AUSTRALIAN MACADAMIA SOCIETY

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The Big Heart of Australia's Macadamia Industry

AUSTRALIAN MACADAMIA SOCIETY

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Front cover. *In July, Australian Macadamias launched a new consumer campaign to celebrate macadamias as the 'Original Macas Down Under'. This billboard, featuring macadamia grower Michael McMahon, was placed outside of McDonald's in inner city Sydney. Read all about it on page 5.*

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Our Mission

The Australian Macadamia Society Limited is established to promote all aspects of the macadamia nut industry; to encourage a free interchange of ideas and information amongst macadamia growers and marketers of macadamia nuts and by-products; and to foster and promote goodwill among members of the Society in furtherance of its objects.

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CEO's report

In every aspect, 2023 continues to be 'anything but a normal season'. Early season concerns about handling and storage capacity, and for some even placing their forecast volume of NIS, have morphed into potential supply shortages.

The reduced crop forecast (July 2023) has been attributed to a range of factors. These include weather conditions at flowering and through to early nut development impacting yield and kernel recovery, and economic decisions at harvest, which for many translated to fewer rounds and, for some, no 2023 harvest at all.

Market dynamics are also far from what to date has been considered 'normal'. The traditional split of approximately 30% of NIS going direct to market, either through a direct path or via Australian processors, has changed dramatically in 2023, with some estimates of a 50:50 NIS vs nut-to-processing (kernel) split.

And while the change in market pathways presents a positive scenario likely to deliver improved returns to many growers, the potential impact of increased NIS sales on availability of kernel for long-term market contracts adds another dynamic to an already challenging season.

As the 2023 harvest wraps up and on-farm preparation for the 2024 crop gets underway, the most common question industry wide is obviously 'what is next season's price going to be?' I have been told to never refer to crystal balls or fairy wands in response to questions on market outlook, but right now I wish I had one, if not both.

Anecdotal market feedback suggests some light at the end of what for many is a very long tunnel, with reports of some strengthening demand and improving price indicators. However, it's your processor or supply chain partner who is by far the best placed to keep you updated and to assist in making decisions for your business. One thing is certain, and that is that a decision does have to be made very soon if you are committing to the season ahead, where productivity and quality will remain absolute priorities to keep options open and maximise opportunities.

One area of focus at recent MacGroups was the 'macadamia landscape', looking at the roles, responsibilities and influences impacting industry at all levels. They provided a forum to raise issues and seek clarity, with questions from marketing plans and supply chain models, to levy collection, administration and accountability. Most importantly, the MacGroups provided an opportunity to talk openly, stay connected and strengthen connections in an industry that even in the most difficult times still demonstrates its unique and collaborative nature.

The July MacGroup presentations will be available online shortly, and a more informal round of regional meetings is planned for early December.

Alongside the planned Australian Macadamias marketing program, the AMS is taking every opportunity to raise awareness of macadamias in our own communities. We will be joining Queensland Fruit & Vegetable Growers (QFVG) for a 'macadamia-themed day' at the Ekka and supporting 2023 as the 'Queensland Year of Horticulture' in other activities later in the year. Watch this space.

Similarly in industry development, alongside the levy funded initiatives, the AMS is involved in several exciting new projects, such as the next stage of the Australian Tree Crop Map, creating a macadamia-only map providing valuable data for industry forecasts and planning, biosecurity management and sustainability challenges (see page 65).

From an industry representation and advocacy perspective, there are currently many concurrent areas of focus ranging from national issues such as the ongoing technical market access negotiations for macadamias to India; the extended involvement in seeking a fair agreement between affected parties and government for the current *Varroa destructor* incursion and engagement in the national levy review process and the proposed (July 2024) biosecurity levy; to a range of regionally focused priority areas ranging from labour availability, to water access and environmental impact.

Finally, as many of you pointed out at MacGroups, the co-designed engagement model with Hort Innovation for R&D prioritisation is very similar to the historical R&D committee model, proving nothing is ever new. The critical factor in the new model is effective engagement and communication both in assessing and setting priorities and in monitoring project delivery to ensure every levy $ delivers tangible value to industry.

In coming weeks there will be a call for nominations to participate in both regional groups and in the macadamia SIAP. The selection criteria and responsibilities for each are currently being finalised. The regional groups will also provide a vehicle for closer engagement on regional issues and a mechanism to encourage involvement in existing industry projects and initiatives.

As always please reach out to me with your feedback, thoughts and ideas.

Clare Hamilton-Bate

Global macadamia environment remains highly competitive



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Global supply

The 2023 global crop is forecast to be 308,559 t in-shell @ 3.5% moisture, up 3% on the 2022 season. Australia's 2023 crop forecast was revised down to 53,160 t in June. The 2023 Australian crop has been impacted by variable seasonal weather conditions and prudent economic decision-making by growers as a result of the softest farm-gate prices in over a decade. South Africa recently reduced its 2023 forecast from 81,566 t to 77 659 t, a 12.8% increase on 2022. China's forecast of 56,000 t is 10% down on last season.

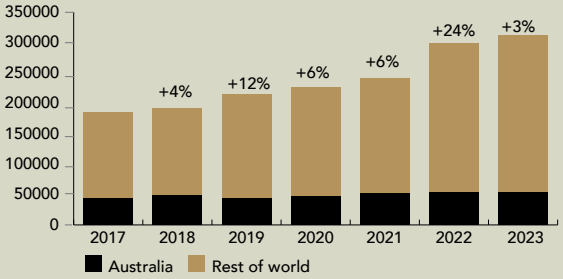


Figure 1. Global macadamia crop volumes 2017-2023 (tonnes) Source: INC, AMS, SAMAC. All volumes are at 3.5% MC.

Global product innovation

Total new products launched using macadamias as an ingredient increased by 16% in the 12 months to June 2023, after a four-year period of limited growth. This is indicative of macadamias becoming more attractive to many sectors, particularly manufacturers, as customers are more confident in the long-term surety of supply.

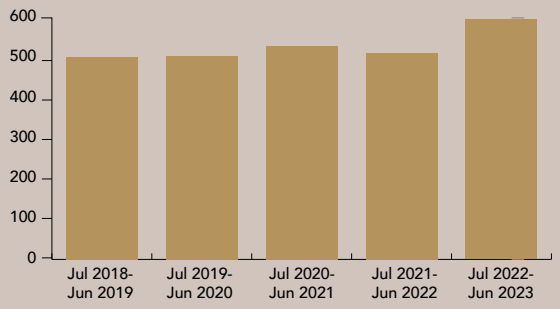


Figure 2. New product launches using macadamias as an ingredient. Source: Mintel GNPD, July 2018 - June 2023

Global demand

In the 12 months to April 2023, global macadamia kernel imports to the top five markets combined grew 13% on the prior MAT period. The USA, Japan and China markets were in growth, with Europe down 4% and the domestic market down 6%.

With global supply continuing to increase at a faster rate than global demand, the sales environment for kernel remains highly competitive. Average price per kilogram data for imports across all markets continues to indicate significant downward price pressures, particularly in the ingredient styles.

Global in-shell imports to China for the period MAT May 22 to April 23 were the highest on record for many years, reported at 51,581 t (+17% on prior period). Australian imports remained steady, with South Africa, USA and Zimbabwe experiencing growth. South Africa currently holds a 50% market share, with Australia at 27% (see table).

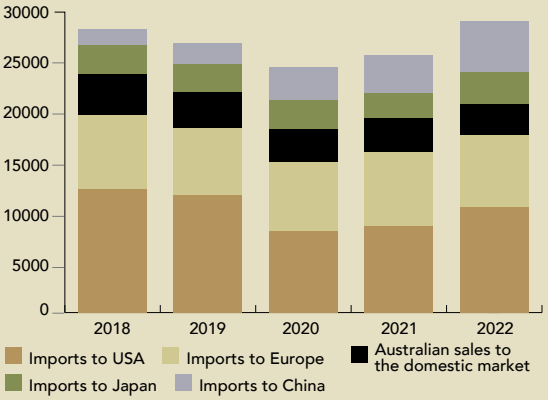


Figure 3. Macadamia kernel imports to top 5 markets (tonnes) MAT May to April. Sources: USDA, Eurostat, Japan Customs, China Customs, via IHS Markit Inc, AMHA.

China (in-shell imports kg)	May18-Apr19	May19-Apr20	May20-Apr21	May21-Apr22	May22-Apr23
World	16,696,163	24,624,855	24,854,311	40,713,457	51,581,660
Australia	7,998,487	10,295,185	12,609,699	13,972,153	13,921,103
South Africa	2,574,660	6,770,485	6,765,284	14,760,123	25,971,955

Table. In-shell imports to China (2018 to 2022).

Driving demand for Australian grown macadamias

The Australian levy-funded macadamia marketing program is focused on driving demand for *Australian grown* macadamias. The 2023 marketing plan is active in Australia, Japan, South Korea, China, and Taiwan and has two clear objectives:

1. To inspire the food manufacturing sector to increase the use of Australian grown macadamias as an ingredient
2. To make consumers aware of Australian grown macadamias and be inspired to experience them.

The plan reinforces the message that Australian macadamias are a premium wholefood that grow in their natural home and offer a delicious, indulgent experience that can elevate food and life. They are a super nut!

Ultimately, the objective of the marketing plan is to have *more* people consuming *more* Australian grown macadamias in *more* ways.

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- australian-macadamias.org/consumer
- trade.australian-macadamias.org

MACAS MADNESS: Australian macadamias show Aussies that they're the original macas down under

This was the scene outside McDonald's in Sydney's St Peters on Friday 21 July as we launched an exciting new consumer PR campaign to celebrate macadamias as the 'Original Macas Down Under' – with some help from Australian macadamia grower Michael McMahon (also known as 'Maca'!).



A fixture in Australian culture for over half a century, McDonald's, affectionately called Maccas, has garnered a dedicated following here. However, most Australians don't realise that the macadamia nut is the true Original Macas Down Under, having originated in Australia over 60 million years ago.

The campaign is calling on every Aussie to show their love for a true Aussie original, Australian macadamias. To help Aussies go nuts for native food and experience The Original Macas, Australian Macadamias has teamed up with Masterchef alumni and proud Bundjalung woman Mindy Woods to create two native-infused recipes, The Original Macas Burger and Mylkshake.

Both recipes have been crafted to highlight the wonder of native ingredients and show Aussies just how delicious and nutritious macadamia nuts are. The two hunger-busting recipes demonstrate how macadamias can be enjoyed in innovative ways, from a native spiced beef and kangaroo patty featuring the Original Macas, to the creamy delight of macadamia mylk and butter in The Original Maca(damia)s mylkshake. It's macadamias like you've never enjoyed them before.

Mindy Woods says, "I have always loved macadamias and incorporating them into recipes, their versatility allows me to experiment with them in new ways and infuse their robust flavour profile into my cooking. The native credentials of macadamia nuts also hold a special place in my heart. As a First Nations woman, I seize every chance to share the significance of native and indigenous foods. The connection they foster with my ancestors and culture makes native food incredibly meaningful to me. I'm thrilled to be working with Australian Macadamias on The Original Macas menu, to shine a light on native foods and inspire Australians to embark on their own discovery of the wonders of native ingredients."

Aussies can enjoy the taste sensation of The Original Macas menu at home by heading to the Australian Macadamias website australian-macadamias.org/consumer for the full recipe.





Hort Innovation MACADAMIA FUND

Leoni's orchard rounds



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The majority of the 2023 crop has been harvested and, for most, it has been a lower yielding season, with a combination of smaller kernels, kernel recovery at least 3% lower than the long-term average and 741 performing poorly. While quality in Queensland has been excellent and processors are reporting factory rejects well under 2% and commercial grade less than 5%, there has been an increase in insect damage in NSW and quality has been more variable. It is clear the initial industry crop forecast was too hopeful in a season when there was less incentive to harvest. The revised forecast is currently (end July) 57,000 t in-shell at 10% moisture.

A drier and warmer season ahead

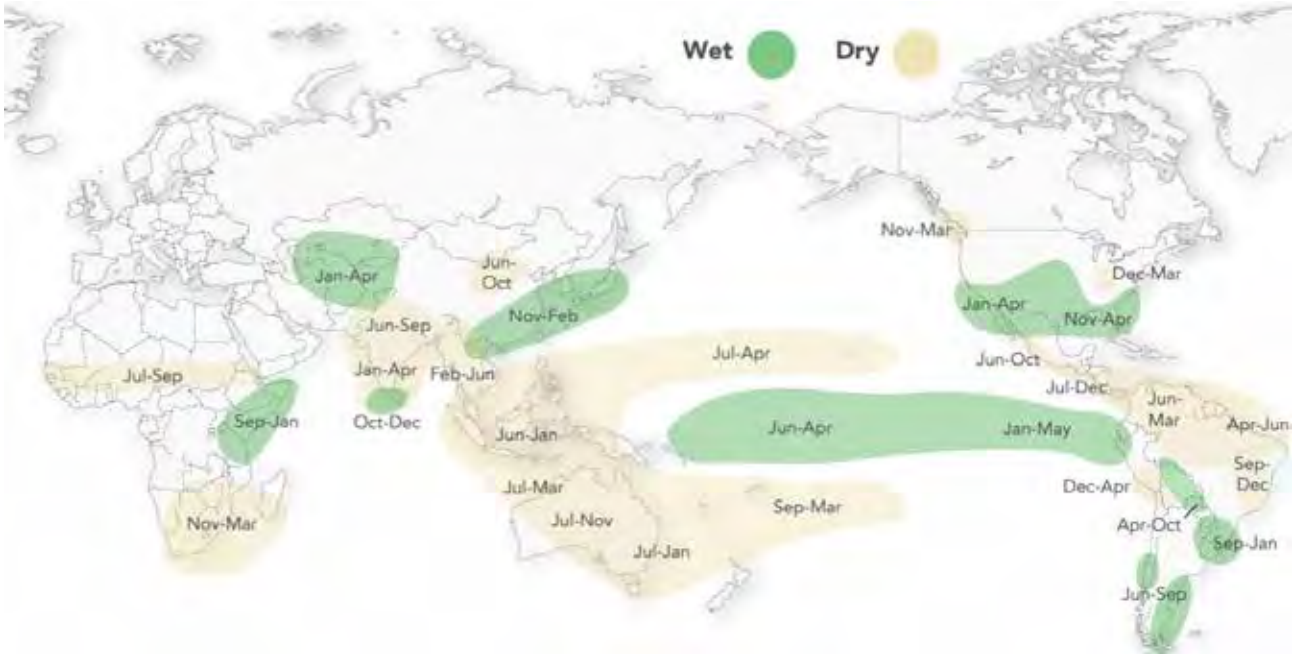
The world's climate monitoring fraternity have predicted a moderate to high strength El Niño event for the second half of the year. Some of the impact of an El Niño is shown on the world map below. For most macadamia growing origins, including South Africa, the largest producer, and for Australia, El Niño will likely bring extreme weather with drier and warmer months during the growing season. In Kenya and parts of China (third and second largest producers respectively), a wetter season is forecast. The duration of the El Niño is uncertain, but many growers would be relieved at the chance of a drier flowering.

Flower blight prevalence and risk

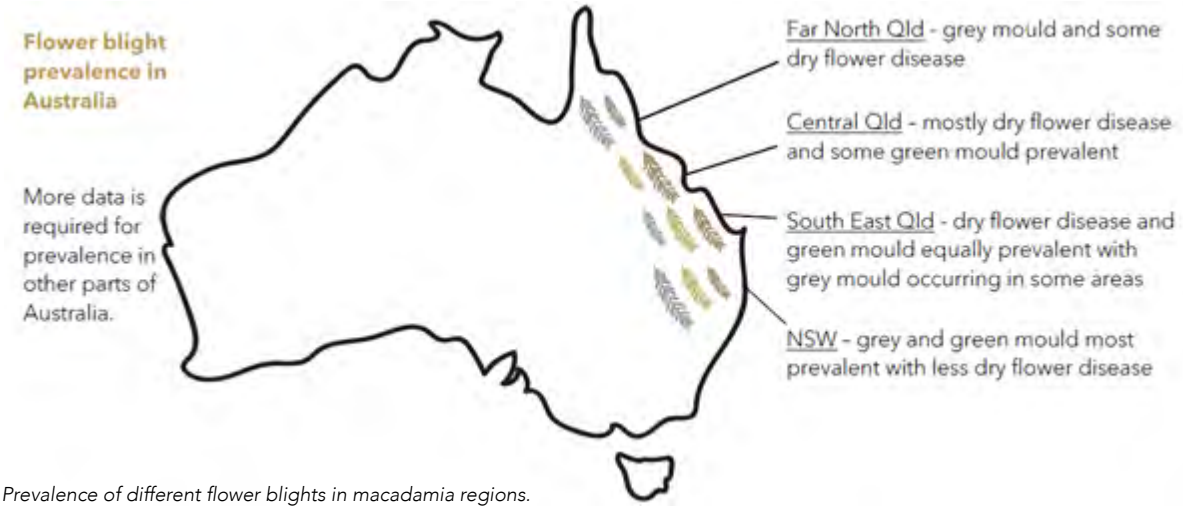
Looking back at last season's flowering, which was certainly prolific, some of the lower yield could be the result of a wetter flowering and nut set period. Flower blights are a growing concern for growers, and we don't fully understand the true crop loss from flower diseases. Once you see the disease developing, the damage has likely been done. There are also few control options and a lack of understanding about timing of spray applications. Most products are protectants and have limited curative activity, meaning you need to be very aware of your risk, including:

- a history of flower blights
- conducive weather conditions (temperature and humidity)
- closed canopies with limited sunlight and ventilation.

A flower blight prevalence map has been developed based on research from the levy-funded Integrated Disease Management Program, delivered by the University of Queensland. It shows which flower blight you are more likely to experience, depending on your region. Pest scouts will be careful monitoring for dry flower disease this season, which can impact most growing regions.



Map 1. Typical precipitation patterns under El Niño conditions
Source: IRI 2023 ENSO Resources, International Research Institute for Climate Prediction, Lamont-Doherty Earth Observatory, Columbia Climate School - Columbia University.



Map 2. Prevalence of different flower blights in macadamia regions.

	Grey mould *Botrytis*	**Green mould** *Cladosporium*	**Dry flower** *Pestalotiopsis complex*
			
What do I monitor for?	• Brown to dark brown flowers clustered by grey fungal strands • Disease develops a **fuzzy grey** appearance on flowers	• Brown necrotic flowers • Disease develops **olive green mould clumps** with fungal spore	• **Dry looking, dark brown** flowers • Infected flowers dislodge easily
Weather conditions promoting occurrence	• Wet and cool • Rain or humidity above 70% • 18 - 20°C	• Wet and warm conditions • Rain or humidity above 60% • 25 - 27°C	• Dry and warm conditions • Humidity below 40% • 25 – 30°C
	Wet ← → Dry Cool ← → Warm		
Susceptible flower stages	• Open flower stages	• All flower stages	• All flower stages, including raceme elongation
Cultural controls	• Open, well-ventilated canopies - spores mainly carried in water droplets • Sunlight distributed throughout canopies – temperatures above 35°C pose a risk to flower diseases.		
Chemical controls	✔ Tebuconazole and Fluopyram (Luna Experience) registered for botrytis only. Group 3+7 fungicide, adjuvants not required. Protective spray with limited curative action. Apply to green flowers.		
	✔ Penthioryrad (Fontelis) registered for flower blights. Group 7 fungicide, no adjuvants required. Protective spray with limited curative action. Apply to green flowers.		
	✗ Iprodione is registered for botrytis, but this Group 2 fungicide has since been banned in many export markets. Use in macadamia for any disease can result in rejection by your processor.		

Research into flower blights is ongoing and we hope to have a clearer picture of climatic, cultivar and other orchard factors in seasons to come as well as a more refined suite of management options.

Leoni

Industry and AMS stalwart celebrates 100th birthday

In evidence that macadamias contribute to longevity, former president of the AMS, Geoff Garratt, turned 100 on 18 December 2022. Geoff celebrated his varied life filled with achievements - including almost fifty years largely dedicated to macadamias and the AMS - with his wife Ursula and many friends.



His amazing adult life commenced as a navigator in Lancaster bombers in World War II over Europe. When he returned to Australia, Geoff settled in Grafton as a trained watchmaker where his many community interests and his effective leadership skills led him to be elected as deputy mayor.

After a moving to Sydney, he became involved in real estate and came to know Paul Mendels from The Nut Shop. Paul still grows macadamias at Dunoon and his family continues to tantalise consumers with the odour of roasting macadamias from their Strand Arcade shop.

Geoff's entrepreneurial spirit led him to pursue a range of interests, many of which were successful and some of which were less so. One of his ventures was the purchase of a prawn trawler, which sadly later burnt and sank in passage to the Gulf. Another major investment that was a good idea implemented at the wrong time was establishing a brewery in Timor in the 1970s. While it was being built and Geoff was located there, the Indonesian invasion occurred, and the project had to be abandoned. Fortunately, he was able to retrieve some of his losses by selling the plant to the Philippines.

Geoff, always seeking new goals, turned his gaze to macadamias whose potential he was convinced of. In 1976 he bought 'Macadamia Integrifolia' from Bernie Mason at Gympie. This was an 800-tree orchard planted by Italian internees at the end of WWII, which during the 1950s was probably the largest producing orchard in Australia. Geoff topworked many trees, encouraged organic growing, built a small processing factory where he designed most of the equipment and successfully marketed the kernel. He continued to work the orchard until 2020 at the age of 98.

He wasn't content with just being an orchard owner, and seeking other ways to contribute, joined the AMS in its early days and in the late 1980s was elected to the Management Committee or Board. In 1994 he accepted a nomination as president, a position he held until the former president's health recovered, and then was elected president again in 1997.

This was a tumultuous time with a divided industry and Board. Geoff became known as the 'People's President' because of his wise, quiet, unselfish leadership embracing and involving all aspects of the industry. He made the AMS more professional and more relevant, and his applied sound business skills to help build a progressive society and industry.

Geoff continued as a director on the AMS Board for almost ten years and then as an active member at meetings. His mind is sharp and his passion for macadamias undiminished.

Geoff is gratefully acknowledged as one of our pioneers as a grower and leader who guided us into become a proud successful industry.

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Monitoring the top tip from consultants

We asked consultants Alan Coates from South East Queensland and Bob Maier from the Nambucca growing area to give an insight into what they are seeing in the orchard this season as far as crop protection and nutrition are concerned.

While different pests and diseases are affecting these two growing regions, their key message is the same, and that is that it is crucial that growers maintain their monitoring programs so they know what is happening in the orchard and as a way of minimising issues into the future.

South East Queensland

Alan noted that lace bug activity is already significant and that flower caterpillar, fruitspotting bug and flower blight are issues for some growers, depending on orchard density and block topography or whether they had wet weather at flowering.

Some growers have decided to leave crop on the ground, something that brings with it risks without a follow-up good crop protection strategy in place.

"The key risk is that growers will not monitor for pests, rather they will go to calendar spraying with hard chemicals," said Alan. "This means that they will potentially have problems with secondary pests such as thrips, mites, scale and feltid coccid because of the impact of these chemicals, which will decimate beneficial insect populations."

Alan's strong recommendation is for growers to "stay on top of crop protection", noting that it is important to continue to monitor and work out strategies with a crop protection advisor. He suggested that growers look at target spraying rather than blanket orchard applications of chemistry.

While macadamia seed weevil is not yet an issue in the Gympie area, leaving unmulched crop on the ground is a concern and growers should monitor for the occurrence of this pest.

As far as nutrition is concerned, Alan identified that this is an area where growers need to be cautious when considering reducing inputs, especially if orchard organic matter levels are not high and soil health is poor.

"While nutrition is often the area growers look at cutting back, particularly with the current high cost of fertiliser, this is the last input I would suggest you reduce unless you do this strategically in conjunction with an experienced nutrition adviser," he said.

This is particularly the case as macadamia is a perennial crop; what you do now has longer term consequences, particularly in older orchards with poorer nutrition and soil health.

Alan's **top tip** for keeping trees healthy is to maintain organic matter inputs as this is the key to soil and tree health and production.

Nambucca

Bob Maier identified that in the Nambucca region macadamia nut borer has been more active again and that insufficient control from Trichogramma wasp releases has been reported at a number of sites. Levels of fruitspotting bug damage have also been reported by growers in the region.

Prolonged wet conditions during flowering in 2022, mainly in late opening varieties like A4, have resulted in ongoing out-of-season flowering which acts as an attractant for FSB. When the sudden downturn in gate prices for nut hit, some growers opted not to do ongoing drop-sheet work to monitor for FSB pressure and some thin-shelled A4 blocks were targeted by late FSB activity. Monitoring flowers now for macadamia lace bug and flower caterpillar should be underway as well as doing a risk assessment for disease pressure.

Like Alan, Bob strongly recommended that growers keep monitoring regularly for pest activity.

"This is the best way to stay informed about actual pest and disease pressure in real-time," he said.

At a recent presentation, benchmark growers were shown how cost effective maintaining IPM inspections is, especially now that processors have increased penalties on reject levels. Bob contrasted this with the risks that growers are taking in stopping IPM inspections as well as wasp releases this season.

With the current financial pressures on growers, Bob suspects one response will be a higher uptake of drop-sheet work to target FSB hot spots, and he will be looking at monitoring hedges closely this season as an indicator of pest activity.

Benchmark growers in the Nambucca region are continuing with soil and leaf sampling to highlight any key nutrient target areas. With returns much lower this season, Bob noted that some growers who had previously been applying luxury levels of organic matter are now reducing programs to maintenance levels in the short term.

"Provided organic matter can be sourced at reasonable cost, growers see this option as returning better, longer term value for money than expensive shorter lifespan, chemical-based fertiliser," he added.

For growers looking to adjusting their orchard strategies, Bob suggests that this is a good time to do canopy management to let the light back into dark, overcrowded blocks, thereby reducing pest and disease pressure and allowing ground covers to come back.

Bob's **top tip** for crop protection and nutrition this season is for growers to keep up with a regular monitoring program.

quality

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Searching for systems in macadamia orchard nutrient management

Daowei Sun and **Jeremy Bright,** NSW DPI

Working with the NSW Clean Coastal Catchments (CCC) project team, Department of Primary Industries (DPI) researcher, Dr Daowei Sun, aided by DPI Macadamia Development Officer Jeremy Bright, has taken a novel approach to understanding the fertiliser decisions made by macadamia growers in NSW coastal areas. This approach uses a systems analysis of the macadamia production system to identify and understand the drivers and barriers that macadamia growers may face in changing the way they perceive and manage nutrients and erosion on their farms. In this article, Daowei and Jeremy explain what they have done so far in the project.

The background to the CCC project is the fact that agriculture is one of many industries acknowledged as contributing to nutrient run-off, which can create significant environmental issues as a result of excess nutrient and sediment accumulate in creeks, rivers and estuaries. The project, which is funded by the Marine Estate Management Strategy 2018-2028, is seeking to address this issue proactively by trying to fill some of the knowledge gaps to help NSW farmers better manage fertilisers on-farm.

As part of the systems analysis, we asked growers and other key stakeholders in NSW growing areas to describe their practices in farming and nutrient management, and what they consider to be important barriers and knowledge gaps that limit their ability to continually improve orchard management.

Understanding fertiliser decision making

Ideally in a rainfed macadamia production system, if fertiliser can be applied in the right amount, in the right place and at the right time to match the tree's phenological stage, rainfall will wash fertiliser through the soil to the active root zone of the trees where nutrients will support maximum production. Unfortunately, conditions are not always ideal and opportunistic applications of nutrients timed for rainfall events often lead to excess nutrients being washed off the farm and into creeks and rivers.

Traditional research has long focused on understanding the movement of nutrients from the crop and the farm



Excess fertiliser applications in orchards can lead to toxic nutrient loads accumulating in nearby creeks, rivers and estuaries. Photo: NSW DPI Clean Coastal Catchments.

landscape and into the broader environment. While research is important, it is the growers and key industry stakeholders who can make the biggest difference in tackling the problem of nutrient run off, through specific practice changes.

It is important to understand that while most growers know what best practice is, the costs of implementation can be significant and can come at a trade-off or significant risk. Research in the right areas will help to fill knowledge gaps and reduce the associated risks of practice change.

This is an area where systems thinking can be valuable in helping to understand complex systems, and we have been applying it in the CCC project's work with the NSW macadamia industry to how fertiliser decisions are made.



Working out how much fertiliser to apply to a macadamia orchard is a complex calculation that needs to consider existing nutrients in the soil, potential nutrients added through composts, and the nutrient value removed when nuts are harvested. Photo: Jeremy Bright.

This research has allowed us to diagnose where further research should be undertaken, with the next step in the research identifying possible intervention strategies that will have the best chance of helping farmers improve their practices based on a systems analysis.

Model developed to answer key questions

The CCC systems thinking research is investigating three key questions:

- What are the decision making processes of growers involving their fertiliser use in northern NSW coastal regions?
- What are the drivers of growers decisions in fertiliser use?
- What are the intervention strategies that could help macadamia growers achieve desirable changes in fertiliser management?

The aim of the research is to achieve the following outcomes:

- Improved understanding of the decision-making process by horticultural growers in their fertiliser application
- Improved understanding of the key barriers and drivers for growers to adopt changes in land use practice
- Better, more reliable information for growers in intensive agricultural systems in coastal NSW to respond to risks and change and make more informed decisions about the management of nutrient and sediment runoff.

A systems model focusing on the macadamia orchard fertiliser decision process was developed. This model was based on data drawn from semi-structured interviews with seventeen key industry stakeholders in NSW including growers, consultants, a local government officer, a representative of macadamia industry body and fertiliser suppliers.

The interviews revealed that numerous factors influenced grower decisions about the rate and timing of fertiliser applications, including fertiliser prices and other incidental factors such as weather conditions, particularly drought or heavy rainfall.

Key finding

A key finding from the research relevant to growers in NSW coastal areas in particular was that some may be unintentionally over-fertilising crops, which could lead to nutrients washing off the macadamia orchard and into the broader environment. One of the critical drivers of over-fertilisation was that rates of fertiliser application typically recommended were above the ideal range of elemental nitrogen. Another was lack of knowledge about release rates of nitrogen, phosphorous and potassium from composts.

An issue in determining the best rate of fertiliser application based on nut nutrient removal values is a lack of understanding of how much of the nutrient is lost to the environment through volatilisation and leaching,



Applying organic matter or compost to enhance soil health is common practice across the macadamia industry, however on many orchards the nutrients contained in organic matter are not considered when calculating fertiliser requirements.. Photo: J. Bright

as well as how much nutrient taken up by the trees does not end up in the nut harvest and the contribution from other sources of nutrient such as compost applications. Each of these unknown factors contribute to potential overestimation of orchard fertiliser demand.

While composts are often applied to improve soil health, routine addition of compost can result in too much nitrogen being applied where the latent elemental nitrogen within the composting blend is not factored into nutrient input. Among the surveyed group of growers, amounts of compost applied varied from 20 to 50 t/ha annually. Composts are generally made of wood chips and chicken and/or cow manures and contain low quantities of nitrogen, phosphorous and potassium. When added at high volumes, however, they may contribute significant additional amounts of these nutrients.

Lack of knowledge about nutrient release rates from compost. A key knowledge gap identified from the interviews and systems analysis was that the release rate of nitrogen, phosphorous and potassium from compost material is not well understood. Further research on nutrient values, nutrient release rates and nutrient effects of composts will help growers better meet, without exceeding, their orchard nutrient requirements and move toward best practice "right amount and right time" fertiliser application.

Quantifying these nutrient release rate values from composts is essential to provide consultants and fertiliser resellers with reliable information that will enable the nutrients from applied composts to be factored into fertiliser calculations and recommendations.

Improved understanding to help with better nutrient decisions

The systems thinking research has given the CCC team an enhanced understanding of the complexity of the fertiliser decision-making process. Key drivers that may

result in overfertilisation have been identified, such as the application of composts that supply additional nutrients that were not included in fertiliser calculations, and future research needs have been outlined and intervention strategies supported by data and logic have been mapped.

Intervention strategy recommendations from the systems analysis also strongly supports the continuation of integrated orchard management (IOM), a strategy considered key to effectively addressing erosion and nutrient management in macadamia orchards. The IOM approach focuses on ground cover, drainage and canopy management to improve orchard productivity and resilience. The guide can be downloaded from the DPI website, https://www.dpi.nsw.gov.au/agriculture/horticulture/nuts/growing-guides/macadamia-integrated-orchard-management.

Meanwhile, the CCC project is continuing to work with growers and other key macadamia industry stakeholders to facilitate practice change in nutrient management. The aim is to support farm production and profitability while also improving water quality in coastal waterways and helping to protect the reputation of the macadamia industry with regard to environmental impacts.

Information

For information go to the Clean Coastal Catchments website https://www.dpi.nsw.gov.au/agriculture/water/clean-coastal-catchments or scan the barcode.

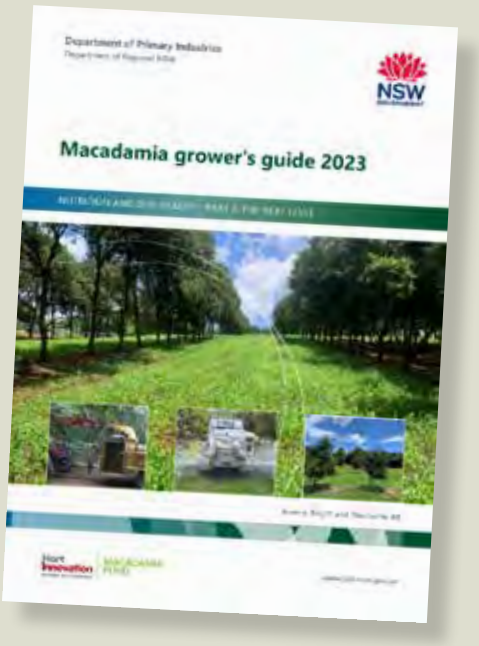
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NSW DPI releases new nutrition and soil health module

NSW DPI has released the next module to be added to its *Macadamia Grower's Guide*. The module, Nutrition and soil health – Part 2: the next level, is a companion to Nutrition and soil health – Part 1: the foundations, which was released earlier this year and made available in print and online formats.

Part 2: the next level builds on the foundational practices described in Part 1 and includes information on:

- Refining foundation practices. Growers can further enhance their practices based on the knowledge gained from the foundational approach. Finetuning these practices ensures more efficient and effective management of nutrition and soil health.
- Making more use of monitoring information. Regular monitoring of soil and tree health provides valuable data. In Part 2, growers are encouraged to make even more use of this information to make informed decisions about their orchard management.
- Investigating the causes of nutrient disorders in trees. It is essential to investigate the root causes behind nutrient disorders or deficiencies that affect trees. Understanding these underlying issues helps in implementing targeted solutions.
- Positively managing nutrition and soil health. Part 2 emphasises a proactive approach to nutrition and soil health management. By staying ahead of potential problems and continuously optimising practices, growers can achieve better outcomes.
- Increasing fertility and productivity over the life of the orchard. The ultimate goal is to maintain and improve fertility and productivity throughout the orchard's lifespan. This involves consistent care and application of best practices based on monitoring and data-driven decisions.



Part 1: the foundations provides a nutrition and soil health framework for orchards and focuses on: correcting pH, building up organic matter, implementing effective drainage and replacing nutrients and correcting imbalances.

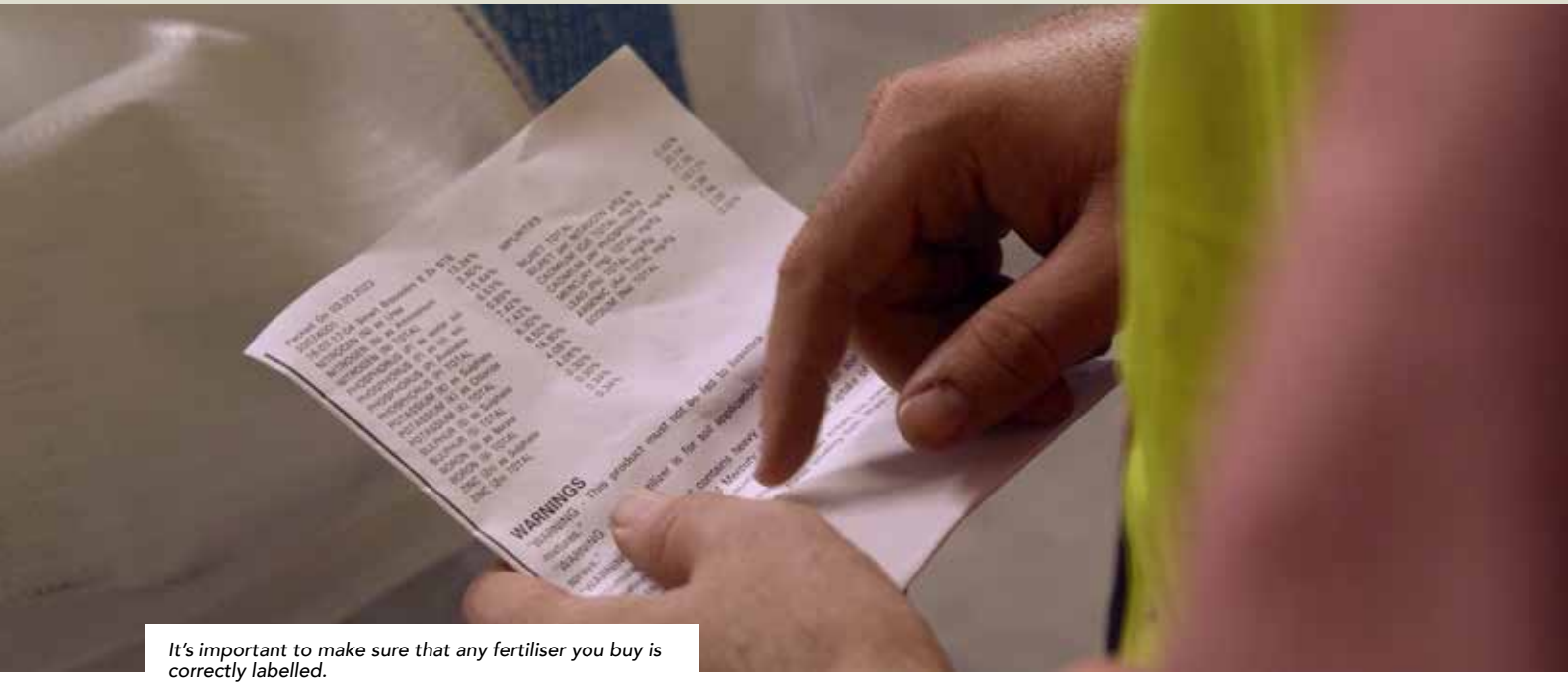
To download Part 2, go to NSW DPI website https://www.dpi.nsw.gov.au/agriculture/horticulture/nuts/macadamia-growers-guide/macadamia-growers-guide-nutrition-and-soil-health-part-2-the-next-level.

Acknowledgment. This project has been funded by Hort Innovation using the macadamia research and development levy and contributions from the Australian Government and co-investment from NSW DPI

Are your fertilisers labelled correctly?

As a result of a number of incorrectly labelled fertiliser products being imported recently, a national Fertiliser Labelling Awareness campaign has been launched to help growers and advisors identify when a label does not meet local requirements. The campaign, which has been developed by Fertilizer Australia, the fertiliser industry's peak body, highlights:

- why correct fertiliser labelling is important
- how to recognise whether a fertiliser is correctly labelled
- the potential consequences of buying products that are not accurately labelled.



It's important to make sure that any fertiliser you buy is correctly labelled.

Supply chain restrictions resulting from COVID and Russia's invasion of Ukraine have led to several examples of products being sourced from markets Australia is less familiar with and which are unfamiliar with Australia's labelling requirements. Several of these consignments, primarily sold into the horticultural industry, had no labels at all. Some didn't even have correct safety data sheets or certificates of analysis.

Macadamia growers, particularly those looking for cheaper products in a price-sensitive environment, are potential victims of products whose contents are not accurately disclosed. And while the grower might save on the purchase price, profitability and tree health could be affected by not applying the right nutrients at the right rate or time because that crucial information is missing.

What is the potential impact of incorrect labelling?

Fertiliser labels contain vital information to help agronomists and farmers decide about nutrients for optimal crop yield and quality while caring for the environment and food safety.

While most fertilisers are not classified as dangerous goods, some products are scheduled poisons or hazardous substances. Labels provide this information so people transporting and handling the products stay safe.

There have been cases where the quality of imported fertiliser has not matched the certificate of analysis provided by the supplier. In one case, cadmium levels far exceeded the maximum permissible concentration. In another, the "fertiliser" appeared to be simply soil. Usually, these issues are managed by the manufacturer's and importer's QA systems, including sampling and product analysis.

Fertiliser labels also aid traceability, a requirement of quality assurance schemes such as Freshcare.

What should be on the fertiliser label?

Agronomists and farmers use fertiliser labels to determine the best product to meet their needs. This is called "the four Rs":

- right nutrient or product
- right rate
- right application method
- right timing.

That's why fertiliser labels must be descriptive and include all relevant information, such as the plant nutrients contained in a fertiliser, the form of the nutrient and its concentration. Nutrients may only be included on the label if they meet or exceed the concentrations in the tables below.

Nutrient	Minimum (% w/w)
N, P, K, S, Ca, Mg, Si	0.5
Fe	0.1
Cu, Mn, Zn	0.05
B	0.02
Mo, Co, Se	0.001

Table 1. Minimum nutrient concentrations in solid fertiliser.

Nutrient	Minimum (% w/w)
N, P, K, S, Si	0.1
Ca, Mg	0.1
B, Cu, Fe, Mn, Zn,	0.005
Co, Se, Mo	0.001

Table 2. Minimum nutrient concentrations in liquid fertilisers and soluble solids intended only for use in solution.

Fertilisers can also contain contaminants that can accumulate in the food chain. Inorganic fertiliser labels should provide warnings on impurities when they exceed a "trigger concentration." These contaminants include cadmium, lead, mercury, fluorine and biuret. Maximum permissible concentrations (MPCs) have been set for impurities of concern. It is often impossible to know if poorly labelled products exceed MPCs without a chemical analysis of the product.

What can you do?

Fertilizer Australia members must have QA systems and labelling that meet the National Code of Practice for Fertilizer Description and Labelling. This means you can buy fertiliser products from Fertilizer Australia members with confidence. You can check our members' list here https://bit.ly/41P4qxB and you can find the National Code of Practice for Fertilizer Description and Labelling at https://bit.ly/3zfFHWk.

Acknowledgment. This article was provided by Fertilizer Australia.

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LRS 4002 TWINSAW
Smooth Cut Of Branches
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Limb ø: 16cm (6.3")



LRS 4802 TWINSAW
Smooth Cut Of Branches
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Limb ø: 21cm (8.3")

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Manure wood chip and urea: both sources of nitrogen but not the same

With many growers looking to rationalise costs this season, one item in the budget being looked at closely is nutrition. An important element in any nutrition program is nitrogen, which can be sourced in different forms such as through synthetic fertiliser (e.g. urea) and as manure and organic material. When deciding what form of nitrogen to buy, it is important to make sure you understand the benefits of each and the fact that they are not all the same.

The table below highlights the key differences between using urea compared to a manure wood chip blend as a source of nitrogen.

Synthetic urea fertiliser (46% N)	Manure wood chip blend (1.68% N)
	
$900/t ($1.96/unit of N)* $1050/t including lime (2.28/kg N)*	$35.00/t ($1.75/unit of N)*
Has a long-term acidifying effect on pH (requires 2 to 3 kg lime to neutralise every kg of N)	Has a long-term stabilising effect on pH
Provides only nitrogen, no other nutrients	Provides nitrogen, phosphorous, potassium, calcium, micronutrients and crucially carbon
Uniform product with instructions	Less uniform product with no instructions
Nutrient release rates are quick	Nutrient release rates are variable
Granular - relies on rain for incorporation	Incorporated through biological processes
Feeds just plants	Feeds plants, soil and microorganisms
Adds no organic material and can deplete soil carbon	Adds organic material and improves soil carbon
No biological or physical soil benefits	Substantial biological and physical soil benefits
Does nothing to improve erosion or compaction	Reduces compaction and improves waterholding capacity
Sterile and contains no pathogens	Can bring a range of pathogens into the orchard
Easier to store and potentially easier to apply	Generally harder to store and apply
Does nothing to improve IOM	Improves orchard floor condition and harvestability

Table. *A comparison of the properties of urea and manure wood chip blend. * Figures current as of August 2023.*

Know what you are buying

One advantage of synthetic fertilisers is that they must be correctly labelled and have instructions about application and safe handling.

This is not the case with buying organic matter. This means it is important to spend the time and do your homework. If you are buying compost, mulch or a soil conditioner, there is an Australian standard (AS4454) for the supply of these products, and you can request details of the physical, chemical and biological properties from your supplier. At a minimum you should ask for:

- material origin and treatments applied
- ingredients, including any manures in the blend
- pH, C:N ratio and EC.

Keep records

Whichever source of nitrogen you decide on, it is important you understand the materials being added to the orchard and the nutrients they release. Always keep good records of the product and when and how it was applied.

New Reef Regulations have come into effect in Queensland requiring record keeping of orchard inputs. Similar catchment management regulations are likely in NSW.

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Zunkers embrace the learning journey

Growers: The Zunker family (Darren and wife Linda, son Ethan and his wife Emily), Bundaberg

Orchards: Three coastal orchards, one near the Hummock and two at Riverview

Size: 35,000 trees, planted from 2017 to 2022

Cultivars: A203, 741, A4, A16, Daddow and MCT1 on 9 x 4 m spacings

Soil type: Ferrosol, sandy and forest loams

Irrigation: Trickle irrigation being converted to under-tree sprinklers



The appearance of a raceme in July in some of their six-year-old trees has put Bundaberg's Zunker family on alert as warm weather may prompt an earlier than expected start to the next season. Far from being alarmed, the early flowering provides another learning opportunity for the family, which diversified into macadamias from its well-established Bundaberg Gold brand of sweet potatoes about five years ago.

"We're proud to be in the macadamia industry. There's a good future and we're learning every week," Darren Zunker said.

The Zunker family – Darren and wife Linda, their son Ethan and his wife Emily, plus their two sons Louis, 3, and Henry, 2 – have 35,000 trees in the ground split between three coastal farms in the Bundaberg growing region, one near the Hummock and the other two at Riverview. The orchards have been planted in stages, so trees range from one to six years old. They harvested their first crop two years ago, with hand harvesting bringing in about 2 t. Last year that jumped to 10 t, while this year they hit the 45 t mark.

When all trees are mature, the three orchards should produce a total of about 500 t.

Labour costs prompt diversification

The rising cost of labour was one of the determining factors that prompted the family to diversify into macadamias. Some paddocks were converted from potatoes to nuts while the Riverview properties were bought specifically for orchard plantings.

The Zunkers looked to well-known industry identities such as Chris Searle, Simon Andreoli, Rohan Orford and Daryl Wake for advice in establishing their orchards.

"We are very reliant on listening to what everyone says," Linda said.

From the ground up

Darren and Linda have been longtime advocates for soil health with their previous farming experience teaching them that good crops start from the ground up. This is applied to each of their macadamia orchards, which are soil and sap tested.

Emily said Darren and Linda have always been "super passionate" about soil health. This has been important as soils in their orchards range from volcanic soils (ferrosols) to sandy loams. While farming on the volcanic soils wasn't a big transition as the family has grown vegetables in similar soils, the sandy and forest loams have prompted some changes in thinking.

According to Darren, who was quoting his father-in-law, sandy soil is a bit different because it's only there "to hold the plant up", so it's important to feed it. Despite this, he said a markedly better nut is produced on the red soil, something that comes through in the sorting shed.

Another important part of their orchard floor and soil management is mulching, and trees have been mulched since they were young to help retain water and nutrients. Compost has also been purchased and spread to increase soil biology.

Soil moisture status is important in managing the orchard and determining when to irrigate. Soil moisture probes, weather stations and Phytech trunk-probes provide a continual flow of information to keep on top of tree health. This is critical given the varying way the different soils handle and hold water. They have also adapted by scheduling short irrigation cycles more often to fill up moisture profiles, a practice that helps comply with their Reef Certification as well.

Water is supplied from on-farm storage and underground sources with run-off caught in catchment dams and re-used.

Above-ground trickle irrigation was used to get trees established but that is being converted to under-tree sprinklers in all the orchards.

Vigilance important

The sight of flowers on the trees in July prompted the Zunkers to be proactive with their management. Agronomist advice suggests if the cool weather remains, the flowers will stay dormant, but if things heat up, they will continue to develop. After a lighter yield last year, there could be the potential for the trees to bounce back with extra vigour.

"So whether these trees are going to retaliate and go hard again, we don't know," Darren said. "But you want to be prepared. I just want to make sure we tick the boxes because there is no 'give' on these things."

A surprise hit of macadamia flower caterpillar last year saw them lose about 25% of their flowers. This has heightened their vigilance for any signs this year, with a residual spray ready to be applied when a quarter of the orchards are in flower to help sustain them through the remaining season.

The family is looking to use more beneficial insects in the coming years having found good success already with introduced pollination flies.

Menacing macadamia macropods

It's not nut borer, feral pigs or even the flower caterpillar which has been the biggest pest headache, rather it is kangaroos, something that other growers in the area have found. According to Linda, they are full of itch, and are rubbing themselves on the trees and destroying them. To date kangaroos have damaged more than 100 trees and have added to the problems they cause by destroying irrigation lines around the tree.

Other environmental influences have tested them too, particularly coastal wind. While it has the advantage of providing a cooling effect, the downside is that trees have to be pruned more heavily on the breeze-facing side to spread the load.

An eye on prices

Like most growers, this year's wholesale macadamia price drop (sitting at about $1.70/kg @33% KR at the time of writing) made the Zunkers sit up.

"Everyone has had a bit of a smack behind the ear this year, but I think we've got a good future ahead of us," Linda said. "We knew the money wasn't going to stay there like it was. I don't think you will ever see that money again."

She agrees that it is an issue that the price has come as low as it has but says it does open the doors for more consumers to enter the wholesale industry buying at lower prices and increase consumption.

"Processors are going to use them, and people are going to demand them, and at the end of the day, I think it's going to be beneficial," she said.

Looking ahead

Even with increasing nut yields, there are no plans to get out of sweet potatoes despite the juggling act of producing two different products.

"Things are going to get a little bit more hectic next year when we've got more nuts to sort," Linda said.

Decisions will have to be made as to whether they engage another company to do the processing or invest in upgrading their sorting equipment to keep it in-house.

"That's something we've got to think about and work out as we go along," Linda said.

Whatever direction they take, the Zunkers will no doubt embrace the opportunity to learn, with ideas blossoming like macadamia flowers in July.



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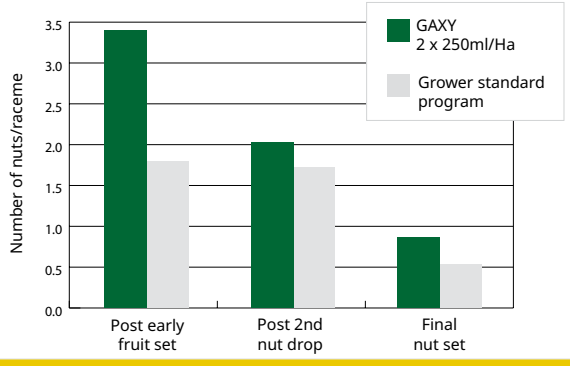
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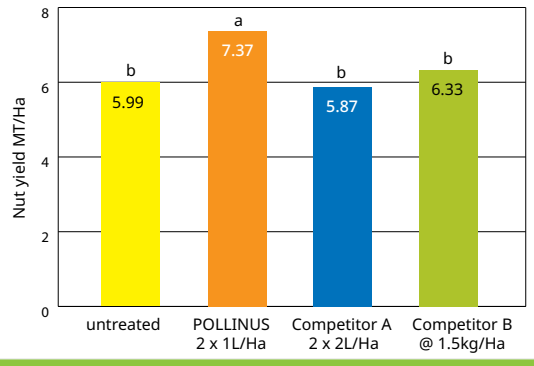
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Inter-row cover crop effects on soil health in macadamia plantations

Terry Rose, Agronomist and **Mick Rose,** Soil Biologist, Southern Cross University

While sowing annual crops in the inter row of macadamias is gaining interest to provide habitat and food for beneficial insects as a part of integrated pest management programs, many growers are keen to know if cover crops also improve soil health.

Inter-row cover crops are often reported to improve soil health in perennial tree or vine crops, but they are typically compared to the district practice, which in many cases is a bare fallow. In most macadamia plantations that have enough light reaching the canopy floor to grow a cover crop, perennial ground covers are typically already in place. The question is whether over-sowing perennial ground covers with annual species (i.e. a cover crop) provides additional soil health benefits. In this article, Terry and Mick describe a trial designed to help answer this question.

Cover crops on trial

A field trial was established at David and Sharon Grellman's property near Alstonville in 2021 to investigate the impacts of mixed species cover crops on soil health. A winter cover crop was sown 24 June 2021 and mulched down 10 November, and a summer cover crop was sown 11 November 2021 and mulched down 10 February 2022.

The control treatment for each cover crop was perennial ground covers that were left unmown. Biomass production of cover crops and unmown perennial ground covers was assessed in each plot before mulching by taken two quadrat cuts from each plot. Cuts were also taken from control (non-cover crop) plots at the same time. Soil samples (from 0 to 10 cm deep) were taken to assess a range of soil biological indicators, including labile carbon (C), soil protein, microbial biomass and microbial activity in control and cover cropped plots for the duration of the trial. Seeding rates for the cover crops are shown in Table 1.

The winter cover crop was sown after nut harvest after the rows were mowed. Ideally, an autumn-sown cover crop that provides food (flowers) in early-mid winter would be grown to build beneficial insect populations. However, on David and Sharon's 9 m row spacing, even an inter-row cover crop impedes nut harvest, so the first cover crop was sown in winter. In other orchards with different row spacing or canopy management, autumn-sown cover crops may be feasible.

Cover crop species	Seeding rate (kg/ha)
Winter mix	
Sunflower	4
Radish	0.3
Buckwheat	0.6
Field pea	8
Rye corn (cereale rye)	5
Vetch	0.5
Mustard	0.2
Canola	0.4
Chicory	0.3
Summer mix	
Sunflower	0.6
Millet	3
Cowpea	2
Radish	1.2
Buckwheat	4

Table 1. Species and seeding rates of winter and summer cover crops.





Inter row in the orchard trial area after nut harvest before sowing the winter cover crop (left) and summer cover crop before termination (right).

Soil protein content increases

Both winter and summer cover crops produced a similar amount of biomass to the unmown perennial groundcover control treatments (see Table 2).

There was little difference between the soil indicators and functions between the two treatments, probably because plant growth (food for soil microbes) was similar across both treatments. The exception was significantly higher soil protein content in the cover crop plots during the winter cover crop growing period (see figure). This could be related to the release of more proteins from N-fixing legume roots in the cover crop mix.

Soil proteins are important because they have been shown to act as a 'biological glue', improving soil aggregation and water infiltration. The inclusion of legumes for providing extra biological N and potentially improving soil structure could therefore be an additional benefit of over-sowing with specific inter-row cover crops.

The bottom line

Overall, the cover crops did not provide any consistent measurable soil health benefits over the 12-month period. The most likely reason is that they did not create any more biomass than the unmown control treatment, and therefore did not add any additional carbon inputs into soil to feed soil microbes. However, the cover crops likely provided additional insect habitat, and it is possible that changes in soil biology may occur over a longer period. While cover crops may provide some additional benefits, the key to good soil health appears to be maintaining perennial vegetation in the inter row to feed soil microbes and prevent soil erosion.

	Control (kg/ha)	Cover crop (kg/ha)
Winter cover crop	919 ± 170	869 ± 15
Summer cover crop	3562 ± 635	3268 ± 171

Table 2. *Biomass production (mean ± standard error) at termination of cover crops in cover crop and control plots.*

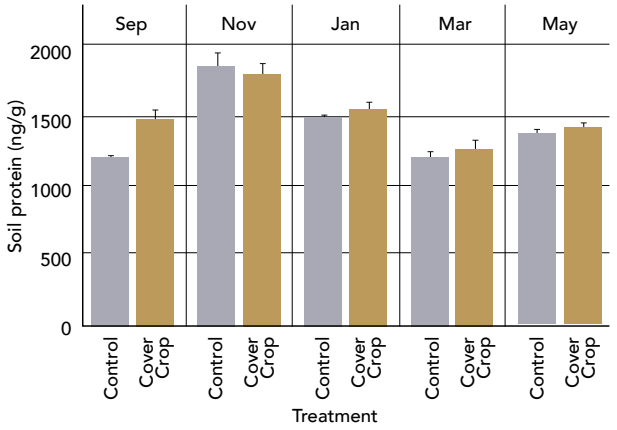


Figure. *Soil protein measured in control vs cover crop plots. The red star indicates a statistically significant (P<0.05) effect of the cover crop.*

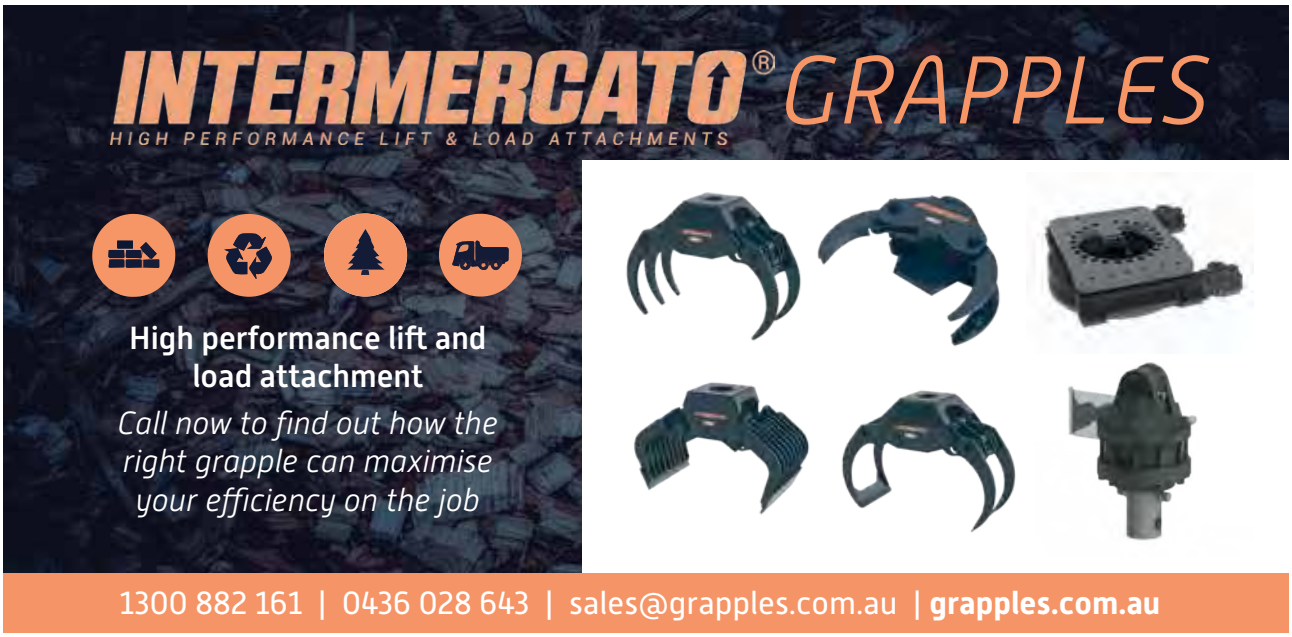
David and Sharon Grellman

David and Sharon observed the following benefits and challenges of growing cover crops in the orchard.

Key benefits: "Cover crops don't require a large time investment to sow and maintain, and with 9 m row spacing, the area under the trees can be mown while leaving vegetation in the inter row."

Key challenges: "Ideally, a cover crop would be planted in autumn to flower at the same time as macadamias are flowering but maintaining a cover crop in the inter row during harvesting is problematic, so at present winter cover crops are sown after harvest and a spring-summer cover crop is sown in November."

"Limb removal operations impede cover crop growth, so no cover crops are sown in areas of the plantation earmarked for limb removal that season."



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To hedge or not to hedge?

Dr Dan Manson, Rural Funds Management Limited **M:** 0488 552 644 **E:** dmanson@ruralfunds.com.au

A common approach to manipulating young macadamia trees that has been implemented in the Bundaberg region over the last few years is the use of mechanical hedging machines to repetitively hedge young macadamia trees. This practice has not emerged from the results of trials from industry research bodies, rather has been introduced by larger growers as a pragmatic way to manage macadamia tree structure at scale without the requirement for extensive manual pruning. While the reasons for doing this vary from grower to grower, there are a number of common themes, including producing earlier flowering and yields, reducing the risk of wind-throw by growing a larger and stronger root system, reducing canopy size, and creating a shorter tree with a lower canopy position.

Without any research evidence to support the assumption that hedging does create a stronger root system, and given the fact that lower farm-gate prices have reduced the imperative to generate early yields, growers would be wise to consider alternatives to hedging, e.g. pruning trees to create a higher clear bole on the main single stem by removing low lateral branches.

In this article, Dan Manson looks at whether there is evidence to support the case for hedging young trees.

Reasons for hedging young trees

Earlier flowering and yields. While one of the reasons given for hedging young trees is to promote earlier flowering and yields, there is no public body of scientific evidence to show that it increases yields. To the contrary, a formal study of the difference in yield between the 'Bundaberg standard' hedging approach and the central leader pruning, conducted at the Bundaberg Department of Primary Industries trial site, showed no significant yield advantage from hedging in the first four years of growth.

The supposed evidence of early yields is anecdotal, and the common narrative is that repetitive disturbances to the crown architecture seem to bring flowering and yield on earlier in some cultivars. The economic motivation for pushing macadamias for early yields, regardless of the cost, has changed significantly with lower macadamia prices over the last couple of years. As a result, some of those who have incurred the significant cost of pushing fast early growth and hedging have been left out of pocket having not achieved the economic advantage that they expected from this high-risk strategy.



Hedging the tops of young trees stunts their growth and creates a very dense crown with high levels of self shading.

Growers who push orchards for early yields are often left with trees with significant structural issues that need to be corrected with extra orchard operations including selective limb removal or ongoing hedging. Anecdotal evidence suggests that high nitrogen inputs and repetitive hedging create orchards that often hit a productive wall as early as 10 or 11 years of age, at which time extra management costs are incurred to maintain faltering yields.

More resilient trees. Some growers claim that hedging produces a stronger root system, however, this seems to be unfounded. Measurements of trees in numerous macadamia industry trials have identified that repetitive hedging or pruning inevitably results in a tree that is smaller in all dimensions compared to the unhedged control.

If the aim of hedging is building a stronger root system for a given sized tree, it is highly likely that this will not occur, rather there will be potential for generating the opposite effect. Being subtropical rainforest trees, macadamia species are highly responsive to tree-fall gaps in the forest, which it senses through crown breakage and an increase in light levels. When the crown of the tree is disturbed, such as from branch pruning or hedging, the tree instantly redirects resources that were allocated to root growth up to the crown to replace the lost branches/canopy to quickly take advantage of the apparent tree-fall gap created in the forest.

The result of this intervention is a potentially unbalanced tree that has a lower than desired root-shoot ratio. The risk is that it will become top heavy in the short term and yield less in the medium and longer term than a tree that is left unhedged. Pushing fast early growth and repetitive hedging swing the balance to create a more vigorous tree. While a larger, more vigorous tree could achieve slightly higher yields in the early years in some cultivars, in the long term it will tend to be lower yielding and more expensive to manage.

Vigour management. Macadamia yields have been shown to be highly responsive to vigour level, with reduced yields often observed in macadamia trees which have excess vigour. Unfortunately, we can't reduce vigour through common mechanical hedging approaches as this tends to only exacerbate already high levels of vigour. The only readily available, easily applicable tools in the kit to reduce vigour are reducing

the stem water potential by changing the irrigation schedule to maintain lower soil moisture levels, or lowering tree nitrogen status through a consistent reduction in soil nitrogen levels.

Manual pruning techniques designed to reduce vigour do exist but require more intensive management and an understanding of the vigour-altering effects of different levels of selective limb removal.

High yielding tree architecture. No one would argue that the key to a high yielding macadamia tree is homogeneous nut production throughout the entire crown volume. This being the case, the instant we hedge any part of the macadamia crown we will potentially ruin stem and branch architecture and prevent those trees from ever being very high yielding trees through their 55-year+ potential lifespan.

Even without pruning or hedging, over-vigorous macadamia trees will shade out the internal part of their crown, which will quickly turn into a dead centre, and the only yielding part of the crown will be the external, light-exposed branches. Production from trees whose internal crowns are dead or non-productive rarely exceeds 3 to 4 t/ha NIS in the longer term, and these trees will require expensive and repetitive selective limb removal to maintain these lower yields.

Many newer growers have pushed trees hard to achieve early yields in the last few years of high NIS prices, applying repetitive top hedging to invigorate sensitive cultivars (including A4 and A203) in the first few years of growth. Once these especially sensitive cultivars reached 4 or 5 years of age, growers had to consider expensive selective limb removal programs to let light back into what had become unproductive crown centres.

There is a growing realisation, especially in the context of lower nut prices, that if trees were not top hedged, they might now be higher yielding. A non-hedged tree would have more homogenous entire-crown light interception without the non-bearing, dead-centre issues and would not have incurred the extra expense of more irrigation, more fertiliser, hedging rounds and the future cost of selective limb removal.

All the desired architectural and early yield outcomes can be much better achieved through careful management of vigour through the primary controls of water and nitrogen management, using selective pruning and limb removal as a last resort.

To manage canopy size. A common aim in hedging young trees is to make a small, compact and dense canopy that is as low as possible to the ground to facilitate spraying and other management practices.

A study published by McFayden *et al*. in 2004 revealed that macadamias do not suffer from reduced yields as a result of crowded canopies to the extent observed in many other tree crops. The study showed that, in general, the larger the canopy, the higher the yields in macadamia orchards. This finding highlights the fact that reducing canopy size for ease of machinery access or spray coverage will often reduce potential yields before any real canopy-crowding effects reduce yields, something that has been shown to hold true for even very large canopy sizes to an upper study limit of 45,000 m^3/ha.

This implies that hedging to reduce canopy size in itself will have a negative effect on potential yield. If the focus instead is on calibrating and adapting spraying equipment to achieve adequate coverage in as large a canopy as possible, we should be able to improve the overall economics of macadamia orchards. An orchard with a higher and less dense canopy that allows machinery access and easy spray penetration will minimise the requirement for hedging and will logically be higher yielding than an orchard where hedging has forced a denser canopy with excess lateral growth that restricts machinery access and spray penetration.

In essence, we should be designing our spray equipment to deal with canopies of any size and position (large and high) rather than hedging to create a smaller canopy in a lower position just to suit our spray equipment.

Is hedging best practice?

Growing high-yielding macadamia orchards does not mean simply pushing trees to grow as fast as possible and then repeatedly hedging them to check growth and produce dense low canopies. There is a clear and growing body of evidence supporting the fact that, like growing apples, there is an optimum vigour level that is only attained only through a balanced approach.

The managers of the highest yielding macadamia orchards are all extremely aware of this and use relatively low, often cultivar-specific, nitrogen applications (from 50 to 70 kg/ha/year) tailored to check tree growth and vigour and to maximise yields. It is understood that there may be some circumstances when mechanical pruning or hedging is needed to fix up extreme issues where there is no other solution. However, it should always be left as a the very last resort after all else has failed, and growers and managers should be able to foresee, navigate and avoid these extreme situations before the only option left is to reach for the rotating mechanical knife.

Rather than hedging the tops of young trees to encourage greater vigour, an alternative pruning approach, described as follows, is best practice management. Its focus is on removing lower branches back flush to the main stem (in multiple steps) to achieve a high clear bole to at least 1 m above ground level. This will allow easy access for machinery, including for harvesting, and for irrigation droppers to be fixed so that irrigation lines can be pushed clear if or when trees need to be mechanically shaken.

A clear bole-pruning approach, which is common in forestry (see figure), creates the opposite physiological effect of top hedging and involves pruning trees flush to the main stem with the intent of reducing excess vigour in in the early years by reducing low lateral branching and encouraging vertical growth.

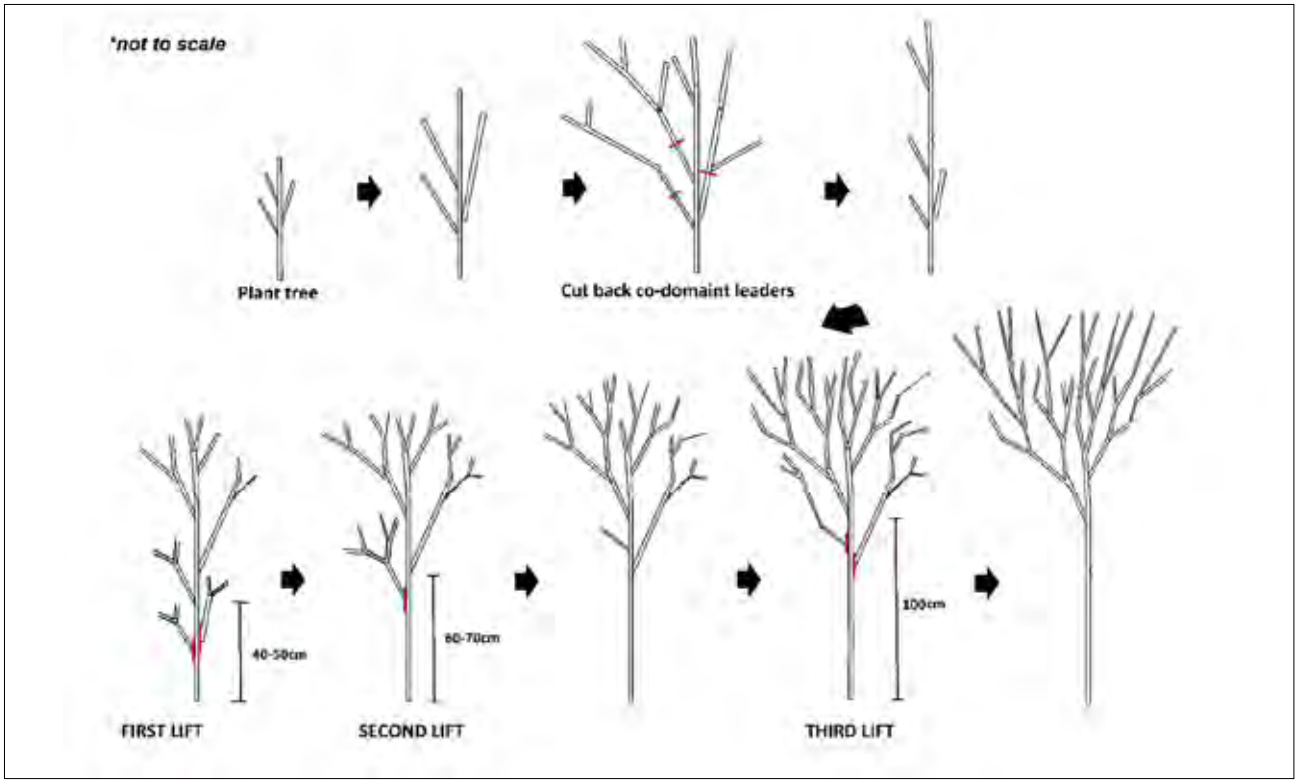


Figure. A pruning alternative to top hedging trees which focuses on attaining a clear bole (single stem) up to a height of 1 m in several stages. The step of managing co-dominant leaders back to to be subdominant (prune back by 1/3 to 2/3 depending on cultivar) in a step timed before finallly pruning branches flush to the main stem is aimed at lowering the centre of force of any prevailing high winds to reduce the risk of trees being blown over, developing a lean or becoming bent in the direction of prevailing winds whilst they are young and supple. A metric of never pruning lower branches flush with the main stem higher than one-third of the total height of the tree will reduce the risk of the trees becoming top heavy which can occur if the centre of wind force is in the top of a lollipop shaped tree.

Towards better tree structure metrics

As an industry we need to generate better defined tree architectural goals and best bet metrics for optimum stem growth rates and leaf nitrogen levels to guide us towards our best management practice targets.

One such metric we can generate on the back of an envelope is an evenly distributed 17 nuts/m^3 in 35,000 m^3/ha of canopy at maturity to deliver 6 t/ha NIS (assuming 100 nuts/kg).



An unhedged tree with an open canopy has an even light distribution throughout the crown and balanced branch architecture which can set the tree up for a potentially high yielding life. A high, clear bole, which has been encouraged by timely pruning of low lateral branches, is evident. This allows easy installation of irrigation infrastructure and access for operational machinery including harvesters and tree shakers.

Another metric we can control is the ratio of vertical to lateral branches. A tree with excess vigour will tend to have a lot of large lateral branches that tend will impede machinery access and require ongoing side hedging which will create a non-productive 'wall of death' on the sides of the crowns. A higher yielding tree of lower vigour will tend to have fewer large lateral branches, reducing the need for side-hedging operations.

Growers should consider investing money previously allocated to regular hedging to tools that can help achieve optimum tree growth rates and architecture. We should be using tree nitrogen status management and deficit irrigation techniques to manipulate tree physiology to prevent the growth of overly dense canopies with too much lateral branching, driving tree architecture and root-shoot ratios in our favour.

More regular leaf nutrient testing and plant-based water status sensors will allow us to better manage nitrogen and water application rates to grow our trees with optimum vigour and structure. Achieving optimum tree vigour will allow orchards to obtain the highest yields possible while minimising input costs in what is now a commodity market.

Reference:

McFayden et al., 2004. The relationship between orchard crowding, light interception and productivity in macadamia. *Australian Journal of Agricultural Research*, 2004, 55, 1029-1038.



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Regenerative agriculture: why the buzz?

There has been a lot in the media lately about regenerative agriculture and agricultural and horticultural producers who have switched to this philosophy to manage their farms. We were interested to find out how macadamia growers who are adopting its principles are finding the transition, so we went to Southern Cross University in Lismore, which is running a Regenerative Agriculture Mentoring Program, which includes representatives from our industry.

The University's first 12-month program, which began in July last year and is supported by the NSW Government through its Environmental Trust, has just finished. SCU also runs a six-month mentoring program in eight regions in Northern NSW and Southern Queensland. This program is delivered by Southern Cross University's Regenerative Agriculture Alliance and Farming Together, with support from the Southern Queensland and Northern New South Wales (SQNNSW) Innovation Hub through the Department of Agriculture, Fisheries and Forestry (DAFF).

The aim of the programs is to support collaborative learning in a small group environment to better understand farming systems, while also providing regionally specific context. Mentees have direct access to mentors, and the wealth of experience they have in the local area. This program can help validate ideas, increase exposure to different networks, accelerate business productivity, lower costs and support farm scale sustainability.

Macadamia growers sign up

Five macadamia growers have participated in the 12-month program and in this article, they describe how they have tailored their approach to regenerative agriculture to their farms and what they have learnt in the process.

Ross Arnett, Lindendale, Northern Rivers

Ross Arnett has focused on establishing cover crops to build insect diversity and help improve soil health.

Ross started implementing regenerative agriculture practices on his 2000-tree orchard in 2010 and has focused on cover cropping, soil health and diversity to help restore his orchard's natural systems.



According to Ross, cover cropping drives the whole system on his farm. While his first motivation for establishing them was to build insect diversity, he has since come to understand the importance of plant diversity to soil health.

"What happens under the ground is so important. Multi-family plants work together, and you get fantastic soil biodiversity," he said.

Keeping the evolution going is one of Ross' key goals for the future. He will finetune the good work he's already doing, including his composting process, and look for new technologies. He is also thinking about using his drone licence to put out biologicals and micro-nutrients as a way of reducing soil compaction.

He is also analysing his use of inputs, like chicken litter, and is working with local suppliers to find bare seed for cover crops.

TOP TIP

Ross' top tip for growers thinking about transitioning to regenerative agriculture is to firstly develop a good understanding of it is and what it means to them.

"What is your philosophy, and where do you want to take it? Find your tribe and you will make real leaps forward," he said, adding that collaborating with lots of people and continuing to learn are important.

Miranda Liebmann, Rous, Northern Rivers

Miranda has been implementing regenerative agriculture principles on her 7000-tree orchard for about ten years. As a newcomer to farming, she knew that she and her husband, an accountant, would need guidance, something they initially found a bit of a struggle. They have had advice from across the spectrum and, according to Miranda, have "flip-flopped" between conventional and regenerative practices trying to find what works for them.

Miranda acknowledges the support of growers like Ross Arnett, who she and her husband have found has motivated them to keep on with applying regenerative agriculture principles.

Like Ross, Miranda has planted cover crops and said she enjoys seeing insects and predatory bugs in the orchard. Priorities for her are to take a holistic approach and to reduce human impact on their environment, and she has developed a number of goals to do this, as follows:

- keep reducing the use of chemicals
- introduce new technologies such as solar-powered machinery
- avoid soil compaction
- reduce costs and labour-intensive work
- rehabilite creek areas.

"It's important for us to plan and budget well," she said. "When we came into the industry prices were high, so we'd only known good times. But they've since fallen off a cliff and we need to be prepared for the ups and downs."

TOP TIP

Miranda's top tip is to remember that observation is critical: "Stand back and look at the whole landscape, then investigate the details," she said.

She also cautions that patience is essential as it can take a long time to see changes in the orchard.

Jamie and Jenette Williamson, Dunoon, Northern Rivers

Jamie and Jenette bought their 3000-tree orchard in 2017 and almost immediately began to look for ways of managing other than using a conventional approach. According to Jamie, the reason for this was that the farm was "lifeless" with bare soil so that when it rained erosion was a significant issue. He also wanted to learn how to "farm for the future" and said that this has been his inspiration in seeking out a regenerative pathway.

As a result of adopting regenerative practices, he has made a number of changes, including the following:

- pruning trees to 6 m to let more light into the orchard
- planting flowering cover crops such as brassicas, sunflowers and clovers, over spring and summer
- halving the amount of sprays applied so that now they are more targeted and not applied in a blanket fashion
- using MacTrix wasps to help manage insect pests such as nut borer.

His regenerative farming goals now include to:

- finish heavy pruning across the orchard
- achieve full ground cover
- build up organic matter
- plan the orchard out properly and remove some rows to allow for the planting of flowering shrubs, with the aim of having year-round insectaries
- introduce Anastatus wasps, which will target fruitspotting bugs
- make a bio-fertiliser
- discover more ways to have healthy trees without chemicals.





Before adopting regenerative agriculture principles, the Williamson's orchard had bare soil under the trees and in the inter rows. A change of approach and focusing on ground cover has brought about a big change in the orchard and dramatically decreased the risk of erosion.

TOP TIP

Like Ross, Jamie emphasised the importance of being informed and researching the potential of regenerative farming.

"When you are ready to implement a regenerative practice, trial it in a small area first," he said.

Jamie also says persistence pays off: "Last year was the first year we were able to get the beneficials in the ground, and in December, I was walking around the orchard, and it was unbelievable. It was humming with bees, butterflies, dragonflies and it was just alive. It was such a noticeable change."

Revell family, Rous, Northern Rivers

The Revell family orchard is run by Eleanor Williams along with her parents, Andrew and Kim Revell, and brother Jon. Eleanor said that their goal is to farm regeneratively while maintaining good production on the 10,000-tree orchard.

The transition to regenerative principles began almost five years ago and has not been without challenges. One of the most significant issues is that the orchard was already established when they took it over, which meant that the row spacings were already set, as well as the cultivars. At present they are going through a block-by-block process of removing some of the trees.

"We also had issues with the wet weather (in 2022), which meant we lost a lot of crop, and we couldn't harvest for a long time," she said.

As well, they lost all of their compost.

"We had been working really hard on improving the orchard floor. It's more important than ever for us to make good choices going forward," she said.

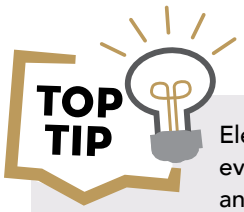
Changes to how they manage the orchard include the following:

- spraying twice a year instead of five times
- spending $60,000 on pruning trees to improve airflow, promote grass cover and regenerate trees
- planting insectaries down the middle of rows
- planting 30 varieties of native flowering shrubs.

Eleanor explained that an aim was to eventually have native flowering shrubs planted right across the farm. A long-term goal is to run some animals, but this will have



to wait until they can acquire more land because of the restrictions of having animals in the orchard before and during harvest. She also plans to regenerate vegetation along the creek line and continue improving their practices, moving away from systemic fertilisers and just using compost and bio-stimulants.



Eleanor's top tip is to question everything you do on the farm. As an example, she said that when they bought the farm, they used Roundup because that is what everyone in the industry was doing. They then asked themselves, 'why?'.

"Many growers spray their orchards five times a year, but no-one could tell us what would happen if we only sprayed twice. Don't do things just because everyone else is doing it," she said.

Acknowledgment. This article was compiled from information, including farmer case studies, provided by Southern Cross University. To find out more about regenerative agriculture and courses available, go to website www.farmingtogether.com.au or contact Simone Blom at email simone.blom@scu.edu.au

The seven principles of regenerative agriculture

The RAMP workbook introduces participants to The Seven Principles of Regenerative Agriculture identified by Lorraine and Ethan Gordon through their PhD research, which has been contextualised for the Australian environment.

1. **Be ecologically literate, think holistically and understand complex adaptive systems.** Appreciate how ecosystems behave in complex, adaptive and often unpredictable ways. Consider how the landscape is nested within, and interconnected with, smaller and larger ecological, social and economic systems.
2. **See your landscape as a community that you belong to and work with.** Your ecosystem is a community of species that you are part of. Do not try and control the members of this community but work alongside them.
3. **Acknowledge and consider diverse ways of working with landscapes**. There are many approaches to managing landscapes and be open to integrating them with your practice.
4. **Understand that human cultures are co-evolving with their environments.** People and landscapes are relational. We are co-evolving with our environments on a biological and cultural level.
5. **Engage with First Nations people.** Be active in reconciling the trauma of landscapes and displaced communities.
6. **Remain curious; seek transformative experiences and continuous learning.** Be comfortable in the ambiguity that comes with not having all the answers, be open to paradigm shifts and expanding your thinking.
7. **Engage in ecological renewal and make place-based decisions through monitoring.** Focus on and monitor landscape functions such as biodiversity, soil health, carbon sequestration, ground cover, water cycles, mineral cycles and energy flow.

Keeping a check on seasonal conditions with NSW DPI program

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The NSW Department of Primary Industries (NSW DPI) is responsible for regularly reporting on seasonal conditions and drought across NSW. One of the ways it does this is with the Seasonal Conditions Monitoring Program, which provides farmers and the community with the practical tools they need to prepare for, monitor and manage variability in seasonal conditions and drought in NSW.

How does the program monitor seasonal conditions?

Seasonal conditions are tracked through five different drought phases calculated from rainfall, soil moisture and plant growth information using the Enhanced Drought Information System (EDIS). Together these form the basis for the Combined Drought Indicator (CDI) which provides a more comprehensive indicator of drought conditions than relying on rainfall alone.

Recent improvements in the EDIS now allow NSW DPI to monitor conditions across NSW at a 1 km resolution. This provides a better understanding of and improved confidence about what is happening across the state.

How do I access maps and data?

Data and information from EDIS are stored in the Seasonal Conditions Information Portal (SCIP). This includes drought history charts and maps from the State Seasonal Update. These files can be searched and downloaded for your location in several formats directly to a computer.

Recently upgraded and re-released, NSW DPI Farm Tracker is an app for mobile devices that enables users to record seasonal conditions at their farm. It also has links to other Government resources that may be useful to help make business decisions, particularly during periods of extreme seasonal conditions like drought.

How do I stay up to date?

Sign up to the NSW State Seasonal Update (SSU) to receive monthly email updates. The SSU includes information on current seasonal conditions, the NSW CDI map, the climate outlook for the next three months and a detailed regional breakdown of conditions to aid decision-making with respect to seasonal conditions for your region.

To provide feedback on the Seasonal Conditions Monitoring Program, visit: https://www.dpi.nsw.gov.au/dpi/climate/seasonal-conditions-and-drought/have-your-say

For information on seasonal conditions and to sign up to receive the monthly State Seasonal Update, visit: https://www.dpi.nsw.gov.au/dpi/climate/seasonal-conditions-and-drought

Seasonal Conditions Monitoring Program

State Seasonal Update: Conditions and Outlook

Conditions and Outlook. Produced monthly. The SSU is the official point of reference of seasonal conditions across NSW for producers, government, stakeholders and the public.

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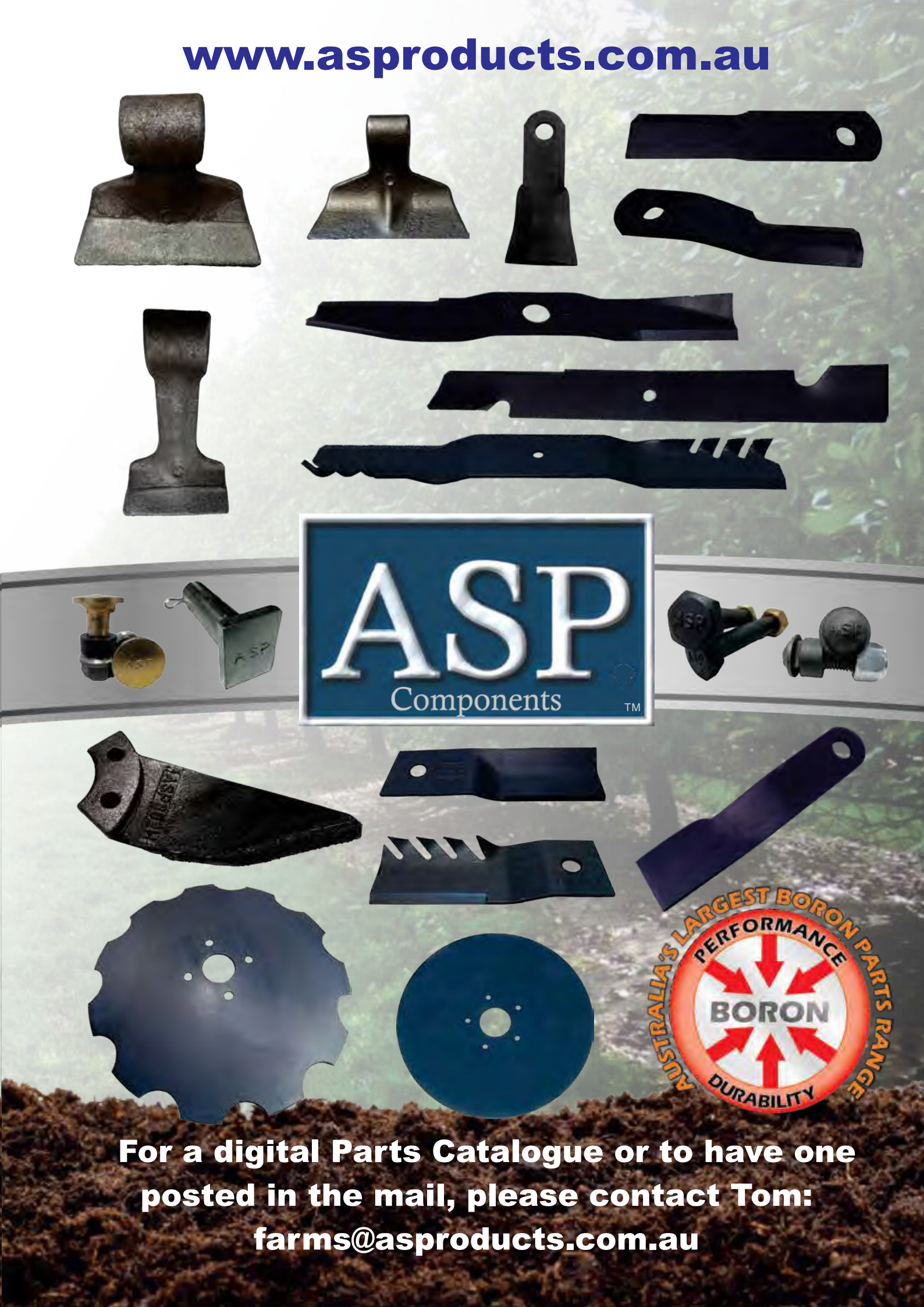
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Drone offers another option in the orchard



(l to r): Paul Duncan, Robyn Watson and Cathy and Steve Ferndale have been trialling the use of drones to apply chemistry in their Northern Rivers orchard.

When Cathy and Steve Ferndale bought their Northern Rivers orchard in 1998, their aim was to make it a second career. The orchard, located on the southern boundary of the Nightcap Range National Park and surrounded by bush, had 2800 mature trees of mixed Hawaiian cultivars - mainly H2, 246, 660, 508 and 800 - planted in the mid-1970s and '80s. Because of the steep terrain, the orchard had been planted on the contour on mainly 10 x 5 m spacings. Soils are shallow and heavy with a clay base.

The Ferndales operated the farm as absentee farmers until Steve retired from the army in 2010, when they began to concentrate full time on the orchard. In 2011 they planted 500 new trees, 816, 842 and 849 cultivars, on a 9 x 4 m spacing. After attending one of Alan Coates' macadamia growers courses, they began to implement IOM and IPM strategies with a view to increasing production and crop quality and having a more consistent result year on year. Over the last five years they have averaged 5 t/ha with a TKR of over 36%.

In 2021 Cathy and Steve went into partnership with Paul Duncan and Robyn Watson, longtime friends who had extensive experience with broadacre farming. According to Steve, they decided to take on partners because of their age and so they could share the workload and thereby extend the length of time that they could continue to farm the property. Paul and Robyn also introduced new ideas and fresh energy into managing the farm.

Wet conditions make ground application impossible

With 2022 being such a wet year in the Northern Rivers, for the first time the orchard spray program couldn't be fully implemented; either weather was too wet or the ground was too soaked to put machinery on. This meant that only one and a half rounds of the planned spray program were completed. This not only put 2022's crop at risk (USK increased from 1 to 3.6% the previous year) but was also a long-term threat to the health of the trees. With this in mind, they looked for ways that they could overcome this problem.

Luckily, drones were being introduced into the industry, so they decided to investigate their use. By their logic, if the ground was too wet to use an air blast sprayer, then any spray was better than no spray.

Following a conversation with Scott Fisher from Skytech, he came out and mapped the farm with his drone, after





With the ground in the orchard too wet to get machinery onto, an option was to use a drone to apply chemistry.

which they would be able to see what the coverage would be like. The only difficulty Scott foresaw was with the tall trees, which were mainly situated around the boundaries, where the safety margin would not allow the drone to do some of the edge rows or trees. The cost appeared to be competitive with that of a contractor using an air blast sprayer and it seemed like it would take about two-thirds of the time to complete the spray.

The drone spray rate was 150 L/ha, comprising five loads at 25 L per flight. The chemical application rate was the same as for a ground rig, i.e., Assault 1.75 L/ha, Simbo 1 L/ha and Designer 1% per litre of water. In each tank, the load was 350 mL Assault, 200 mL Simbo and 3 mL of Designer. This was all premixed in a standalone 100 L tank and pumped into the drone for each flight.

Assessing drone effectiveness

After the first spray application, Paul analysed how the drone worked and its effectiveness. The following is from his notes.

A pest Inspection by Jarrah Coates on 8 August found a medium level of lace bug with 39 samples of nymphs and young bugs as well as a reasonable level of beneficials. Based on this, it was recommended that we spray for lace bug. We sprayed the orchard using a drone on 15 and 16 August and Jarrah conducted a second inspection nearly a fortnight later after, when he found a low to medium level of lace bug with 20 samples of young nymphs in the bottom section of the canopy. He also reported that one dead lace bug was found and that there were low numbers of beneficials present.

The drone spray demonstrated a level of success when the following points are considered after a gap of 21 days between pest inspections:

- *the very low numbers of adult lace bug that were found*
- *the numbers of dead lace bugs found*
- *the nymphs and young that were found could very well have been eggs when the spray was applied*
- *spray timing would have impacted the success of the application.*

As the drone has obviously applied the chemical from the top of the canopy, it is assumed that control in this area was better than the bottom of the canopy. While the control in the bottom of the canopy was fair as suggested above, it could be assumed that the control in the top was very good.

As it is not uncommon for a second lace bug spray, circumstances may be pushing us to think that the drone application was not as successful as ground application. However, we can never know how successful a ground application is in the top of the canopy unlike with coverage from the drone application, which we could assume as being good. As a lot of the crop is in the top of the canopy, this may carry greater weight in our consideration of application method.

There are some areas where the drone has not been able to cover the trees. This is to do with where the drone can safely operate, something that possibly could be addressed by clearing some tall timber or flying the drone manually.

Considering that there are often times in the Northern Rivers when a ground application cannot be achieved



The flight path used by the drone over the orchard.

because of wet weather, waterlogged ground and the physical nature of the farm, perhaps a combination of the two types of applications may be the best answer.

Another tool in the kit

The drone was used a second time to apply chemical to the steeper parts of the orchard because the ground was too wet for tractor operations.

The partnership has decided that the drone is another very effective tool in their armoury. They don't believe that at this stage it will replace the air blast sprayer, but it certainly does complement it and will allow them to cope more effectively with a wider variety of weather conditions.

There needs to be more trialling of different size spray nozzles and drone speeds to perfect how it can best be applied to each different farm. It will also be more effective when a greater range of chemicals are approved and registered for drone application.

Pros and cons of using a drone

Since using the drone last year, Paul has thought about the advantages and disadvantages in using this method to apply chemistry. Here are his thoughts:

Pros

- Can apply a spray when the ground is too wet for tractor operations.
- Main effort goes into the top of the canopy where most of the crop is located.
- A drone applies chemistry more quickly than a ground rig so in some circumstances application using the drone may be more timely.
- The property only has to be mapped once.
- There is less risk of spray drift as the drone is just above the canopy and uses the rotors to push the spray down.
- It is very effective on young trees and would use less chemical per hectare as the drone would track directly over the row with little waste.
- Application with a drone is very cost effective when dealing with pest hotspots in the orchard.
- No damage to the orchard floor or nuts driven into ground by a spray rig.
- Not as noisy as an air blast spray rig.
- Uses an extremely small amount of water which could be critical in dry times.
- Could be more effective in old orchards with narrow row spacing and a high canopy.

Cons

- Possibly the coverage in the bottom of the canopy of big trees may not be as consistent as the top, particularly with hedged orchards.
- Not all the required spray chemicals are currently registered for drone application.
- The size of the safety zone around large trees, especially forest or windrows.

Finetuning for the future

Paul said that some fine tuning is required to further enhance the use of drones for spraying. He listed these as follows:

- establishing the optimum height for operating the drone above the canopy
- minimising the danger area around obstacles such as forest trees
- investigating optimum nozzle size for each task
- establishing the best water rate for applications
- designing a chart with applicable chemical rates.



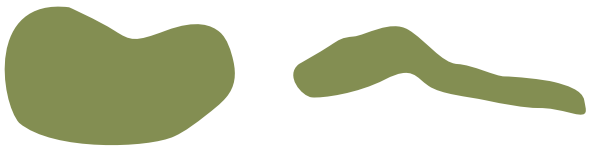
Cat's claw creeper and other weeds – humans the most effective biological control

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

While humans are using armies of jewel beetles and tingid bugs as biological controls for cat's claw creeper (*Dolichandra unguis-cati*), it is worthwhile considering that as members of a biological species, just as insects are, we have the greatest influence on what grows where, including weeds.

We use physical and chemical controls in our weed management strategies, as well as co-opting other organisms to help, but it is our initial actions in introducing species to new areas and modifying landscape-wide management practices such as tree cover and fire that lead to both intended (monocultures such as sugar and wheat) and unintended consequences (such as the impact of cane toads, cat's claw creeper and flammable pasture grasses). The weeds website, www.weeds.org.au, provides a sobering list of these consequences.

Wild macadamia habitat is no less immune to the serious threats posed by weeds. The smaller the patch of remaining habitat - and much of the remaining macadamia habitat is both small and narrow - the greater the risk of weed invasion.



Boundary to area ratio of 0.2 Boundary to area ratio of 0.8

Figure. *The impact of habitat size (boundary to area ratio) on habitat.*

The figure illustrates the effect of size of habitat using boundary to area ratio. The larger patch of forest on the left has the same length of boundary and thus exposure to weeds as the smaller patch on the right. While the boundary length might be the same, what is important is the area of the habitat so that the larger the area, the more plants living there are able to withstand invasion and destructive events such as fires. This is particularly the case for weeds that produce a big fuel load, as a large patch of rainforest (smaller boundary to area ratio) can stop a fire, where a small patch might be overwhelmed.

Two other important vectors for weeds are water and birds. In the case of a narrow strip of rainforest remnant along a creek, the boundary to area ratio effect is exacerbated by having a creek down the middle that brings in reproductive vegetative material as well allowing sun-loving, flammable weeds to grow along the creek.



Flowers attract humans to be biological agents to spread cat's claw creeper. Photo: Yamuna01 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=90657421

Cat's claw creeper and Madeira vine: runaway problems

Cat's claw creeper is a fast-growing, climbing vine with bright yellow flowers. With an ability to seed prolifically and a vast root system, it can spread rapidly both vertically and horizontally to affect all plant layers of a forest ecosystem.

Madeira vine (*Anredera cordifolia*) has fleshy, heart-shaped leaves and can climb to the very top of rainforest trees where the weight of the vine can break off branches and smother trees. It grows from tubers, leaves and bits of stem. Because of this habit, if you pull the vine down, it detaches little tubers from along the stem to fall onto the soil, making it extremely difficult to contain.

Gympie and District Landcare has been lobbying governments and running projects to develop and implement controls for cat's claw creeper and Madeira vine in the Mary River Catchment since at least 2008. Their sad conclusion is that cat's claw is so established in the Mary Valley that eradication is no longer possible; the best approach is to control outbreaks and reduce spreading.



The eponymous cat's claw that helps the creeper climb to great heights. Photo: Paul venter - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=43548684

Control and reduce spread now the priority

To control and reduce the spread of cat's claw creeper and Madeira vine, Gympie and District Landcare advise setting smart goals:

- Start at the top of a catchment and work down.
- Start at the edge of an infestation and work in.
- Stop flowering and seeding wherever possible by cutting climbing vines.
- Use a mix of control measures for the best results, but do not use chemicals in the same area where you release biological agents – insects will not thrive on poisoned plants.
- To stop flowering, cut vines climbing up trees and apply chemicals to the stump.
- Apply foliar spray to dense vine on the ground or release bio-control agents.
- Check and retreat as necessary every year.
- Encourage native vegetation by spraying a weed free area of at least 1 metre around young plants – check and repeat every few months.

The MCT has been working with partners since 2011 to control these two invasive vines, successfully applying for a Queensland Government grant to help Gympie and District Landcare increase their capacity to grow and distribute biocontrol agents and working with HQPlantations to release agents in Amamoor Forest. Our current project is focussed on the forest around the Walk with Wild Macadamias to ensure that the wild trees that have become such a popular attraction do not fall victim to these powerful smothering vines.

Information

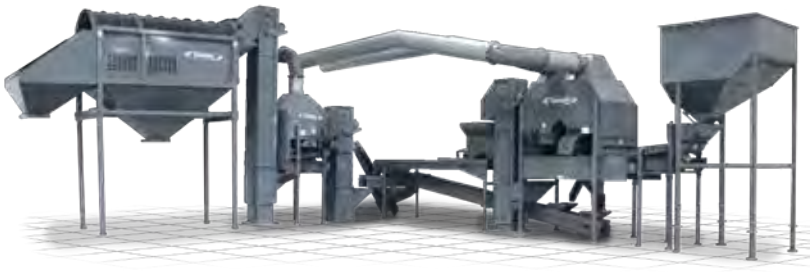
For information about managing cat's claw creeper, go to Gympie and District Landcare website and download the cat's claw creeper brochure: https://gympielandcare.org.au/invasive-plants/

Next time someone offers you a cutting of something that "strikes so easily and has such pretty flowers", remember **your** power as a biological control agent. Ideally, choose a local native species that will support the local ecosystem, and if it has to be an exotic species, choose one that may take a little more effort to grow, but will only grow where **you decide** it should grow, and will not spread.



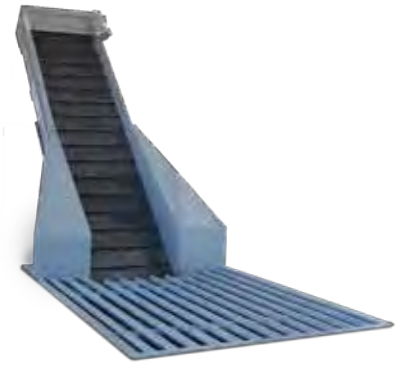
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40th World Nut and Dried Fruit Congress spotlights opportunities on the horizon

Jacqui Price, Market Development Manager **P:** 02 6622 4933 **E:** jacqui.price@macadamias.org

It was a full house and a packed agenda at the 40th World Nut and Dried Fruit Congress, as 1300 professionals from 65 countries converged on London in May to share ideas on market development and demand creation, the latest findings in health research, and information about the sustainable growth of the nut and dried fruit industry.



The World Nut and Dried Fruit Congress is a key global event that brings together industry decision makers, the commercial sector and international customers.

The global congress event is the flagship event of the International Nut and Dried Fruit Council (INC), the umbrella organisation for the nut and dried fruit industry, and it was attended by several Australian macadamia representatives.

The congress is a key event for disseminating critical information, acting as a global meeting point that brings the industry's main decision makers and thought leaders together in one space. It's where our industry's commercial sector can meet face-to-face with international customers, secure new contracts and meet with potential buyers. From consumer trends to supply updates and product innovation news, the wealth of information shared at the congress enables attendees to better understand the global market.

It's also where the INC's Sustainability, Statistics, Research and Ambassador committees meet each year, with Australia having representation on each. I represent Australia on the Statistics Committee, which is responsible for collating consolidated production, trade flow and consumption data.

The global nut industry's current state of play

As discussed by industry leaders during the congress, the forecast for world tree nut production for 2023-24 is 5.7 million metric tonnes (kernel basis, except pistachios in-shell), up by 5% from the previous season. Although still early days, almond, walnut, cashew, hazelnut and pecan crops are expected to remain mostly flat, or just slightly above the previous season, while pistachios and macadamias are projected to increase by 37% and 9% respectively from 2022-23.

The need to create demand worldwide through innovative new product concepts was a theme throughout the congress, aligning with one of the cornerstones of the Australian macadamia marketing strategy.

The trends working in our favour

There's no questioning the challenges that many nut industries, including our own, are currently facing, with inflationary pressures, rising input costs and unfavourable prices for growers acknowledged as



An Australian Macadamias website designed for the Indian market was recently launched.

key concerns across the board. As we navigate this unsettling period of shifting supply and demand dynamics, it's also important to note the trends that are unfolding alongside us. Many are pointing to opportunities that, if leveraged correctly, will steer us towards a period of greater stability. INC Executive Director Goretti Guasch shared some results from the INC's recent global survey, revealing a number of retail and manufacturing trends that bode well for the macadamia industry.

- **Demand for snack products in growing markets is firmly up.** High-purchasing markets are demanding more flavoured nut products, while lower-purchasing markets are showing increased demand for bulk nuts.
- **Demand for functional food products is up in both growing and mature markets,** driven largely by increasing health awareness among consumers.
- **Product innovation is firmly up in growing markets,** particularly in terms of flavour innovation, functional products, and nut drinks and oils.
- **Demand from manufacturers for nuts and dried fruit continues to rise in growing markets,** particularly for flavoured nut products and nut drinks, bars and muesli.
- **Demand from manufacturers for added-value nut products is up in both growing and mature markets,** particularly for flavoured nuts, gift boxes, plant-based ingredients and ready-to-eat products.
- **Retail demand is up across several key categories** including flavoured nuts, nut drinks, nut spreads, nut mixes and health snacking products.

These trends play into the strengths that macadamias offer as an ingredient and align with the benefits the Australian macadamia marketing program focuses on in both trade and consumer communication.

India: the market ripe for development

The INC has conducted in-depth analysis of the markets that offer high growth opportunities for the nut industry over the next 10 years. While South America, China, and Southeast Asia all hold significant demand potential, it's India that has been singled out as the most promising.

Already a growing market with bright prospects, it has the largest population in the world with an economy that is expected to grow between 7 and 8% annually over the next decade. The health benefits of nut consumption are well covered by Indian media, helping to drive awareness among consumers. India's population is young, with more than 60% aged under 30. The spending power and influence of these younger consumers in the home is growing, which prompted INC to look at Gen Z (age 18 to 26) in this market more closely. A number of findings signal good news for nuts like macadamias:

- 69% of Gen Z in India consider protein to be an essential component of their diet
- 48% of Gen Z in India consider nuts to be rich in protein, more so than meat and fish or seafood
- Gen Z in India already perceive that nuts and dried fruit are delivering the three main benefits that they seek in foods: protein, energy and immunity
- 74% of Gen Z in India snack at least once a day
- the main requirement for snacks among Gen Z in India is that they are tasty and/or healthy
- while chips and savoury snacks and fresh fruit are the most popular snacks among India's Gen Z at 61% and 59% respectively, nuts come a close third at 56%
- Gen Z consumers in India decide and shop for their own snacks, even if meal and shopping decisions are made by other family members.

These findings are encouraging for the Australian macadamia industry and support the market development work that has recently commenced in India. A localised Australian Macadamias website has now launched, featuring health, sustainability and growing information as well as a collection of Indian-inspired recipes featuring macadamias. The inaugural Australian Macadamia Festival will take place in India later this year, thanks to a grant awarded to the AMS by the Queensland government as part of its Food and Fibre to Market: Industry Partnerships Program. The festival will create a platform to showcase the sensory, health and versatility benefits of Australian grown macadamias to Indian trading partners, chefs and consumers.

Two of India's largest nut importers recently visited Australia to gain a better understanding of the Australian macadamia industry. One of these importers, VKC Nuts was recognised by the INC for its nut and dried fruit brand Nutraj BactoPure. With progressive packaging featuring QR codes that provide consumers with access to quality control certificates, the brand was the winner of the 2023 Innovation Award at the Congress.

Uniting to increase global consumption

While there will always be an element of competition between nut producing origins and industries, we also recognise that there is much we can achieve by uniting as a category to help drive global consumption for all nuts. The work of the INC is dedicated to this, and the annual congress facilitates the sharing of data, news and ideas that are crucial to fulfilling this mission. We thank the INC for hosting such a successful event.

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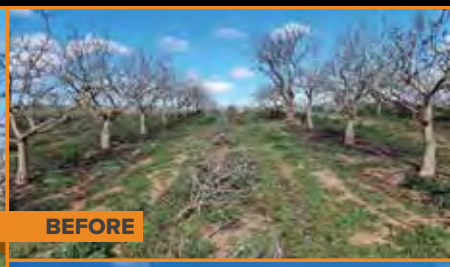
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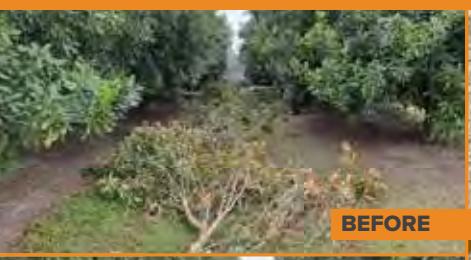


BEFORE



AFTER

PISTACHIO



BEFORE



AFTER

MACADAMIA



FINE MULCH



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TOB



BEFORE



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Benchmarking insights from 2009-2022

Shane Mulo and **Grant Bignell,** Department of Agriculture and Fisheries
E: macman@daf.qld.gov.au **P:** 07 5381 1334

The macadamia industry benchmarking project (MC22000) is continuing to collect data on farm productivity and quality over the next four seasons to allow growers to confidentially compare their farm with regional and industry averages. Sustainability metrics will be added as part of the latest project to help industry to demonstrate its environmental, social and governance credentials.

Another key element of the latest project is an intensive study of on-farm crop loss. Grower feedback suggests that on-farm losses may be much higher than factory rejects in some cases, so this work will measure those losses on selected farms over multiple seasons. An assessment of the relative economic significance of those losses will prioritise future R&D investment.

A summary of findings up to the 2022 season were recently presented and discussed at benchmark group meetings held in all major production regions. The table shows participating farms by region in 2022, as well as average farm size, average tree age and nut-in-shell production for those farms. Averages shown are weighted by either production or planted area.

A total of 307 farms (274 bearing) submitted yield and quality data for the 2022 season, totalling about 63% of industry production that year. Production cost data was provided by 92 of these farms, representing 28% of national production.

The following summarises results for a number of key measures.

Yield for mature farms

Figure 1 shows trends in weighted average nut-in-shell (NIS) and saleable kernel (SK) yield per bearing hectare for mature farms (10+ years old). The long-term (2009-22) averages for NIS and SK yield are 2.86 t/ha and 0.91 t/ha respectively. In 2022, average productivity was the highest since benchmarking began in 2009. This was the result of record high average yields in Queensland (3.9 t/ha NIS). NSW farms were below the long-term average in 2022 (2.4 t/ha NIS), partially due to flooding and prolonged wet weather, which impacted harvest.

Productivity typically varies according to seasonal weather events and timing of farm management activities such as canopy management and orchard rejuvenation. A five-year moving average is included to minimise the impact of these seasonal fluctuations and identify long-term shifts in productivity. The five-year average shows a net increase of about 0.61 t/ha (25%) for NIS and 0.26 t/ha (35%) for saleable kernel since 2009.

NIS productivity over five years

Figure 2 categorises NIS productivity over the previous five seasons, ranging from less than 1 t/ha to more than 5 t/ha, and shows the proportion of farms within each of those categories based on their average productivity during that period.

More than two-thirds of participating farms in NSW averaged between 2 and 4 t/ha of NIS. Relatively fewer farms were evident in both lower and higher productivity categories (20% and 12% respectively). A wider productivity range is evident in Queensland, with 51% of farms

Region	Farms providing yield and quality data (%)	Average planted hectares	Total planted hectares (%)	Average tree age	Total tonnes of nut-in-shell (%)	Farms providing cost data (%)
Central Queensland (CQ)	71 (26%)	61	6837 (58%)	16	22,488 (63%)	42 (46%)
South East Queensland (SEQ)	52 (19%)	13	1501 (13%)	27	5259 (15%)	10 (11%)
Northern Rivers NSW (NRNSW)	125 (46%)	18	2964 (25%)	26	6759 (19%)	28 (30%)
Mid North Coast NSW (MNNSW)	26 (9%)	13	450 (4%)	22	1078 (3%)	12 (13%)
All regions	**274**	**22**	**11,753**	**20**	**35,584**	**92**

Table. Regional breakdown of participating farms in 2022

averaging 2-4 t/ha, 13% less than 2 t/ha and 37% greater than 4 t/ha.

PKR and SKR kernel recovery

Figure 3 shows trends in premium (PKR) and saleable (SKR) kernel recovery for all farms in the sample from 2009–2022. Figure 4 shows similar trends for commercial (CKR) and reject (RKR) kernel recovery for the same period. All averages shown are weighted by NIS yield to reflect most of industry production.

SKR and PKR averages in 2022 were consistent with the record high levels seen in 2021. The five-year moving averages for both PKR and SKR have increased since data collection began in 2009 (1.7% and 2% respectively) although these trends vary by region.

The largest gains in PKR over this period were in CQ (1.9%) followed by NRNSW (1.5%) and SEQ (0.7%). The five-year average PKR for MNNSW farms fell by 2.2% over this period.

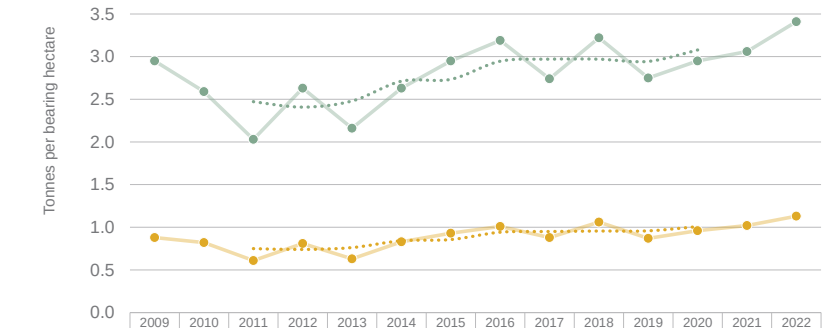
NRNSW farms had the largest increase in SKR (2.4%) followed by CQ and SEQ (1.7%) and MNNSW (1.4%).

Average CKR in 2022 was consistent with the previous season and the five-year average has generally increased by 0.3% across the sample since 2009. This change also varies by region, with MNNSW showing a substantial increase in CKR over this period (3.6%) while CQ farms decreased by 0.2%. Farms in SEQ and NRNSW showed an increase of around 1% in CKR during this period.

RKR increased by over 1% in 2022 after achieving a record low in 2021. This increase was evident in all regions. Over the longer term, RKR has generally decreased by between 0.1% and 0.6% in CQ, SEQ and NRNSW, while farms in MNNSW showed a 0.2% increase.

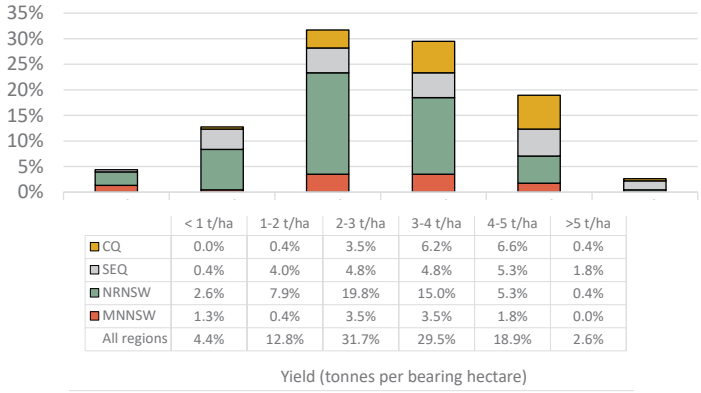
Average factory reject kernel

Figure 5 shows seasonal average factory reject kernel recovery by category. Results are weighted by nut-in-shell production, which shows the relative significance of each



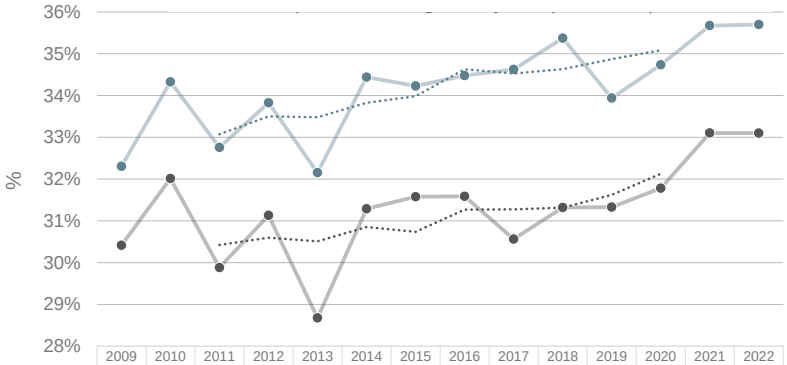
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
NIS yield	2.95	2.59	2.03	2.63	2.16	2.63	2.95	3.19	2.74	3.22	2.75	2.95	3.06	3.41
NIS 5-year avg			2.47	2.41	2.48	2.71	2.73	2.95	2.97	2.97	2.94	3.08		
SK yield	0.88	0.82	0.61	0.81	0.63	0.83	0.93	1.01	0.88	1.06	0.87	0.96	1.02	1.13
SK 5-year avg			0.75	0.74	0.76	0.84	0.86	0.94	0.95	0.96	0.96	1.01		

Figure 1. Nut-in-shell and saleable kernel productivity trends for 2009 to 2022



	< 1 t/ha	1-2 t/ha	2-3 t/ha	3-4 t/ha	4-5 t/ha	>5 t/ha
CQ	0.0%	0.4%	3.5%	6.2%	6.6%	0.4%
SEQ	0.4%	4.0%	4.8%	4.8%	5.3%	1.8%
NRNSW	2.6%	7.9%	19.8%	15.0%	5.3%	0.4%
MNNSW	1.3%	0.4%	3.5%	3.5%	1.8%	0.0%
All regions	4.4%	12.8%	31.7%	29.5%	18.9%	2.6%

Figure 2. Distribution of long-term average nut-in-shell productivity (2018 to 2022)



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
SKR%	32.3	34.3	32.8	33.8	32.2	34.4	34.2	34.5	34.6	35.4	33.9	34.7	35.7	35.7
SKR 5-yr avg.			33.1	33.5	33.5	33.8	34.0	34.6	34.5	34.6	34.9	35.1		
PKR%	30.4	32.0	29.9	31.1	28.7	31.3	31.6	31.6	30.6	31.3	31.3	31.8	33.1	33.1
PKR 5-yr avg.			30.4	30.6	30.5	30.9	30.7	31.3	31.3	31.3	31.6	32.1		

Figure 3. Premium and saleable kernel recovery trends for 2009 to 2022



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

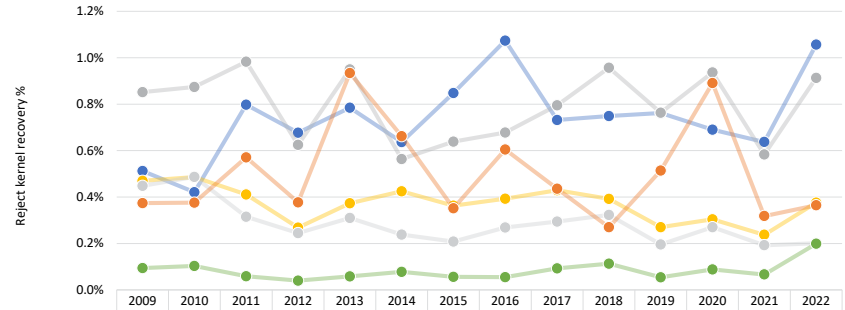
Figure 4. Commercial and reject kernel recovery trends for 2009 to 2022

reject category at a whole-sample level. Losses were up in all reject categories in 2022, especially insect damage and brown centres.

Brown centres has been the most significant cause of factory rejects over the last 14 seasons when weighted by NIS production. Brown centres rejects tend to be more prevalent on larger farms in the benchmark sample, particularly in the CQ region. Levels increased in 2022 to above the long-term average of 0.79%. This was influenced by large increases for farms in Queensland and the NRNSW region..

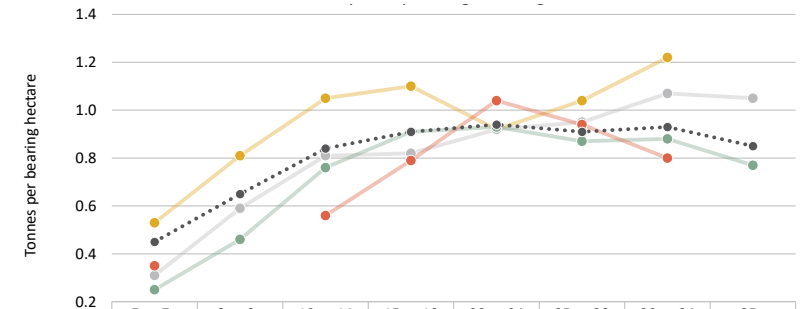
Insect damage increased by 0.42% between 2021 and 2022 and was the leading reject category in the 2022 season. Insect damage levels were 0.29% higher in 2022 than the 2009-2022 long-term average. Increases in insect damage were particularly evident in CQ (up 0.62%) and SEQ (up 0.4%).

Immaturity levels in 2022 remained well below the long-term average of 0.5%. While levels are typically lower than both brown centres and insect damage, immaturity tends to spike on some farms in particular seasons, such as farms without irrigation during prolonged hot and dry weather.



	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Insect	0.51	0.42	0.80	0.68	0.79	0.64	0.85	1.07	0.73	0.75	0.76	0.69	0.64	1.06
Mould	0.47	0.49	0.41	0.27	0.37	0.43	0.36	0.39	0.43	0.39	0.27	0.30	0.24	0.38
Discoloured	0.45	0.49	0.32	0.25	0.31	0.24	0.21	0.27	0.29	0.32	0.20	0.27	0.19	0.20
Brown centres	0.85	0.87	0.98	0.63	0.95	0.56	0.64	0.68	0.80	0.96	0.76	0.94	0.58	0.91
Immaturity	0.37	0.38	0.57	0.38	0.93	0.66	0.35	0.61	0.44	0.27	0.51	0.89	0.32	0.37
Germination	0.09	0.10	0.06	0.04	0.06	0.08	0.06	0.06	0.09	0.11	0.05	0.09	0.07	0.20

Figure 5. Factory reject trends for 2009 to 2022



	5 to 7 years	8 to 9 years	10 to 14 years	15 to 19 years	20 to 24 years	25 to 29 years	30 to 34 years	35+ years
CQ	0.53	0.81	1.05	1.10	0.92	1.04	1.22	
SEQ	0.31	0.59	0.81	0.82	0.92	0.95	1.07	1.05
NRNSW	0.25	0.46	0.76	0.91	0.93	0.87	0.88	0.77
MNNSW	0.35		0.56	0.79	1.04	0.94	0.8	
All regions	0.45	0.65	0.84	0.91	0.94	0.91	0.93	0.85

Figure 6. Saleable kernel yield by tree age and region for 2009 to 2022



	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Imputed labour					$415	$589	$421	$470	$414	$321
Cash costs	$5,232	$5,619	$6,611	$6,881	$7,976	$7,752	$8,023	$8,583	$8,802	$9,580
Total costs					$8,303	$8,341	$8,443	$9,052	$9,217	$9,901
NIS price	$3.00	$3.83	$5.09	$5.51	$5.62	$5.81	$5.83	$6.65	$5.42	$3.57
NIS yield	2.14	3.05	3.01	3.43	2.95	3.39	2.79	3.01	3.17	3.28

Figure 7. Costs per planted hectare, yield and nut-in-shell price for 2013 to 2022

Average saleable kernel yield

Figure 6 shows a regional breakdown of average saleable kernel (SK) yield per bearing hectare by tree age category for 2009–2022. Missing values on the chart indicate that there was insufficient data available for specific tree age categories in some regions. It is important to note that there is relatively less data available for higher average age groups, such as beyond 30 years.

CQ farms with an average tree age of 19 years or younger had higher average yield of SK per hectare than farms of the same age in other regions (P<0.01). While there is a significant positive correlation between tree age and yield in younger trees, these relationships are complex and farm performance can be influenced by other regional, genetic, climatic or management factors.

In SEQ there is generally a positive correlation between tree age and SK yield per hectare (P<0.01). In NRNSW average SK yield appears to plateau from around 15 years onwards. There is a significant negative correlation between tree age and yield (SK and NIS per bearing hectare) among farms 35 years and over, indicating a decline in yields for trees above this age in this region (P<0.05). This may also relate to external factors other than tree age, such as those mentioned above.

In MNNSW SK yields appear to peak in the 20 to 24 years age group, with a general decline in older age groups. It's important to note that there are fewer farms in

the benchmark sample from the MNNSW region than from other regions, and in this case long-term averages for specific age categories are more heavily influenced by seasonal variation due to the smaller sample size.

Average costs per hectare

Figure 7 shows weighted average costs per hectare for mature farms contributing cost data from 2013 to 2022. Cash-only costs are shown from 2013 to 2016 (green bars) while those from 2017 onwards include unpaid labour (orange bars) imputed at $30/hour. Seasonal industry average NIS price and NIS yield per hectare for those farms contributing cost data are also shown.

Average operating costs per hectare have increased in most seasons since 2009. Cash costs increased by over 80% over the ten-year period from 2013 to 2022. Imputed labour accounted for about 3% of total costs in 2022, although this varies significantly between managed and owner operated farms. Total operating costs, including imputed labour, increased by nearly 20% from 2017 to 2022. Feedback from growers suggests that favourable margins in previous years have supported increased farm expenditure in some cases, however the recent reduction in NIS price is likely to be accompanied by reduced average expenditure in the future.

Average costs per planted hectare

Figure 8 shows average costs per planted hectare across major heads of expenditure for mature farms in the benchmark sample. Results for the 2022 season (red bars) are compared with the previous five seasons for which imputed labour data is available (grey bars). The costs shown are weighted by planted hectares.

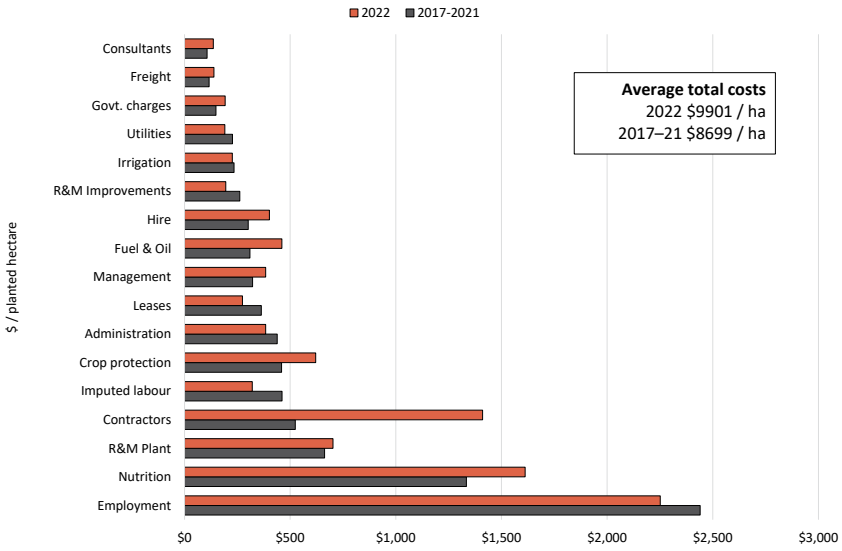


Figure 8. Average operating costs by category for 2022 vs 2018-2021

In 2022 average total costs were $9901/ha, which is almost 14% higher than the average for the previous five seasons ($8699/ha). Employment is typically the most significant cost category, accounting for approximately 30% of total costs. While employment and imputed labour costs in 2022 were markedly lower than the average for the previous five seasons, the most significant cost increases over previous seasons included contractors, nutrition, crop protection and fuel and oil.

This article has been produced as part of the "Macadamia benchmarking and sustainability insights 2022–2027" project (MC22000). This is a joint initiative of the Department of Agriculture and Fisheries, University of Southern Queensland, New South Wales Department of Primary Industries and the Queensland Alliance for Agriculture and Food Innovation.

The project has been funded by Hort Innovation, using the macadamia research and development levy and contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian horticulture. The Queensland Government has also co-funded the project through the Department of Agriculture and Fisheries.

Participation in benchmarking is free and individual farm results remain completely confidential. The benchmarking service allows growers to confidentially compare their farm business performance against industry averages. For more information about participating in the benchmarking project, contact the team at macman@daf.qld.gov.au or call (07) 5381 1334.

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love macadamia™

Growing the love of macadamias

The World Macadamia Organisation is creating a movement around the world – it's all about building the love of macadamias and it's called Love Macadamia™.

There is a lot to love about macadamias. Research tells us that often people really enjoy them, saying things like "they are my favourite nut". However, when you delve into the numbers, they aren't buying them that frequently – often only once or twice a year. Love Macadamia™ aims to elevate macadamias from an occasional food to something considered an integral part of a balanced and healthy diet. The target is consumers who are mindful about their food choices, often selecting healthy wholefoods. There are three core elements to the approach: to increase awareness so macadamias come to mind more often; to increase understanding of the credentials, so favourable health attributes are associated with macadamias; and to give inspiration for how macadamias fit into their lifestyle.

We drew inspiration from other foods and what they'd done to grow their categories – standouts were "Avocado Fruit of Life", the "Incredible Egg" and "Got Milk?".

Love Macadamia™ was launched in the middle of 2022 and now is across three websites and six social channels, tailored for the specific needs of the USA, China and India audiences.

Each country uses the same core Love Macadamia™ elements and they are adapted for that cultural environment, the people we are trying most to connect with, and the behaviour change that we're looking to encourage.

INDIA



India is a significant market for nut consumption, however macadamias are not well known at all. Research led us to focus activities on wealthy women, 30-40 years old, who actively care about their and their family's health. We wanted these women to try macadamias, often for the first time, and to build them into their regular food choices because they understood it would help them with their health and wellness objectives. These women often take advice from nutritionists, and both talking to nutritionists and having nutritionists credibly share the macadamia story, was important. We are focusing initially on Delhi, and have in place a programme that includes macadamias being featured at lifestyle events, lots of health-orientated influencers sharing their experiences of macadamias, articles in aspirational publications, and building social channels that now have 10,000 followers after only five months.

Early signs of success in India

One of the results that stands out is the offtake in a premium food retailer called Foodhall. Prior to the Love Macadamia™ activities, the two stores we measured sold about 1kg of macadamias per week. This increased to 6kg per week during a promotion which included sampling and sharing information, an encouraging result but often instore promotions drive peaks in sales. The most exciting number in the three month period after the promotion was that the average weekly sales were sustained at nearly 5kg per week. This indicates the Love Macadamia™ activities are changing consumer behaviour, including that important metric of repeat purchase.

www.lovemacadamia.in lovemacadamia.india lovemacadamiaindia

USA

The United States is the biggest snacking market for macadamia kernels and there is still a lot of potential upside. The Love Macadamia™ movement is targeting health-conscious millennials, who often are aware of macadamias but they aren't part of their regularly consumed healthy food set. The USA is a big country, the epicentre of Love Macadamia™ activities is California. The key elements of the USA activities have been digital advertising to drive people to the Love Macadamia™ website, reinforcing a clear health message centred around good fats, and creating online communities and activity. Love Macadamia™ focuses on growing the overall macadamia category and we are partnering with consumer brands who have macadamia offers to amplify communication.



Early signs of success in the USA

A stand out result is in the area of user-generated content, often known as UGC, which is where consumers (or influencers) have created and shared their own content relating to macadamias – it is often considered the most important metric in digital marketing. One year ago there was almost no UGC relating to macadamias, 65 mentions to be specific in a one month period. This increased to 4,800 pieces of UGC in a recent month, a marked increase and very encouraging. This is an outcome of activity, it isn't something that can be directed, which is what makes it particularly potent. It is important to note that all macadamia category activity will have contributed to this, not just Love Macadamia™ activity.

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Hort Innovation MACADAMIA FUND

Promising NIS yields from high-density planting of cultivar P at Bundaberg

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High density planting of the cultivar P at Bundaberg at 625 trees per hectare resulted in an anticipated yield of 3.75 t/ha NIS from the four-year-old trees in 2023. In this article, Roger Broadley takes us through the details.

In January 2023, we visited a high-density orchard of P cultivar at Moorlands, a few kilometres north of Bundaberg, courtesy of Macadamia Farm Management (MFM). The trees were planted at 8 x 2 m spacings (625 trees/ha) in August 2018, making them just 4.4 years old at the time of the visit.

Each tree was bearing around 6 kg of nut-in-shell, making the estimated yield about 3.75 t/ha NIS, a good result for such young trees. Harvesting was scheduled to start in the second week of February 2023. P trees are precocious, as demonstrated by the fact that this block was harvested in 2021 with a yield of 1.56 t/ha NIS recorded.

An efficient performer

P is a smaller tree than average, with good yields shown in the Bundaberg area by the Department of Agriculture and Fisheries (DAF) Regional Variety Trial 3 (RVT3) trial results over a nine-year period, and a kernel recovery of around 38.9%. Original yield data in the RVT3 trials were based on a tree density of roughly 316 trees a hectare.



P trees in high-density Moorlands block managed by Macadamia Farm Management.

P is also an efficient cultivar in terms of the amount of kernel produced per cubic metre of canopy. It is characterised by long flower racemes and an ability to set clusters of nuts.

Previously, while we had always thought that yields might be higher when P cultivar trees were planted in a higher density situation, we did not have the detailed field data to recommend this. While it is still early days, with good nutrition and water management, we expect these early high yields at MFM's Moorland block to continue. The plan for the orchard is to remove every second tree at some time in the future.

View from the orchard

According to Scott Allcott, Managing Director of MFM, which currently manages 4000 ha of macadamia orchards mostly in the Bundaberg growing regions, cultivar P has potential for high density due to its compact, small nature.

"It does also have good side branching with nearly 90-degrees branch angles often observed. With parents such as A16 and 814, I do feel that the cultivar will perform for many years due to its overall size. The kernel quality appears to be of good overall appearance," he said.

MFM has plans to use P cultivar in more high-density orchards.

Very low NIS per kilogram prices have been noted for the 2023 season. This means it is important for trees to start bearing early and to produce high kernel yields per hectare (a combination of NIS yields and percentage kernel recovery of each variety). P cultivar appears to have the capacity to do this.

Budwood availability

Over the past few years, it has taken some time to build up significant amounts of budwood of G, J, P and R, but we are now at a stage where budwood availability is not a limiting factor for future plantings. You can find nurseries that are licensed to supply trees in NSW and Queensland on website https://macadamiainnovation.com.au/nurseries/.



Nearly mature nuts on trees in high-density P trees, January 2023



The P cultivar has long flower racemes (photo credit Michael Cameron)

Good news for growers planting high-density orchards

The IP owner of industry cultivars G, J, P, and R, the State of Queensland through its Department of Agriculture and Fisheries, has capped the royalty rate for plantings greater than 350 trees/ha, rather than charge on a per tree basis. For growers who wish to plant at normal densities up to 350 trees/ha, the existing royalty rate per tree will apply.

The royalty fee is discounted for growers who buy more than 5000 trees at one time (any combination of one or more G, J, P and R cultivars). This means that if trees are planted at high density (> 350 trees/ha) and more than 5000 trees are ordered, the total royalty cost will be as little as $1,050/ha.

Acknowledgment

The macadamia breeding and cultivar evaluation program has been funded by CSIRO and Hort Innovation using the macadamia research and development levy, with co-contributions from the Queensland Government through its Department of Agriculture and Fisheries and funds from the Australian Government. We are extremely grateful to all macadamia nut producers who have trialled, collected data on, and given feedback on the varieties being tested. This has helped us make more informed and better commercial judgments.





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TREE REMOVAL

Bundaberg growers delve into canopy management at workshop

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In April, almost 100 industry representatives from the macadamia and avocado industries attended a grower workshop in Bundaberg on canopy management and vegetative vigour control. The workshop, hosted by the Queensland Department of Agriculture and Fisheries (DAF) as part of the National Tree Crop Intensification in Horticulture Program (AS18000), featured presentations on canopy management and recent research trials of plant growth regulators. This article summarises key messages from the workshop.

Canopy management a balancing act

First to speak was Simon Newett, DAF extension horticulturist, who shared insights from Australian and international grower surveys, which suggest that growers implement canopy management for three main reasons: to increase canopy light penetration, to allow machinery access and to improve spray coverage.

According to surveyed growers, common signs that pruning is needed are deterioration in fruit quality and yield, poor spray penetration, thin internal canopy, and sparse inter-row vegetation. A canopy architecture with multiple leading limbs was favoured by most growers, as it is well suited for a pruning strategy of selective limb removal. Simon concluded that there is no "one-size-fits-all" solution and recommends viewing canopy management as a balancing act between containing tree size and promoting productivity.

We believe there are many similarities between avocado and macadamia canopy management and that many of the learnings from avocados are thus also relevant to macadamia.

What is canopy management about (adapted from Simon Newett's talk):

1. Light – productivity is dependent on light interception and penetration.
2. Access – allowing safe and efficient machinery operation.
3. Good spray coverage and penetration.
4. Rejuvenating the canopy.

The fundamentals of macadamia canopy management were presented by Dr Rohan Orford, senior agricultural analyst from Stahmann Webster. Rohan also referred to the balancing act of canopy management, which he described as a "delicate balance" between operational considerations and tree productivity.

He discussed the relationships between different aspects of orchard microclimate, soil, light interception and tree physiology. It is known from experimental data that yield levels depend on the amount of light intercepted by the canopy, with maximum yield achieved at 95% interception. He also said that when orchard canopy volume is above a threshold of around 43,500 m^3/ha, reduced yield is likely to occur. Interestingly, 95% light interception is achieved around this canopy volume. Thus, finding the sweet spot of light interception, canopy volume, and operational costs is critical for maximising productivity.

Pruning strategies

Hedging is a very effective pruning practice to manage canopy volume, but it has several disadvantages. One of them is that it promotes a darker internal canopy, where the photosynthetic capacity of internal shaded leaves is low. After the removal of a high proportion of external leaves and the subsequent exposure of shaded leaves through the hedging, it can take up to six weeks for the canopy to re-establish its photosynthetic capacity and thus carbohydrate supply.

A potential solution is to cut windows into the canopy to allow more light penetration, which increases the photosynthetic capacity of internal leaves and promotes a more rapid adaptation once exposed to more light. As a result, the time it takes for the canopy to regain its photosynthetic capacity is reduced. Better ventilation and light penetration can also affect inner-

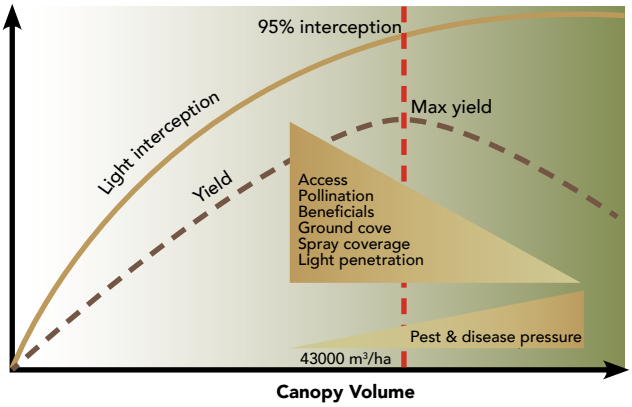


Figure. The relationship between canopy volume, light interception, yield level and other orchard considerations (adapted from Dr Rohan Orford's talk):

canopy temperature and humidity, supporting a higher abundance of beneficial invertebrates and reducing disease pressure.

Potential of plant growth regulators

In many cases, extensive pruning leads to reduced crop production, which can potentially be mitigated through the use of plant growth regulators (PGR), which can reduce vegetative growth and thus pruning requirements. Dr Amnon Haberman, who joined the Bundaberg DAF team last year, discussed PGRs from the triazole family, which inhibit gibberellin (GA) biosynthesis, a key phytohormone regulating plant growth. The most commonly used chemicals from this group are paclobutrazol and uniconazole. Neither chemical is currently registered for use in macadamia in Australia, although their potential to reduce shoot elongation and tree size in macadamia was demonstrated in Hawaii over 30 years ago.

Three examples where triazoles are used to manipulate growth in commercial cultivation were described, as follows:

- in avocado, triazoles are sprayed after flowering to increase fruit set and retention by altering resource allocation
- the Chilean Avocado Industry successfully uses triazoles to reduce vegetative growth in ultra-high-density orchards
- in mango, paclobutrazol is used to manipulate flowering.

One of the main messages was that both timing and method of application are critical for achieving the desired effect. Application of PGRs by soil drench takes multiple weeks to come into effect, but continues to affect growth for several months. In contrast, spray applications impact growth almost immediately, yet the effect is much shorter lasting.

The National Tree Crop Intensification in Horticulture Program is developing a better understanding of PGR applications as a tool for canopy management. Carola Parfitt and Hanna Toegel from DAF reported on recent research trials assessing the effect of paclobutrazol on the vegetative vigour of macadamia and avocado in our subtropical environment.

In macadamia, spray applications either at pruning or 21 days later, when regrowth had started, resulted in a shoot length reduction of 36%; spraying 30 days after pruning, when the new flush was half extended, did not affect shoot elongation, but led to severe leaf distortion. A paclobutrazol soil drench also reduced shoot length, in this case by 27%, but required a longer lead time to affect the targeted flush, and it also reduced the length of the next flush by 53%. Results presented for similar trials in avocado were generally in line with the trends observed in macadamia.



The Q&A panel members, from left to right: Dr Amnon Haberman, Dr Chris Searle, Simon Newett and Dr Rohan Orford.

Key messages from Q&A

The workshop concluded with a Q&A panel session, which discussed common pruning mistakes and debated the opportunities for orchard intensification.

The panel agreed on the importance of starting pruning early in the orchard's life and concluded that macadamia is likely to be more amenable to intensification than the naturally more vigorous avocado.

This event piloted bringing the macadamia and avocado industries together, providing the opportunity to share and learn from each other. Feedback from participants was very positive, indicating that the workshop had contributed to their understanding of the different aspects of canopy management.

Acknowledgment. Thanks to Dr Rohan Orford from Stahmann Webster, Dr Chris Searle from MacAvo Consulting, as well as Simon Newett and Carola Parfitt from QLD DAF for their crucial contribution to the workshop.

Further reading and resources

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Hort Innovation MACADAMIA FUND

Understanding Leptocoris bugs better

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The increasing presence of *Leptocoris* spp., commonly known as soapberry bugs, in macadamia orchards has raised concerns about their potential to cause damage and has emphasised the need for sustainable management strategies to mitigate losses. In this article, Bishwo describes questions the Macquarie University team is seeking to answer as a way of developing effective control strategies.

Snapshot

- While research has provided some insights into *Leptocoris* spp., there are still information gaps that need to filled before management strategies can be developed.
- Two questions that the research team at Macquarie University are seeking to answer To do with the thermal thresholds of *Leptocoris* spp. (to understand their survival and distribution) and whether they can complete their development on macadamia.
- Answering these questions will be important in understanding the life cycle of the bugs and in enabling prediction of population dynamics, both important elements in developing management strategies.



Leptocoris spp. are Rhopalid true bugs that are widely distributed throughout Australia and have evolved as specialised seed predators, mainly targeting plants from the Sapindaceae family. While *L. tagalicus* and *L. mitellatus* species can be found in most areas of Australia, *L. rufomarginatus* is mainly limited to the far eastern and northern moist subtropical and tropical regions.

Previous studies have contributed to our understanding of *Leptocoris* bugs to some extent. However, several knowledge gaps still require further investigation, including to do with their biology and life cycle. Understanding their behaviour, reproductive patterns and preferred habitats will aid in developing targeted control strategies. Research focusing on the impact of environmental factors such as temperature and humidity on their population dynamics and distribution would be invaluable. Additionally, investigations into the specific damage inflicted by *Leptocoris* bugs on macadamia trees and nuts are crucial. Addressing these research gaps will provide valuable insights into their biology, ecology and management in macadamia.

Temperature effects and life cycle

At Macquarie University (MU), we have established a colony of *L. tagalicus* on *Alectryon tomentosus* (woolly rambutan) to investigate two main aspects:

- the temperature-dependent development of *Leptocoris* bugs
- whether *Leptocoris* bugs can complete their development on macadamia.

Currently, newly laid eggs of *L. tagalicus* are being subjected to six different constant temperatures, ranging from 10 to 35°C. Daily observations track the survival and development of the bugs until they reach adulthood. The adult bugs are then paired, and their survival, fecundity and fertility at those temperatures are recorded.

This information will be vital for understanding the thermal thresholds and phenology (timing of life cycle events) of the insects, enabling the prediction of their population dynamics. By determining the temperature thresholds at which insects can develop, we can identify optimal conditions for their growth and reproduction. This knowledge will help growers, pest scouts and consultants to plan interventions, such as pesticide applications or biological control measures, targeting the most vulnerable stages of the insect's life cycle.



Adult and nymphal instar of Leptocoris.



Dr Syed Rizvi examining the development of Leptocoris *bugs.*

Following the completion of the temperature-dependent development investigation, the team plans to investigate whether or not *Leptocoris* bugs can complete their development on macadamia. This research will help uncover their nutritional requirements and open avenues for further research on the bugs' stage-specific damage potential to macadamia.

The investigations are expected to be completed by January 2024, and outcomes will be shared with the macadamia industry.

Information

For more information, contact Dr Bishwo Mainali at E: bishwo.mainali@mq.edu.au.

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Macadamias crack 40,000 ha

Craig Shephard, Senior Researcher, Applied Agricultural Remote Sensing Centre, University of New England, Armidale **| E:** cshepha2@une.edu.au

Snapshot

Researchers at the University of New England's Applied Agricultural Remote Sensing Centre (AARSC) working with AMS have updated the national map of commercial macadamia orchards under a new project to spatially enable horticulture tree crop industries in Australia.

- The Australian Tree Crop Map was most recently updated on 30 May 2023 and now includes 40,320 ha of macadamia orchards. The largest production area by Local Government Area (LGA) is Bundaberg with 16,387 ha (41% of the national total). Ballina has 5,509 ha (14%) and Lismore has 5,235 ha (13%).
- wField validation was completed in Central Queensland in April, and Northern Rivers and Mid North Coast of NSW in May.
- Since October 2022, the greatest area of new plantings has been in the Bundaberg LGA with 1,071 ha while the Central Highlands LGA in Queensland has added 392 ha.
- Eight-eight per cent of the orchards mapped in Australia are current to 2022 (mapped in year) or sooner.
- Contribution to the map by industry using location-based tools continues to inform updates. This feedback is essential for mapping new plantings.

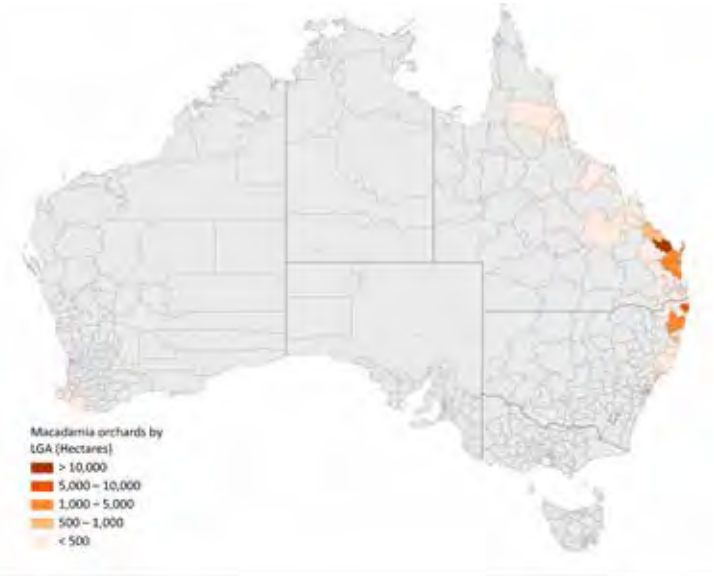


Figure 1. *Macadamia orchards (total area) by Local Government Area (LGA)*

The Australian Tree Crop Map (ATCM) was originally developed under Phase 1 of the *Multi-scale Monitoring Tools for Managing Australian Tree Crops project*, which then included all commercial avocado, macadamia and mango orchards greater than 2 ha. First published in 2017, the ATCM provided each industry with an accurate baseline of the extent and distribution of production area. Under the Phase 2 project, AARSC has built on these foundations by updating the map at greater detail (> 1 ha), and also included all commercial citrus orchards, olive groves and banana plantations.

Australian Tree Crop Map Dashboard

This dashboard-style web application (www.une.edu.au/webapps) features the latest map and includes metrics for avocado, mango, macadamia, citrus, olive, banana and truffle orchards (area of production in hectares). At national scale, clicking the map will return the total area of orchards by state and territory in a pop-up), while zooming in to the map will show local government areas (LGA). Users can navigate around the map using the bookmark tool, or by simply typing an address or place name into the search box and/or panning and zooming the map. The dashboard will update the summary statistics for each tree crop (at bottom) on-the-fly, based on the map view extent.

At state-level, Queensland has the largest area of macadamia orchards with 24,210 ha (60%), followed by New South Wales with 16,005 ha (40%). Bundaberg is the largest LGA with 16,387 ha (41% of the national total) followed by Ballina with 5,509 ha (14%) and Lismore with 5,235 ha (13%). (Figure 1).

In this latest update published in May, AARSC have completed field validation in Central Queensland (April) and Northern Rivers and Mid North Coast of NSW (May), which included many new plantings. Figure 2 shows the route (GPS track) in Bundaberg and highlights the new plantings added since last update was published in October 2022.

Developments continue in new project

In the new project, the map will be taken to the next level as a high-value, industry-only data collection, collation, analysis and presentation tool. Funded by the Future Food Systems CRC, Hort Innovation, UNE, Avocados Australia Ltd, Australian Banana Growers Council, Citrus Australia and AMS, AARSC will further develop the ATCM by building industry-only maps to support more applications to underpin forward selling, traceability, biosecurity, market and sustainability challenges.

Each industry body will work with their respective grower base using an AARSC developed 'Block Builder' application (app) to assign information to orchards at block level (e.g variety, planting date and management).

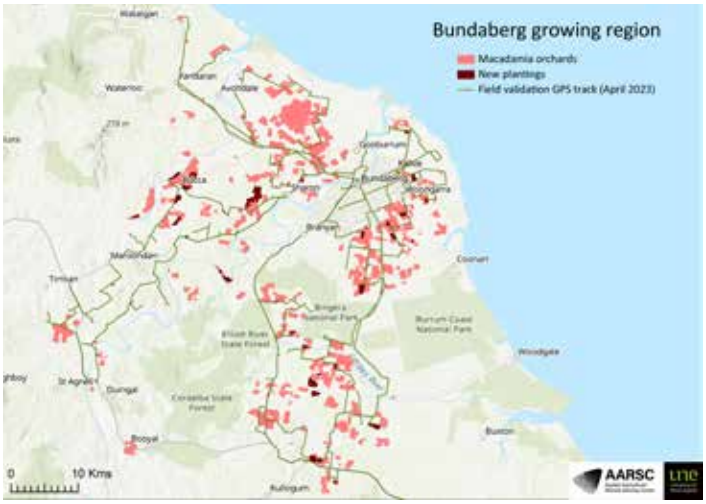


Figure 2. *Field validation of the Bundaberg growing region (April 2023)*

These industry-specific maps will capture more detailed spatial, temporal and attribute data that will significantly enhance industry level decision making into the future.

To achieve this level of data collection, the AARSC will train staff from each industry body on how to use the spatial framework. This is an essential step as not only does this enable the industry bodies to collect their own grower data, but by building in-house capacity ensures the continuation of the mapping into the future. Importantly, the Block Builder app and all data it holds is managed and secured by AARSC under strict sign-in access for AMS only. The app will also be supported through a mobile data collection tool which runs on a tablet device (iPad). This industry only map supports AMS to make more powerful and informed decisions, beyond the limits of the ATCM which only includes the extent of macadamia orchards.

Help maintain the map

The phenomenal growth in new orchards highlights the need to maintain the map at least annually. Mapping new crops is best informed with the engagement of industry and growers using location-based tools built by the AARSC.

Anyone can review the map in the Industry Engagement Web App www.une.edu.au/webapps (best on desktop) or use the ATCM Survey, https://arcg.is/0H0L9P (best for mobile), to provide feedback. If anything is missing or incorrectly mapped, or a new orchard is being planted, either of these tools can be used to bring it to the attention of the research team at AARSC.
Figure 3 shows an example of survey submitted for a new macadamia orchard (including photo), which has since been actioned and updated in the map, with the extent of the new macadamia orchard shown.

The ATCM survey, which is designed for your mobile device, uses your GPS. Complete a survey in four simple steps:

1. Launch the survey by clicking the link https://arcg.is/0H0L9P or scan the QR code (the survey will open in a web browser on any device).
2. Add location of the tree crop by clicking on the map:
   - Either select the crosshair button to quickly 'find my location' or search for an address.
   - Place the pin on the orchard by clicking the map and continue the survey (from a mobile device confirm the location by selecting either the ✓ or the back arrow (<) button in the top-left corner to continue the survey).
3. Select tree crop type and, optionally, and a photo.
4. Click submit to complete the survey!

Information

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Acknowledgment

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The *Spatially enabling Australia's tree crops* project is funded by the Future Food Systems CRC, Hort Innovation, UNE and industry partners including Avocados Australia, Australian Banana Growers Council, Citrus Australia and Australian Macadamia Society.



Figure 3. *Growers can help maintain the accuracy of the map by submitting their feedback through the ATCM Survey*



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Australian macadamia minor use and emergency permits

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Chemical	Permit no.	Pest/Disease use	Application rate	Withholding period (no. days)	Minor use permits
Minor use permits					
Abamectin	PER87510	Thrips and flat or broad mites	• Product containing 18 g/L abamectin: 750 mL /ha plus 5 L summer spray oil/ha • Product containing 36 g/L abamectin: 375 mL /ha plus 5 L summer spray oil/ha	28	All states and territories except VIC
Chlorpyrifos & maldison	PER13642	Australian plague locust	• Product containing 500 g/L chlorpyrifos: 350 mL/ha • Product containing 440 g/L maldison: 1.4 or 1.9 L/ha • Product containing 500 g/L maldison: 1.2 or 1.7 L/ha • Product containing 1000 g/L maldison: 600 or 850 mL/ha • Product containing 1150 g/L maldison: 520 or 750 mL/ha • Ground application	Chlorpyrifos: 30 Maldison: Not required when used as directed	All states and territories except VIC
Diazinon	PER14276	Macadamia lace bug	• Product containing 800 g/L diazinon: 120 mL product/100 L	14	NSW, QLD & WA only
Ethephon	PER11462	Promote nut fall after maturity reached	• Product containing 480 g/L ethephon: 65–250 mL/100 L water • Product containing 720 g/L ethephon: 55–165 mL/100 L water • Product containing 900 g/L ethephon: 44–132 mL/100 L water • Do not spray stressed trees • Refer to critical comments for varietal rate adjustments	7	NSW, QLD, WA & NT only
Indoxacarb	PER86827	Macadamia seed weevil	• Product containing 150 g/L indoxacarb: 50 mL product/100 L • Product containing 300 g/kg indoxacarb: 25 g product/100 L	42	NSW & QLD only
Methomyl	PER90592	Banana fruit caterpillar	• Product containing 225 g/L methomyl: 1.5–2 L/ha • Spraying ground mulch/soil surface up to treelines only • Do not spray tree foliage, flowers or developing nutlets	Not required when used as directed	QLD only
Petroleum oil	PER11635	Macadamia felted coccid	• Product containing between 763 and 861 g/L petroleum oil: 1 L/100 L water	Not required when used as directed	NSW & QLD only
Trichlorfon	PER13689	Macadamia lace bug, fruit spotting bug, banana spotting bug and green vegetable bug	• Product containing 500 g/L trichlorfon: 200 mL/100 L • Do not apply a spray volume exceeding 1500 L/ha • Do not apply by aircraft or to plants in flower • Not compatible with integrated pest management	2	NSW & QLD only
Emergency permits					
Spinetoram	PER89241	Fall armyworm	• Product containing 120 g/L spinetoram: 40 mL product/100 L	7	All states and territories except VIC

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

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

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