however, results have been variable and there is not the same level of confidence that they are as effective as MacTrix.

Detailed assessment of *Anastatus*

To date only a limited number of studies have assessed the biocontrol potential of *Anastatus* sp. focusing on the spotting bugs, and most of these were thermal biology and/or glasshouse trials, i.e. trials that test the wasp's response to different temperatures, e.g. development rates, survival thresholds, reproduction rate and egg emergence.

To support the development of an efficient biological control program, detailed laboratory assessments are required to accurately quantify key performance metrics, including per-unit parasitism rate, developmental duration, and sex ratio when reared on the target host. In response to this need, the research team has conducted comprehensive laboratory studies on the developmental and reproductive biology of *Anastatus* sp., alongside ongoing investigations into its thermal biology.

Adult *Anastatus* wasps live much longer than other commercially available egg parasitoids of hemipteran pests (hermipterans are "true" bugs, all of which have sucking, beak-like mouthparts, such as spotting bugs, cicadas and aphids). Because of this extended lifespan, it is important to evaluate age-specific parasitism to understand how the wasp's efficacy changes throughout its life.

To investigate this, we obtained *Anastatus* sp. from Bioresources Pty Ltd and established a colony by rearing them on banana spotting bug (BSB) eggs before conducting bioassays. From the colony, mated adult females *Anastatus* sp. of different age groups (1 to 4, 5 to 8, 9 to 12, 13 to 16, and 17 to 20 days old) were individually exposed to freshly laid BSB eggs. There were 15 female wasps in each age group, and each of these females was provided with a batch of 15 BSB eggs for 24 hours.

Following exposure, key biological parameters including daily parasitism rate, developmental time of offspring, and the proportion of males in the offspring were recorded and analysed. These data provide insights into how age affects reproductive performance and the potential longevity of parasitic activity in field conditions.

Parasitism and age range

Parasitism rates varied significantly across the different age groups of *Anastatus* sp. females ($P<0.0001$; see Figure 1). This can at least partly be explained by the fact that the wasp is a synovigenic parasitoid, that is, it has a reproductive strategy whereby it lays eggs over an extended period, increasing its chances of encountering suitable hosts. This was reflected in the fact that the highest parasitism rate was recorded in the 5- to 8-day-old age group followed by the 9- to 12-day-old age group, after which the rate declined. The increased parasitism rate from 5 to 12 days can be attributed to the fact that there were more maturing eggs, while just after emergence (the early adult stage), egg maturation may be in progress.

The slight decline in parasitism in the cohort following the 9-to 12-day cohort could have resulted from partial egg depletion, reduced host-seeking behaviour, or age-related decline in vitality. Nonetheless, it is important to note that the wasps can parasitise even at 20 days of age in favourable environmental conditions. This could be because females can replenish their egg supply throughout their adult life.

Once the host egg was parasitised, the age of the wasp did not influence how long it took offspring to develop (see Figure 2; $P > 0.05$). Studies exploring parasitoid-host interactions have mostly reported host egg characteristics (such as age and quality) as factors that can influence developmental time, rather than the age of the parasitoid.

Interestingly, the proportion of male offspring was higher when parasitisation was carried out by younger female adults, and this proportion declined as the wasps aged (see Figure 3). Significant male-biased sex ratios in egg wasps, which can reduce the effectiveness of bio-control programs, are often attributed to host egg quality and resource availability. While BSB eggs may be of suboptimal quality for *Anastatus* sp. to lay female eggs, another possible explanation is that female eggs mature later than male eggs, and hence we observed the increase in female offspring from the older females.

In a nutshell

The age of females significantly influenced parasitism rates and offspring sex ratios in *Anastatus* sp., with peak performance observed between 5 and 12 days of age. While this was the case, how long it took offspring to develop was not affected by maternal age. On a positive note, the extended longevity of Anastatus sp. and its ability to parasitise host eggs, even at an advanced age, suggest considerable reproductive potential over time, which is advantageous for biocontrol applications.

While these findings highlight the potential of *Anastatus* sp. as a possible effective biocontrol agent against BSB, evaluating their field performance using factors such as dispersal, within-tree distribution, *parasitism*, and field longevity is essential. Released wasps face challenging environmental conditions, and the demands of searching for hosts, exposure to predators, and the need for shelter may significantly drain their energy – all conditions unlikely to be replicated in laboratory assays.

Into the field

After completing all ongoing laboratory trials, the team is preparing for a field case study to assess the field performance of *Anastatus* sp., with the aim of corroborating laboratory findings and evaluating its economic value as a tool for managing spotting bugs. Additionally, the team is conducting molecular identification of the commercially available *Anastatus* sp. to determine its species identity. Identifying parasitoids to the species level is essential to draw on international experiences to do with the wasp's field performance, host range, biological and ecological traits.

About the authors

Lok N Aryal, Syed Z Rizvi and Bishwo Mainali are from Macquarie University Applied BioSciences and Tania Yonow and Darren Kriticos are from Cervantes Agritech.

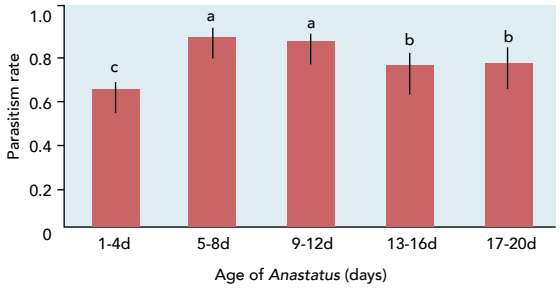

Figure 1. *Parasitism rate (%) by Anastatus sp. mated females of different ages. Bars represent mean parasitism rates ± SD for females that were 1-4, 5-8, 1-12, 13-16, and 17-20 days old at the time of exposure to BSB eggs.*

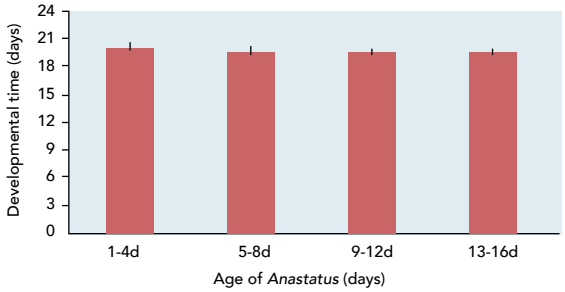

Figure 2. *Developmental time of* Anastatus *sp. on BSB eggs that were exposed to mated females of different ages. The female wasps were 1 to 4, 5 to 8, 9 to 12, 13 to 16, and 17 to 20 days old at the time of exposure to host eggs. Bars represent mean developmental time ± SD for of the offsprings.*

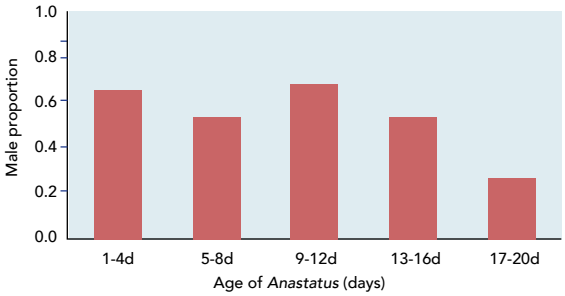

Figure 3. *Male proportion of offsprings of* Anastatus *sp. that emerged from the BSB eggs exposed to mated females of different ages. The female wasps were 1 to 4, 5 to 8, 9 to 12, 13 to 16, and 17 to 20 days old at the time of exposure to host eggs.*

Acknowledgement

The project *An integrated systems based approach for pest management in Australian macadamia* is funded by Hort Innovation using the macadamia research and development levy and contributions from the Australian Government.

Macadamia pollination: What does best practice look like?

Saul Cunningham, Josh Coates and Pele Canon, Australian National University. E: saul.cunningham@anu.edu.au

Project snapshot

A recent project to identify whether particular pollination management practices in orchards resulted in better production outcomes examined 150 research papers and conducted an industry survey of perspectives on pollination practice.

Four key messages from the research were identified, as follows: honey bees are the most important pollinators generally, cross-pollination leads to good yields, production is generally lower in large blocks of the same cultivar macadamias, and wild insect pollinators can play an important role in pollination.

While the industry survey identified that many growers agreed with these messages, there were some differences, for example 40% of growers thought self-pollination was important in single cultivar blocks and some thought wind and other pollinators like moths were important.

Project recommendations included demonstrating best practice pollination in a real farm context, how modifying single cultivar blocks by introducing different cultivars can improve yield and conducting a risk analysis on the changing supply of pollinators.

Achieving good yield is fundamental for all growers and requires balancing a range of inputs and management constraints. Pollination is an important input to production, and growers make many decisions that influence pollination in their orchards.

A feature of the Australian macadamia industry is the wide range of cultural practices growers use, including how cultivars are arranged in orchards and how pollination is supported. So, are there particular practices that research indicates will lead to better outcomes?

To help answer this question, the AMS and Hort Innovation commissioned a project to review the published research literature on pollination in macadamia and to complement this with a survey of industry perspectives on pollination practice. The full report and research compendium is now available on the AMS and Hort Innovation websites.



Four key messages

We found 150 research publications and distilled four main messages that are strongly supported by research and provide pointers to best practice.

- Most pollination is achieved by bees, with honey bees the most important generally, and stingless bees important in some locations. There is evidence that stingless bees are more effective pollinators than honey bees on a per visit basis. Wind does not contribute significantly to pollination.
- Macadamia relies on cross-pollination between varieties to support good yield, with self-pollination accounting for a relatively small proportion of nuts. Self-pollinated flowers often initiate nuts, but these are subsequently aborted in favour of developing nuts from cross-pollination.
- Given the importance of cross-pollination by bees, nut production is generally lower in large blocks of trees of the same cultivar because there is less opportunity for bees to move pollen between cultivars (i.e. cross-pollination) than in blocks with multiple cultivars close to each other.
- Wild insect pollinators play a significant role in many macadamia orchards and they are more abundant and therefore influential in orchards that are close to native vegetation. Thoughtful use of insecticides can reduce harm to wild pollinators and therefore increase that benefit.

Industry perspectives

Industry perspectives were often well aligned with the research. In particular, there was strong agreement that pollination was an important factor in productivity, that difficulty in accessing hives (honey bees or stingless bees) was a concern for the future, and that wild pollinators are important contributors.

There were areas, however, where growers had perspectives that don't align with the research. The following cases illustrate this difference:

- 40% of growers surveyed indicated that they thought self-pollination makes a large contribution to yield in single cultivar blocks, and many felt that yield in these blocks was not compromised by low cross-pollination rates.
- While they agreed that bees were important pollinators, growers also indicated that other forms of pollination (like wind and moths) were also important.

Our analysis indicated that there was a range of reasons for these different grower perspectives. One is that research-based information is not always accessible and therefore does not reach growers and advisors. It can also be that the context in which research is conducted does not always adequately reflect farming conditions or the complex trade-offs that growers need to deal with, so there is concern that the outcomes cannot be relied upon. As for the specific issue of single variety blocks, growers that have these might be more focused on making the best of the plantings they have rather than learning about the benefits of different approaches.

Recommendations

To support better pollination outcomes for the future the report makes a number of recommendations, including that the industry should consider supporting the following:

- Activities that demonstrate best practice in a real farm context. These should focus on benefits (especially yield) relative to cost of implementation considering integrated strategies (for example planting design and associated management) rather than the component variables that much existing research examines.
- Case study research where single cultivar blocks have been modified by replanting that introduces other cultivars. These can illustrate the potential to improve yield without requiring complete replanting.
- Conduct a risk analysis that models possible impact scenarios in terms of loss of pollination from feral honey bees, increased charges for honey bee hives and the capacity for the managed stingless bees to help fill gaps. This risk analysis should consider the economic benefit that might arise from pollinator friendly insecticide use.

New research on maximising macadamia yield

A new research project has just been launched with the aim of gaining knowledge of the macadamia tree's physiological requirements for maximising yield. It is led by Queensland Department of Primary Industries (QDPI) and delivered in partnership with Griffith University. The new insights are expected to help optimise orchard management for greater productivity. Additionally, the project will develop protocols to improve harvest efficiency by shortening the harvest season while enhancing nut quality. The project is funded by the Hort Innovation Macadamia Fund and is set to run over the next five years.

Dr Amnon Haberman leads the QDPI work, which will focus on studying how different stages of the macadamia reproductive development cycle, such as flowering, fruit set, growth, and immature abscission, affect nut production. The findings will highlight the most critical developmental points that limit yield, as well as potential interactions between carbohydrate allocation, vegetative growth, and reproductive development. Immature fruit abscission is often a key process controlling yield potential. The study will investigate the physiological factors that drive immature fruit abscission, aiming to identify opportunities for mitigating this process. It will also seek to identify the most critical stages of nut development during which kernel recovery is determined.

Professor Stephen Trueman from Griffith University will lead the work aimed at improving harvest efficiency. Previous studies have demonstrated the effectiveness of ethephon and mechanical tree shaking, as well as their combination, in enhancing mature nut drop, thereby allowing for a shorter harvest period. The project will assess the optimal chemical application dose and timing for widely-planted late-dropping cultivars, as well as explore additional opportunities to optimise harvest efficiency. For example, mechanical methods, such as tree shaking, will be tested in conjunction with the chemical applications. Additionally, the research will evaluate how different techniques for shortening the harvest season impact nut quality and yield in the subsequent season.

Project updates will be posted regularly on the Hort Innovation project webpage (link in the QR code):

For more information, contact: Dr Amnon Haberman, QDPI at amnon.haberman@dpi.qld.gov.au or 0421 190 089
Professor Stephen Trueman, Griffith University at s.trueman@griffith.edu.au or 07 3735 7719

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Enhancing management of macadamia pests: Targeting fruit and banana spotting bugs

Ian Newton E: Ian.Newton@dpi.qld.gov.au

Research into improving fruit and banana spotting bug control with traps continues to give longer effectiveness and greater efficacy.

Project Snapshot

FSB and BSB result in significant financial losses each season and their control is heavily reliant on applying pesticide.

Thirty-three different adhesives, tapes and trap models were tested and compared to the adhesive performance of currently available trap used for BSB.

The first stage of work to identify whether FSB produces a detectable pheromone has been completed, laying the groundwork for a synthetic lure to be developed.

Fruit spotting bug (FSB) *Amblypelta nitida* and banana spotting bug (BSB) *Amblypelta lutescens lutescens* are major pests impacting macadamia orchards across eastern Australia. Their damage results in significant financial losses each year. Current control methods rely heavily on frequent pesticide applications using fixed schedules due to the absence of effective monitoring tools. This approach runs counter to Integrated Pest Management (IPM) principles and may lead to pesticide resistance as well as outbreaks of secondary pests like thrips, mites, scale insects, and various moth species.

The project *Improving Fruit and Banana Spotting Bug Control* (MT21017), focuses on two major goals:

1. Design a longer-lasting and more effective trap for banana spotting bug.
2. Identify and develop a pheromone lure to target fruit spotting bug.

Improving BSB traps

The currently available BSB trap from Yates-Organic Crop Protectants (OCP) uses a pheromone lure but is limited by the trap's short lifespan. The trap's adhesive efficacy breaks down within 7 to 10 days, especially under direct sunlight, making frequent replacements necessary. This maintenance burden deters widespread adoption by growers and scouts. Attempts to use alternative adhesives or trap types have so far been ineffective, largely due to the bugs' ability to escape traditional sticky surfaces and avoidance of entering enclosed traps.

To address this, the project tested 33 different adhesives, tapes, and trap models from various manufacturers. Each option was first screened under laboratory conditions using live BSBs and compared to the existing trap's adhesive performance. Promising candidates were then subjected to UV exposure tests to determine how well they held up under sunlight.

One imported sticky trap performed particularly well and showed both strong initial capture rates and adhesive durability over a four-week period. It was further field-tested against the commercial OCP trap using traps in blue, yellow, and white. Unfortunately, these new traps only caught around 20% as many bugs as the OCP version. Trials with the original trap in different colours (green, black, and white) confirmed that colour had little effect on catch rate. These findings suggest the new trap's failure was adhesive-related rather than visual.

Additional trap designs are currently under investigation and field evaluation, with the goal of increasing efficiency and reducing maintenance needs.

Developing an FSB pheromone lure

Unlike BSB, no pheromone lure exists for FSB. Past research, including collaboration with the USDA, helped pinpoint potential chemical compounds but did not lead to a functional lure.



Y-tube olfactometer setup used to confirm attraction of unmated female FSB to male FSB.

The second part of this project is focused on solving that problem. Initial laboratory work involved behavioural assays with unmated adult FSB to confirm whether the insect produces a detectable pheromone. This first stage has been completed, laying the groundwork for synthetic lure development in the next phase.

Laboratory bioassays using Y-tube olfactometers have confirmed attraction of unmated female FSB to male FSB. Male-to-male attraction was also tested and did not show any attraction, demonstrating that the pheromone is likely a sex pheromone and not an aggregation pheromone. Reproductive organ maturation was also investigated by a series of dissections at different adult ages of both sexes. It was shown that female FSB reach sexual maturity approximately two weeks after reaching the adult moult stage, whereas males have active sperm in testes 24 hours after reaching the adult stage. Olfactometer bioassays confirmed that females do not respond to males upon reaching the adult moult stage but start to respond to male pheromones as they reach sexual maturity.

Further work testing chemicals of interest and their effect on the physiology of the antennae has also progressed, with some compounds yielding promising responses that will be further tested. Phase two of the project has begun, with compounds recorded from headspace aerations of FSB compiled into a dataset for analysis.



Laboratory testing of adhesives and tapes using live female and male Banana spotting bugs.



Various trap designs undergoing field evaluation.

Expected impact

A more effective BSB trap and the introduction of an FSB pheromone lure would allow for more targeted spraying, which would reduce chemical use, boost crop quality, and cut rejection rates. If effective enough, the new traps could also serve as population suppression tools, decreasing reliance on chemical interventions and supporting sustainable pest management.

This project has been funded by Hort Innovation, using the Hort Innovation avocado and macadamia research and development levy, co-investment from the Queensland Department of Primary Industries, the University of the Sunshine Coast and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture.

About the authors
Ian Newton, Donna Chambers, Stefano De Faveri and Kempsy Adams are from Qld DPI, and R Andrew Hayes is from the University of Sunshine Coast.

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R&D UPDATE

Advances in micropropagation for clonal macadamia rootstocks

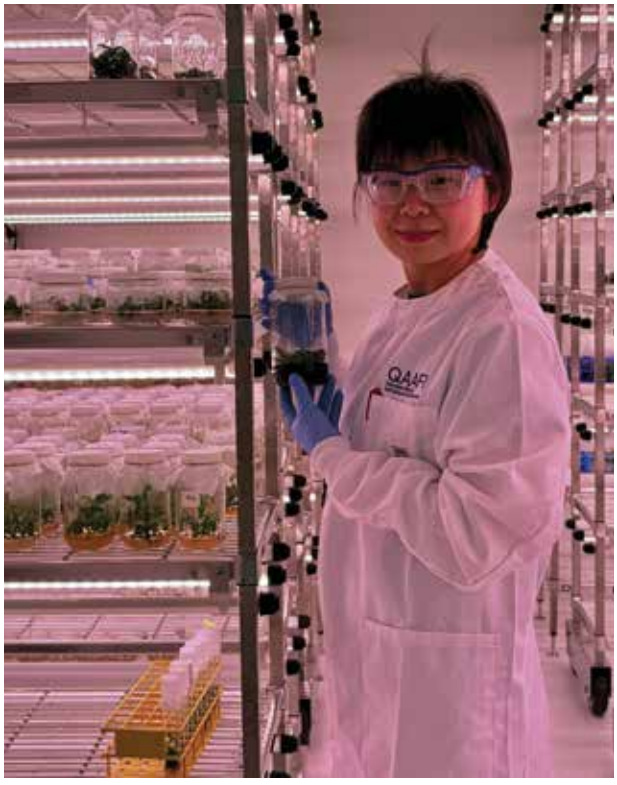
Zhangpan (Magnolia) Hu, Xueying Li, Chris O'Brien, Albert Chern Sun Wong, Maddy Gleeson, Neena Mitter Alice Hayward, Queensland Alliance for Agriculture and Food Innovation (QAAFI). E: a.hayward@uq.edu.au

Project Snapshot

Research into more efficient propagation techniques to multiply elite and true-to-type macadamia trees is underway.

Rootstock cultivar Beaumont is one of the earliest cultivars to progress successfully through testing in the lab.

Identification of promising hormone treatments and conditions will help overcome the 'hard to root' aspect of macadamia seedlings.



Magnolia Hu with macadamia cultures in tissue culture growth room.

A new solution allowing propagation of true-to-type macadamia rootstocks

The Australian macadamia industry relies heavily on seedling rootstocks for variety propagation. While this enables clonal propagation and early bearing of the scion variety, this practice introduces genetic variability into the whole tree performance.

Tree shape, vigour and root system strength can vary from tree to tree, which makes orchard management less consistent and can affect productivity in the long run. The orchard is also restricted by seed availability, quality and germination rates. Importantly, elite rootstock selections, such as those being developed by breeding programs, cannot be propagated from seed; these require clonal propagation technology to ensure genetic quality.

Growing from rooted cuttings can work for clonal propagation of some cultivars, but strike rates can be low and are usually unpredictable. Plant quality requires propagation of quality and robust rootstocks and root systems. This is where plant tissue culture technology has played a pivotal role in clonal rootstock supply, elite rootstock release and advancing major tree crop industries globally including apple, prunus and citrus. In this article we describe our work in developing a high-throughput version of this technology for macadamia.

What's the research about?

Our team from the Queensland Alliance for Agriculture and Food Innovation (QAAFI), at the University of Queensland (UQ), is working on new propagation techniques to multiply elite and true-to-type macadamia trees more efficiently. The core of our research is plant tissue culture. We are applying this technique to both scion and rootstock varieties, supported by industry partners and researchers from Australia's Macadamia Breeding Program and Tree Genomics Programs (Horticulture Innovation Australia).

Briefly, the process starts with shoot tips (containing plant meristems) selected from mature rootstock or scion budwood. These tips are grown under controlled, sterile conditions to multiply plants clonally many times over. The result is hundreds, or even thousands, of healthy plantlets that are genetically identical (true-to-type to the mature field material).

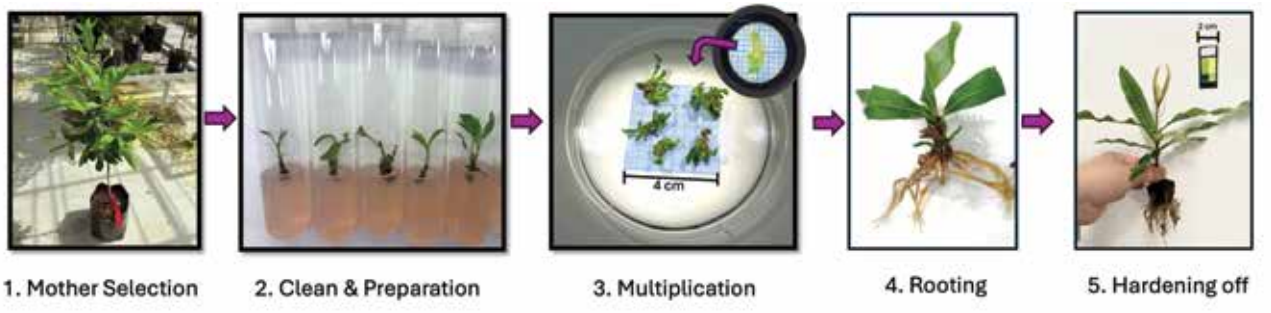


Figure 1. *Macadamia tissue culture steps.*
1. Mature macadamia A16 culture; 2. Initiated A16 nodal cultures in test tubes; 3. Multiplied mature Beaumont from shoot tips; 4. Rooted Beaumont shoots; 5. Hardened-off Beaumont plantlet.

How it works

Step 1. Mother plant selection. Mature budwood from source plants of selected varieties are grafted and maintained in glasshouse conditions to provide healthy and actively growing budwood from true-to-type 'mother plants. Only the best trees are used to establish sterile cultures.

Step 2. Cleaning and preparation. Newly flushed shoots from mother plants are cleaned to remove any pests, contaminating bacteria and fungal spores. This is vital to ensure initiation of sterile and healthy tissue cultures.

Step 3. Multiplication. In the lab, under sterile conditions, the shoot tips are encouraged to grow and multiply using carefully balanced nutrients, light, and plant hormones. Within six months, this multiplication phase produces many hundreds of cloned shoot buds from a single macadamia starter bud, depending on the cultivar. These shoots are then elongated and progressed to rooting.

Step 4. Rooting. For macadamia, rooting is one of the biggest challenges. We're trialling new protocols to get stronger, healthier roots more reliably and faster.

Step 5. Hardening off. Lab-grown plants are delicate. They need to adjust from sterile, climate-controlled environments to real-world conditions. We gradually wean them onto nursery benches, hardening them off before they can be grafted and/or planted in the orchard.

Research progress to date

We are working on five cultivars, including scions and rootstocks, to enable us to produce grafted plants in vitro in the future. A key consideration is that different cultivars respond differently to protocols tested at each stage. Each cultivar brings its own unique challenges. We highlight here our progress made for rootstock cultivar Beaumont, one of the earliest cultivars to progress successfully through our system.

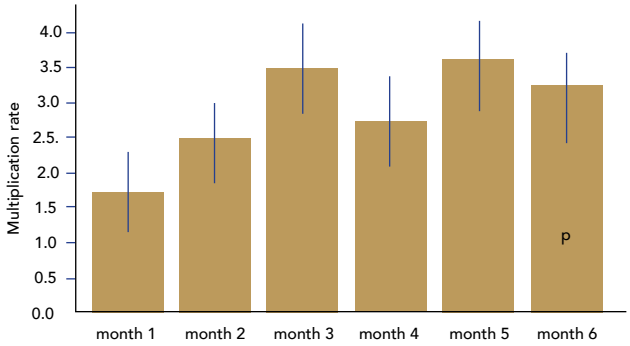


Figure 2. *Multiplication rate of mature Beaumont within 6 months*

Beaumont has shown great promise for high multiplication rates without compromising shoot quality. The system can produce up to 250 shoots from a single shoot tip within six months under lab conditions, with an average multiplication rate at 2.9 every month (see Figure 2).

Meanwhile, cultivars like A16, MCT1 and H2 require extra tweaks to optimise shoot quality and encourage robust root formation.

Our team has identified promising hormone treatments and conditions that help overcome the hard-to-root reputation for macadamias in general, but fine-tuning is ongoing for each cultivar. For Beaumont, we have succeeded in achieving between 90 and 100% rooting percentage of in-vitro shoots within four weeks.

We are now working with nursery partners to plan trials of small batches of plants in nursery conditions this year. The aim is to make a seamless transition from lab to nursery. Critically, the plants will need to be established in field trials, and we will be seeking follow-on support and industry engagement for this phase. We plan to deliver a complete tissue culture and nursery protocol for industry adoption, proven for plant quality and performance through laboratory, nursery and orchard stages, at scale.

What does this mean for the future?

Once ready, this technology could offer the following benefits:

- on-demand supply of new trees
- more uniform orchards with reliable growth
- access to elite cultivars and potentially accelerated access of new releases from breeding programs
- in vitro micrografting for accelerated propagation process
- a platform to enable accelerated non-traditional breeding tools including gene editing.

This platform will provide nurseries the means to produce true-to-type cultivars in higher throughput systems to suit growers' demands.

What's next?

PhD student Magnolia Hu is focusing on scale-up validation of the system. The next phase includes seeking ongoing support for nursery and field trials and watching how different cultivars perform from lab to orchard. We plan to be sharing updates through the AMS, local field days, and other grower networks.

Australia's macadamia industry has a home-grown advantage in innovation to underpin global competitiveness, from early breeding work to modern orchard management. Tissue culture is a key platform that could improve the propagation of elite cultivars, accelerate access to new breeding releases, and provide the gateway to more advanced crop improvement technologies such as precision genome editing.

We welcome industry engagement with our work.

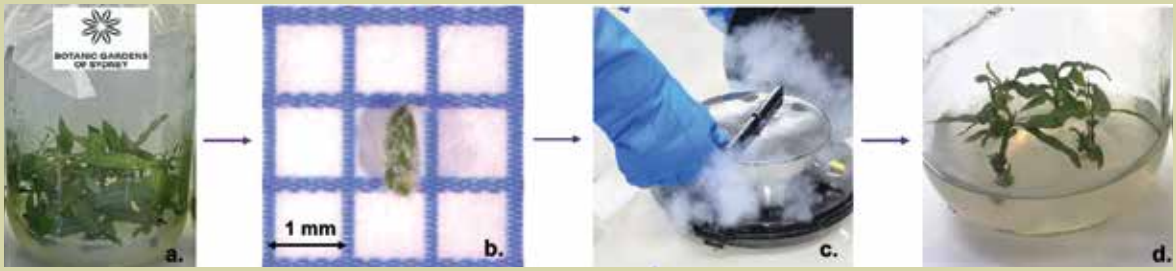
Acknowledgment
This project is funded by the following: The University of Queensland; Australian Research Council Linkage Program; The Royal Botanic Garden Sydney; Department of Agriculture and Fisheries; MacQ Pty Ltd; Aurora Macadamias Pty Ltd; Macs Network Operations Pty Ltd; Bush Holdings Pty Ltd; Australian Macadamia Society; and the Macadamia Conservation Trust.

Safeguarding the future: Cryopreservation for Australian Macadamia Conservation

Another innovative aspect of this project is the development of cryopreservation technology specifically for conserving macadamia germplasm, which cannot be safeguarded using conventional seed-banking methods. All macadamia species are currently threatened in the wild, and commercial germplasm maintained in field collections remains vulnerable to environmental stresses and catastrophic loss.

What is cryopreservation?
The procedure typically starts with the dissection of small plant tissues. In this case, 2 x 1 mm shoot tips were dissected from the juvenile macadamia Beaumont mother plants and then treated with cryoprotectant solutions to mitigate the formation of ice crystals that could otherwise damage cellular structures during freezing and thawing.

After cryoprotection, the tissues are rapidly cooled in liquid nitrogen to achieve ultra-low temperatures. Subsequent recovery and regeneration of the preserved material are achieved through tissue culture, enabling the re-establishment of whole plants. So far, around 14 % regrowth has been achieved for the juvenile Beaumont. Vigorous cultures regenerated post liquid nitrogen storage are shown in the figure. By adopting cryopreservation, researchers can effectively conserve genetic resources and provide a robust safeguard against future environmental and biological threats.



Cryotechnology of macadamia shoot tip: a. Juvenile macadamia Beaumont culture from the Royal Botanic Garden; b. Dissected Beaumont shoot tip, 2 x 1 mm; c. Liquid nitrogen storage process; d. Macadamia Beaumont shoots regenerated post liquid nitrogen storage.

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Australian macadamia minor use permits

Current at August 2025

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

All efforts have been made to provide the most current, complete and accurate information on these permits, however, AMS 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.

AUSTRALIAN MACADAMIA SOCIETY

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