AUSTRALIAN MACADAMIA SOCIETY

AUTUMN 2023 | VOLUME 51 | NUMBER 1

NEWS BULLETIN

PRINT POST APPROVED: 100000824 ISSN 0811 - 3471

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The Big Heart of Australia's Macadamia Industry

AUSTRALIAN MACADAMIA SOCIETY

Contents

Front cover. Pat and Claire Wilson and their children Archie and Billie. The Wilsons have recently embarked on a program of orchard renovation on their orchard near Gympie, which includes removing rows of older trees to improve productivity.

The *News Bulletin* is the official publication of the Australian Macadamia Society Ltd.

The magazine is published in February, May, August and November.

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Subscriptions
The *News Bulletin* is distributed directly to all Australian Macadamia Society members.

Levy payers can download the *News Bulletin* from the AMS website or contact the AMS to receive a hard copy.

Deadline
Third week of the previous month (e.g. 3rd week in January for February issue)

Editorial Policy
The AMS Editorial Committee reserves the right to edit, withhold or reject any material.

Wherever you see this logo, the initiative is part of the Hort Innovation Macadamia Fund. Like this publication itself, it has been funded by Hort Innovation using the macadamia levy and, in the case of R&D, with contributions from the Australian Government. Hort Innovation is the grower-owned, not-for-profit research and development corporation for Australian Horticulture. Some projects also involve funding from additional sources.

Hort Innovation Strategic levy investment | MACADAMIA FUND

AUSTRALIAN MACADAMIA SOCIETY

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

While some in the industry have not experienced market conditions as currently exist, there are also many who have, and their knowledge and experiences will be critically important in helping us all to navigate the road ahead.

The February MacGroup program was designed to draw on that knowledge and experience, and my thanks to those who shared their insights about managing costs and yields in difficult times.

The MacGroups also provided an update on an important element of your levy dollar at work – the Australian Macadamia Marketing Program. More than ever before our focus on demand creation is critical, across all market areas, in both domestic and export markets.

In addition to delivering the core marketing program, our role is to leverage your levy dollar as much as we possibly can. As a peak industry body we will continue to seek additional funding opportunities, particularly in export market development, at every opportunity in the months ahead.

Ensuring that the value of your levy dollar is maximised in all areas is critical. As part of this process, in the last six months we have been working closely with the Horticulture Innovation Team to review and rebuild the macadamia industry engagement mechanism and strengthen the foundations and contributions of the macadamia SIAP. The aims in doing this are to create a more engaged and integrated model to allow information to flow from regions and from areas of R&D focus, and to establish stronger accountability on deliverables and outcomes. It has never been more important to ensure value in both priorities and delivery.

Over the last six months I have been asked about the primary role of a peak industry body, and what my vision is for the AMS. The answer is largely the same, i.e., to listen, to be agile and reactive and to engage and collaborate as we seek to deliver clear and tangible outcomes and benefits for industry.

As the industry navigates the challenges of the future, we need to continue to focus on those areas where we have the greatest ability to influence, e.g., engaging with government and other key stakeholders to advocate where an industry voice is needed.

Collaboration is another core focus, the indisputable benefit of which extends not just across the macadamia industry, where we are working to build closer engagement between stakeholders, but also between industries.

The AMS's active involvement in the Australian Nut Industry Council ANIC is one such example. We are currently working very closely with the ANIC team and the Australian Government in the review of technical market access requirements for India.

Similarly, our collaboration with other peak industry bodies through the NFF Hort Council, provides a strong and united voice to government on issues as diverse as labour laws, land use legislation, carbon initiatives, sustainability, and regional industry support funding.

From an AMS team perspective, the focus remains on establishing systems and resources that are not tied to a single physical location. Our concept of regional 'Nut Hubs' has started with the move to a more permanent space at DPI Wollongbar for those team members based in NSW. Over the coming months, we will be focused on extending the concept to co-locate with other industry service providers in other production regions.

At the AMS Board meeting in Bundaberg in early February, it was decided to defer the proposed AMS membership changes and at this point in time there will be no change to the AMS membership structure with regards to either fees or the associated AMS voting entitlement.

This decision was not taken lightly after the extensive industry consultation of the last 18 months and the unresolved need to provide a surety of funds to allow the AMS to work effectively on your behalf. However, in deferring any change, it recognises one critical factor, that it is not about membership, it's about the need to focus on delivering value to industry and I hope you will all see that value in 2023.

There are undoubtedly many challenges ahead, but in all of them we are stronger together.

Clare Hamilton-Bate | CEO

Driving demand for Australian-grown macadamias is key in 2023

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

Global supply

Global supply of macadamias is increasing rapidly due to the significant number of international plantings coming into bearing. The 2022 global crop was reported as 300,213 t @ 3.5% moisture, up from 241,420 t in 2021 (+24%). The initial 2023 forecast is expected in March.

At the AusMac Conference in November, the World Macadamia Organisation (WMO) shared its expectations of an average annual growth of 11.3% over the next five years, with the global crop estimated to reach 503,425 t @ 3.5% moisture in 2027.

Global demand

In the 12 months to November 2022, global demand for macadamias returned to pre-COVID-19 shipment levels, with imports to the top five kernel markets up 14% overall compared to the prior period.

Global in-shell imports to China/Hong Kong for the period MAT December 2021 to November 2022 were reported at 42,426 t (-6% on prior period).

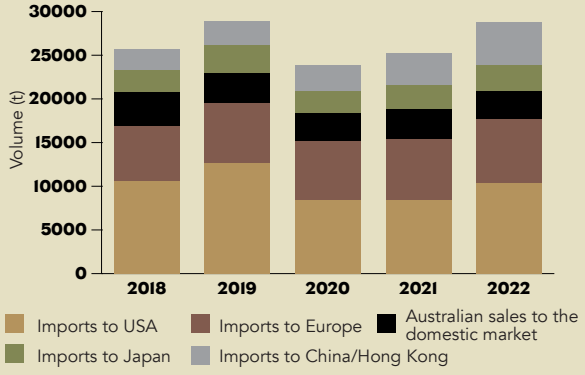

Figure. Macadamia kernel imports to top five markets (tonnes) MAT December - November
Sources: USDA, Eurostat, Japan Customs, China Customs, Hong Kong Census & Statistics Department via IHS Markit Inc, AMHA

Outlook

Global supply has increased at a faster rate than global demand. This imbalance has led to downward pressure on prices and a highly competitive sales environment globally. The situation provides both challenges and opportunities for the macadamia industry. Promisingly, macadamias are now more attractive to many sectors, particularly manufacturers, and this provides opportunities for investing in the development of new products containing macadamias as customers are more confident in the long-term surety of supply. Generating additional demand for macadamias is now more critical than ever.

The dual imperative is to inspire more consumers to eat more macadamias and to drive the use of macadamias as an ingredient in new products.

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 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.

Stimulating demand for the macadamia category

The WMO was formed in 2021 with the ambition of stimulating demand for macadamias by increasing consumption in existing markets and introducing macadamias in new markets. WMO activities are focused on the major markets of USA and China and the emerging market of India. All WMO activity is category-specific and origin-neutral. For more information, turn to page 12 or go to the WMO website worldmacadamia.com

Australia is a member of the WMO and is represented on the WMO Council by Richard Sampson Genest from Stahmann Webster and AMS Board member Michael Russo.

The 2023 Australian Macadamias Marketing Program

The marketing program in 2023 will focus on four strategic priorities:

1. Strong and unique Australian branding
2. Driving innovation among the food and beverage manufacturing sector
3. Providing consumer inspiration
4. Developing a new market

2023 core activities

PRIORITY 1: STRONG & UNIQUE BRAND	PRIORITY 2: DRIVE INNOVATION WITH MANUFACTURERS	PRIORITY 3: INSPIRE CONSUMERS TO EAT MORE MACADAMIAS	PRIORITY 4: NEW MARKET DEVELOPMENT
Refreshed branding for Australian Macadamias that celebrates Australia as the natural home of macadamias.	1. Connect R&D and marketing professionals with innovation news, consumer research insights, promotion highlights and health updates via monthly direct email communications, LinkedIn and PR campaigns. 2. Creation of resources to increase consideration of macadamias in New Product Development. 3. Trade Forum in Japan and South Korea in April 2023*.	Social media / public relations communications that showcase the functional benefits of taste, health and versatility, the ability of macadamias to elevate any food or occasion and share the story of Australia as the natural home of macadamias.	**Phase 1:** Create Indian-localised marketing assets e.g., website, Facebook, Instagram, digital videos, recipes. Enable market access e.g., labelling webinar. **Phase 2:** Awareness and education campaign utilising social media, sampling, PR. **Phase 3:** Engage and partner with restaurants, chefs, influencers and food bloggers.
Differentiation focus	**Market penetration in priority markets: Australia, Japan, South Korea, Taiwan, China**		**Market development in potential high growth market: India**

* Funded under Agriculture Trade and Market Access Cooperation program (ATMAC), by the Commonwealth of Australia represented by the Department of Agriculture, Fisheries and Forestry. (DAFF).

TRADE CHANNELS

Trade website
trade.australian-macadamias.org

E-Newsletter
English
Japanese
South Korean
Taiwanese (2023)

LinkedIn
linkedin.com/company/australianmacadamias

WeChat

Trade & industry publications

Trade PR

Australian Macadamias Marketing Committee

The Marketing Committee consists of 10 members who represent the interests of Australian macadamia growers and the commercial supply chain. The committee members are selected for their strong global marketing expertise and experience, particularly with reference to macadamias, tree nuts and premium foods. The committee provides advice, strategic direction and recommendations to enable the Market Development Manager (MDM) to develop an annual investment plan for marketing and long-term strategic plans.

The MDM thanks the 2022 committee for its insights and support in the development of the plan: Andrew Waddell (Stahmann Webster), Brian Loader (Green & Gold Macadamias), Michael Waring (MWT), Steve Dubber (Macadamias Direct), Larry McHugh / Charles Cormack (Marquis), Trevor Steinhardt (Macadamias Australia), Sarah Leonard (Nutworks), Paul Hudson (Waliz Nuts), and Henrik Christiansen (MacField Farms).

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Leoni's orchard rounds

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After a challenging 2022 growing season, the industry has produced a crop of 56 800 t (@10% MC). While this is a 3% increase on the 2021 crop (55 200 t), something that seemed very unlikely this time last year despite the growth of the industry, this final figure reflects the impact of severe weather on the regions.

Production in the NSW Northern Rivers and Mid North Coast growing regions declined, although less than was expected after what felt like an unending harvest affected by months of weather delays (see Table 1). Similarly for South East Queensland, Gympie's production was lower but, surprisingly, regions closer to Brisbane had an increase, despite localised damaging weather. There was a sizeable increase in the Bundaberg crop as new orchards come into bearing, and the region now grows just shy of half of the national crop.

Average total kernel recovery for the 2022 season was just over 38%, with bearing from newer cultivars with higher kernel recovery lifting the industry average.

Season preparation

Many growers reported staged flowering last spring, with distinct flower sets that have seen different nut growth stages on trees. The impact this will have on maturity and harvest timing is still to be seen. Most regions certainly have adequate soil moisture following the wet season, and crop load looks promising.

With tough market conditions for all nuts, lower farm-gate price and rapidly increasing costs over the last year, all operations are looking to prioritise and rationalise where possible to compensate for the slimmer margins likely this season. It is a position the industry has not been in for more than a decade, and with so many new entrants this is the first really tough season they are facing. Every grower has a cost of production figure and a breakeven point which is now front of mind and sharpening all decisions.

As part of the February MacGroups, seasoned growers shared their experiences of previous challenging times and lessons they learned. I encourage you to watch the video (on the AMS website Industry Resources page) if you were unable to attend and reach out for assistance if you need it.

While the industry continues the journey of demonstrating broader sustainability, this season will include more conversations about personal and enterprise sustainability.

Autumn flush, the driver of production

Generally, conditions for the late summer/early autumn flush have been good. The importance of having these good conditions cannot be understated. This flush is the framework on which the next crop is built, setting up crucial reserves that support flower development and set a good crop. New leaves from this flush are highly productive once mature, and research shows that each nut needs roughly 50 leaves to produce the required resources to maturity.

Research has shown that about 50 leaves are needed to produce the resources necessary for one nut to grow and mature.

Region	Mid North Coast NSW	Inland Northern Rivers NSW	Coastal Northern Rivers NSW	South East QLD	Gympie	Bundaberg	Tropical QLD
2022 t NIS @10%	1756	12720	4257	5672	3797	27,592	1008
2022 % of overall	3%	30%		10%	7%	49%	2%
2021 t NIS @10%	2369	13,021	4432	4828	4038	25,199	1322
2021 % of overall	4%	32%		9%	7%	46%	2%

Table 1. *Regional crop production breakdown for the 2021 and 2022 seasons. Source: AMHA*

Factors that improve flush	Factors that impede flush
• Good soil moisture	• Disease and other tree stress
• Humidity and mean temperatures in the mid-20s (Celsius)	• Long periods of mean hot temperatures >30°C
• Enough sunlight	• Shaded conditions (>60% shade)
• Adequate nutrition, particularly nitrogen	• Ill-timed hedging
• Singular energy sink	

Table 2. *Factors that improve and impede flush.*

Being vegetatively biased, macadamias are driven to flush over any other process, and milder autumn conditions provide the perfect opportunity for this with all the ingredients for growth, including the important singular energy sink.

Nuts have largely used all the resources they are going to, and this flush (leaf and root), unlike the other later in the year, does not compete with other processes. This means it's a really bad time to hedge or to hold back nutrients. We see this so clearly in a nursery setting – if you don't beat the flush by providing the nutrients required, the flush tells all with off-colour, malformed, smaller leaves and shoots. We cannot see this in the root zone, but we know this inadequacy is mirrored there.

While weather conditions aren't within our control, tree nutrients and good root growing conditions with enough organic matter are, and this is what management strategies should focus on.

This is easier said than done in a challenging season when farm income will be stretched thin. The message from seasoned growers is unanimous - prioritise inputs but don't walk away from tree nutrition completely. Abandoning a nutrition program saves the expense in this season, but is far more costly for many seasons to come.

Macadamia growing has made great strides in the last decade. Our product is unique among Australian foods, and is versatile and highly sought after. Macadamia is often the envy of horticulture for its distinctive culture and the high long-term confidence in the industry and its future.

I look forward to seeing you out in the orchard.

Leoni

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New faces on the AMS Board

Mark Napper, Chair

At the AMS annual general meeting last November, Mark Napper took over the reins as Board Chairman. Mark, who previously had a stone fruit and custard apple farm near Bangalow in the Northern Rivers, now operates a business advisory company and has a long background in agribusiness management. His roles include having been deputy chair of Hort Innovation from 2015 to 2018, and a having been member on a number of horticulture related boards such as Santos Organics Ltd, Australian Mango Industry Association Ltd and AUSVEG Ltd.

This wealth of experience will give Mark a valuable perspective as he guides the AMS Board into the future. We spoke with Mark about how he sees 2023 for the board and the industry.

What are you most looking forward to in chairing the AMS Board?

Mark. One the things I am most looking forward to is working with a board of extremely high calibre. The members bring with them varied skills and experiences and they are all driven to ensure the long-term sustainability of the Australian macadamia industry.

As chairman, my role will be to maximise the use of those skills and experiences and provide an effective sounding board and strategic support for management as we serve the macadamia industry.

I will also be ensuring that we are listening and responding to our members – growers, processors and other key stakeholders - as I guide the board and organisation through the current challenging times. As part of this, it will be important to ensure the management of the levies is efficient and effective and that the levy investment is delivering on agreed outcomes.

What are the key issues that the AMS will need to manage this year as far as its members are concerned?

Mark. The AMS is no different to any business or member organisation in that we must ensure it is delivering value for its members by staying focussed on what we are here for, i.e., to unite, facilitate, educate and advocate on behalf of our members. To do that we need to ensure we are engaging with our members, listening to their concerns and responding within the bounds of our responsibilities and resources.

Our CEO Clare Hamilton-Bate has taken over the role recently after a long-serving CEO so there will be change in the way we operate, which will be unsettling for some and exciting for others. Managing that change will be very important.

Another key issue in relation to the investment of levies is to ensure that the three key stakeholders – industry, government and Hort Innovation - are aligned and that communication and processes around the levy investment are efficient and effective. If we achieve this, we can be confident in delivering value to growers and government who are investing in the industry.

Achieving returns on grower investments is particularly important given the pressures on growers from prices, floods and increasing input and operating costs.

What are the key issues for the industry this year and how might the AMS contribute to their management?

Mark. The key concern for all members is price. AMS has a role to educate members on current market conditions so they can make informed decisions and to facilitate communication within the membership to foster collaborative mechanisms through this depressed period.

The current times are extremely stressful for our members. We empathise with their situation and are responding to immediate needs, however, it is important that the AMS does not lose sight of the key underlying strategic issues facing the industry as outlined in the recent macadamia industry plan. These are to:

1. Push demand for macadamias by promoting: an enhanced reputation for high quality safe products, widespread appreciation of their health benefits, effective global market monitoring and analysis, strong customer support for Australian brands and provenance, and targeting new and existing markets and segments with new products that maximise value.
2. Lift industry productivity by: adopting focussed R&D that addresses short- and long-term industry challenges, adopting best practice in orchard management, planting material that is fit for purpose, encouraging innovation in processing, and strengthening industry's social licence.
3. Foster a unified, well-resourced industry.

The AMS sees it has a key role to work on behalf of members, partnering with industry providers and engaging with key stakeholders to deliver on these objectives ensuring that Australian macadamias are the world's favourite nut.

Robbie Commens, director

Robbie Commens is no stranger to many in the AMS and the industry having previously been employed as the AMS industry development manager before he took on a new challenge several years ago and invested in growing macadamias on the floodplain. These roles give Robbie a unique perspective on the industry and the AMS.

What was your main reason for standing for the board?

Robbie. I want to contribute positively to the macadamia industry, and I saw this as an opportunity to do that. And all the previous board members from when I was an employee there made it look like good fun!

What will be your priorities this year for the board?

Robbie. My focus will be to review progress made over the past five years, review and understand the vision the AMS has for the next 20 years (not five, as orchards have a life of well over 20 years) and to identify the opportunities to help drive us toward that vision.

What are the key strengths of the AMS that you feel will support growers as they deal with the challenges of 2023?

Robbie. In my previous role with the AMS, I was fortunate enough to meet hundreds of growers, visit hundreds of orchards and gain a greater understanding of the differences across regions, across orchard size and across grower mindsets. I am hopeful I can help provide input based on that experience. I now also have firsthand experience in orchard development, large-scale tree planting, harvesting and managing older, more mature trees. I am hopeful this experience can add value also.

The main value I hope to add is through a lesson I learnt a long time ago when I was on the Queensland Turf Producers board. It was that (in my opinion) there is no such thing as an "industry". An industry is not tangible, rather I think of it as a collection of people. When there are statements like "the industry needs to…" or "if only the industry would …", I fear this relegates great ideas to a black hole. The AMS does its best to fill that black hole where it can, but the AMS is not the macadamia industry, and the macadamia industry is not the AMS. Macadamia growers, macadamia processors, macadamia consultants, macadamia researchers, macadamia marketers, macadamia suppliers, macadamia orchard employees are the macadamia industry.

The upshot of this is that I would rather there be statements like "we need to..." and "if only we would...". I believe for there to be a profitable and sustainable macadamia industry there need to be profitable and sustainable growers, processors, suppliers, researchers, marketers and employees. And I think we will achieve that through improving our consumers' experience and perceived value. Bring on 2024!

Daniel Howorth, director

Another new member of the AMS Board is Daniel Howorth, a grower based at Dunoon in the Northern Rivers. Daniel recently left the corporate world to work with his wife on her macadamia farms, which she has been running for the last six years.

What was your main reason for standing for the board?

Daniel. When we started farming six years ago, we were really well supported by the AMS and growers - we knew nothing and had embarked on a huge learning curve. We would have never survived if it hadn't been for all the helpful people we found along the way.

Nominating for the board was my chance to repay the industry by using my skills and experience from the corporate world.

What will be your priorities this year for the board?

Daniel. The industry is facing serious challenges, with many farmers operating at a loss last year and certainly in 2023. This is in the context of massive floods, transport delays, COVID-19 and inflation.

How we respond to these challenges and clearly understanding the unique role of the AMS as the peak body in leading the industry forward is an absolute priority. This will require tough discussions to ensure the right focus upon the key priorities as we won't be able to do everything.

Understanding what growers in all regions need and supporting them through these challenges will be important.

Articulating what the AMS role is as the industry peak body and delivering upon this is essential.

Lastly, there are opportunities which can be further exploited, such as leveraging the AMS to represent at all levels of government, seeking their support and assistance, or helping the Australian public understand the price discrepancy between farm gate and store prices.

What are the key strengths of the AMS that you feel will support growers as they deal with the challenges of 2023?

Daniel. The AMS (staff, growers, consultants and processors) has a fantastic culture of helping each other, knowledge sharing and continuous improvement which will allow us to meet these challenges, both in the short and longer terms. It is essential that we retain and build upon this culture.

It is also important to understand what we need to continue, change or stop doing in order to be better prepared for our future and better times ahead.

It is this culture that will help us have a healthy dialogue to address these questions.

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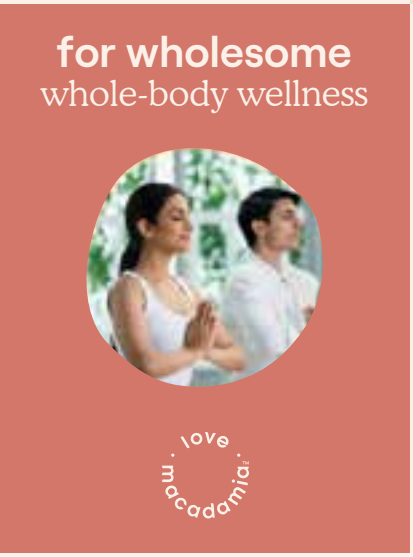

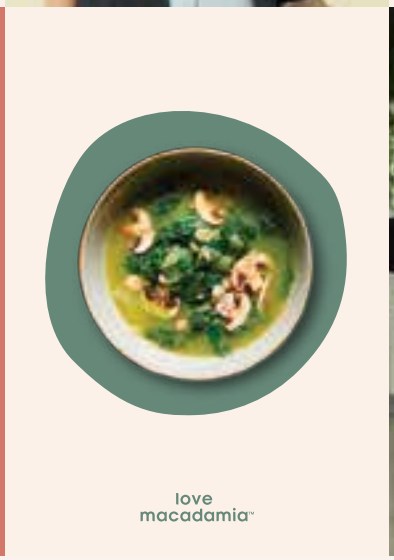

How do we create more macadamia demand?

There are only three ways to increase demand for food products, including macadamias:

- Have people eat them more often
- Have people eat more each time they have them
- Have more people eating them

At the WMO, we are working programmes to change consumers' behaviours to consume more macadamias.

In China, for nut-in-shell, we are targeting consumers eating them more often. Most macadamia consumption is around Chinese New Year, and we are seeing early success in creating a new peak around National Holiday which is in October. In addition, we are introducing kernels as a more convenient form for regular snacking.

In India, we are looking to convert new consumers to macadamias. The initial focus is New Delhi and the wealthy, health-conscious consumers in this city. They rely on dietitians to "prescribe" their food intake, and we are ensuring that dietitians have the knowledge to include macadamias on this list because of their good fat profile.

In the USA, we are encouraging people to eat macadamias more often. On average each person there eats 38g of macadamias per year (less than a third of Australian levels), and more eating occasions will drive this up. This shift is being achieved by increasing awareness and visibility, delivering a stronger health message, and providing inspiration for how macadamias can be incorporated into daily life. Also, we are encouraging food manufacturers to include macadamias in their products, especially those where the good fat content of macadamias helps their product delivery and marketing messages.

Love Macadamia™ is the movement all about building the love of macadamias, and it's now showing up in China, India and the USA.

The WMO receives funds from a number of macadamia producing countries, including Australia, to support its global demand generation activities. Thank you for your support.

wmo world macadamia organisation

KLAS audit verifies consistent assessment standards

Darren Burton, M: 0415 664 335, KLAS@macadamias.org

The AMS Kernel Laboratory Accreditation Scheme (KLAS), which began in 2016 and includes 13 accredited laboratories in NSW and Queensland, plays an important role in providing a transparent and consistent system of nut-in-shell sampling and kernel recovery testing for the industry. Last year, an independent audit of the scheme confirmed that growers and industry can be confident in its integrity, with all laboratories maintaining their accreditation.

Independent audits underpin integrity

As part of the scheme, all laboratories undergo a third-party audit every second year to confirm they are operating according to KLAS rules and the kernel assessment manual. The auditor, Graham Lancaster from Southern Cross University, verifies that each laboratory complies with sampling, drying, weighing and assessment standards. After completing the 2022 audit, Graham gave the scheme and laboratories audited a big tick.

> *"The findings from this year's (2022) audits demonstrate that all currently accredited laboratories are working within the standards outlined in the scheme rules. All of the accredited laboratories demonstrated that they are committed to achieving the goals relating to uniformity within the industry, promoting a transparent and quality service to the growers. As has been noticed in previous years, there are some slight differences in execution by laboratories which show no impact on the quality of result."*

Ensuring consistent standards

There are four other key elements in ensuring accredited laboratories maintain consistency across the scheme. These elements are: following KLAS Scheme Rules and the Kernel Assessment Manual, participation in regular staff training and inter-laboratory testing.

The scheme rules. Under the program, laboratories must follow the KLAS scheme rules, which define all the standards and procedures for NIS sampling, kernel assessment and grower reporting that must be followed.

Regular staff training in KLAS rules, like this one held in Lismore in 2022, is important in ensuring consistency of approach and standards.

The Kernel Assessment Manual. This document contains pictures of all the different types of kernels that exist in the industry and defines whether they are classified as premium, commercial or reject grade kernel. All laboratory staff follow this manual when performing kernel recovery testing.

Staff training. A key element of program is the requirement for laboratory staff to attend annual training events to ensure they maintain the necessary knowledge and skills for undertaking kernel assessments. Ongoing training ensures that all kernel laboratories are classifying kernel in a consistent manner as set out in the kernel assessment manual. Last year, 72 staff from the accredited laboratories completed the training.

Round-robin inter-lab testing. Each year, every laboratory participates in round-robin inter-lab testing, which is designed to examine the degree of variance with testing between them. This is measured by each laboratory being required to undertake a full kernel assessment and NIS moisture test of five NIS samples from the one batch of NIS. The results are analysed by Southern Cross University and reported to the laboratories and the AMS. In 2022, the round-robin results showed a high degree of consistency between all accredited laboratories across the industry.

Information

For any further information about the Kernel Laboratory Assessment Scheme contact the KLAS Co-ordinator, Darren Burton at KLAS@macadamias.org or on 0415 664 335.

Accredited laboratories

- Agreco Australia
- Cropwatch Independent Laboratories
- CL Macs
- Macadamias Australia
- Macadamias Direct
- Marquis Macadamias – Bundaberg
- Marquis Macadamias – Lismore
- MWT Macadamias
- Nambucca Macnuts
- Nutworks
- Pacific Farm Services
- Stahmann Webster
- Suncoast Gold Macadamias

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Varroa mite eradication program continues into 2023

When varroa mite (*Varroa destructor*) was discovered in European honey bee hives near Newcastle, in June 2022, an industry-agreed response plan was initiated, with the aim to eradicate this significant pest and minimise the impact on businesses, communities, ancillary industries and the environment.

Until this incursion, Australia had been the only beekeeping area of the world that had not been infected by *Varroa destructor*. It was detected in Victoria in 2018 in a swarm of honey bees arriving in cargo, but the bees were reported by the crew of the arriving vessel and the swarm was eliminated.

Since varroa mite was discovered mid-last year, NSW DPI has been working with beekeepers across the state to locate infested hives and carry out containment and control activities. An important part of the response has been to restrict movement of beehives based on designated emergency zonings. The zones are:

1. 10 km (red) eradication zone
2. 25 km (purple) surveillance zone
3. general (blue) emergency zone, which covers all of NSW.

Situation now

Up until 1 February 2023, 112 premises in NSW – the majority in Newcastle and the Hunter Valley region, as well as one property in north-west NSW and one on the north coast near Coffs Harbour – had reported bees infested with varroa mite. The last detection, as a result of surveillance of purple zones, was in December at Vacy in the Hunter Valley. This detection means that the red eradication zone was extended to cover this area.

NSW DPI is confident that having the red and purple zones will contain the spread of varroa mite.

According to the National Pest and Disease Outbreaks website (https://www.outbreak.gov.au), increased surveillance may lead to other detections in the red and purple zones, and links to known infestations are currently being investigated. If an infested hive is detected outside of an existing zone and not linked to the movement of an infested hive, this will trigger a review of the response plan.

So far, NSW DPI has humanely euthanised bees from more than 17,000 hives as part of the eradication program, and managed hives are being prioritised for inspection.

States agree on blue zone

On 20 January 2023, all states and territories agreed that the NSW General Emergency Zone, or blue zone, would be declared free of varroa mite. This meets World Organisation for Animal Health requirements for Proof of Freedom.

This is a step towards enabling blue zone beekeepers to resume business and apply for permits to move managed hives across state borders. While beekeepers in the eradication (red) and surveillance (purple) zones will still not be permitted to move hives into or out of their respective zones, they will be permitted to work their hives for surveillance purposes or to prevent swarming and to add a permitted bee feeder to their hive.

Registered commercial beekeepers in the blue zone must still complete a Hive Movement Declaration to move honey bees and hives, to allow for their business continuity and to provide pollination services. They also must meet other requirements, which are detailed on the NSW DPI website.

More detail on requirements for beekeepers across NSW can be found at the NSW DPI website.

Information
For information go to your department of agriculture or primary industries website or the BeeAware website, www.beeaware.org.au

NSW DPI publishes regular updates on the response at their website https://www.dpi.nsw.gov.au/emergencies/biosecurity/current-situation/varroa-mite-emergency-response

Note: This information was correct at 9 February 2023.


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Camera solution for wheel blockages with bespoke tractor

By **Samantha Elley,** journalist

Growers: Trevor and Barbara Martin

Orchard: Bunya Bunya, Eureka, Northern Rivers NSW. Bought in 2011

Size: 8,300 trees

Cultivars: Ten cultivars, mainly A4, A16, A38 and 849 with the rest being Hawaiian cultivars

Soil type: Red ferrosols

The quest for harvest efficiency has motivated Eureka grower Trevor Martin to make some innovative modifications to his machinery.

Trevor Martin, whose Bunya Bunya macadamia farm is nestled in the small Northern Rivers village of Eureka, has taken advantage of the past decade when yields and prices for macadamia nuts were high. According to Trevor, this is the time to equip the farm properly.

"This has allowed us to be able to buy the machinery we have today," he said, adding that while they knew a downturn would come, they didn't think it would be "so quick and so severe".

Machinery modifications focus on harvest efficiency

Harvest efficiency has been a priority for Trevor, and it motivated him to look at the farm equipment to see if there were modifications that could be made. With the help of Lismore Engineering and using an 84 kW Fendt 211P Vario tractor, he has built a bespoke machine that he believes is a one of a kind.

His idea of using the Fendt tractor to not only harvest but also mulch in one pass, came about when he wondered if there was a more efficient way of operating rather than spending long hours doing multiple passes on each row.

"The tractor and the harvester were part of that strategy because when we are faced with commodity prices as low as we are experiencing at the moment, we need to be as efficient as possible," said Trevor, who previously farmed rice in the Riverina.

"With most crops you do a single pass and you're done, but it's not like that here," he said.

One of the pieces of equipment Trevor looked at to help with this strategy was his Faustini mulcher. He knew that it already did a really good job and this was the basis for some tests with a concept in mind.

"The double-pickup front on the harvester is not new but to be able to harvest and mulch at the same time, well, I don't know of any machine in Australia that can do that," he said.

All the tests that Trevor performed were so successful that he decided to take the concept to the team at Lismore Engineering, who worked on bringing it to fruition over the next six months.

"They knew it would be a game changer in the industry and so they were keen to build it," Trevor said.

With the harvester to be fixed to the front of the tractor and the mulcher and bin to be fixed to the back, the important task for Lismore Engineering was to work

Trevor's modified tractor with harvester fixed to the front and the mulcher and harvest bin on the back.

out the purchase weight and whether the tractor would handle it.

They also had to mount the bin over the mulcher, something that Trevor said they "have done a great job of".

Camera installed

Trevor's bespoke tractor didn't come cheap as it put him out of pocket by just over a quarter of a million dollars. And it has not stopped the occurrence of wheel blockages.

"This is one of the biggest problems in macadamia harvesting, and I need to be able to see those wheels and stop and reverse and clear the blockage as soon as possible," he said.

On his previous nut harvester Trevor said it was easy to see all the wheels, but this wasn't the case with the Fendt. With a total of 30 wheels operating when the tractor is working in the orchard, Trevor decided that installing a camera would be the solution. In fact, this was an essential part of the build of the harvester.

"The camera, which cost around three hundred dollars, has been a success, as it gives a very clear vision of all the wheels operating," said Trevor.

When he is harvesting, he can see two-thirds of the wheels, but with the camera he can see the whole lot.

He initially had two cameras, one on the back and one on the front, but he found that the one on the back was not necessary.

More plans on the drawing board

Trevor hasn't finished with his modifications, and is now thinking about installing a motion sensor for the wheels to alert him earlier when there is a problem with blockages.

"The quicker you can get a wheel blockage detected you're more likely to be able to reverse up and go again," he said.

Trevor said while many people have commented on the efficiency of his tractor, which allows him to harvest and mulch at the same time, not many are prepared to pay such a high price. This is especially the case because people are used to doing two passes with the harvester then mulching.

"They might be set up for that with staff and labour but we're not," he said.

With only he and Barbara working the farm, they want to be as efficient as possible.

The return on the Martin's large investment is ongoing, with significant savings made in labour and fuel. The comfort of an air-conditioned cab with cruise control and hydraulic suspension also can't be underestimated.

"I can go longer in the day, so there's a lot of plusses," he said.

"I am very happy with it."

The camera is mounted on the harvester and Trevor can see on a screen mounted on the dashboard when there is a wheel blockage.

Why growing macadamias sustainably is a future imperative we cannot ignore

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

At AusMac 2022, Australian Macadamias Market Development Manager Jacqui Price and I explored the growing importance of sustainability, what it means for our industry and action that can be taken on farm to help growers optimise their long-term green credentials. Here we revisit some of the key points to help you chart your own sustainability plan and prepare for the inevitable changes the call for sustainable production will bring.

Sustainability: what does it mean and who is driving it?

While we hear a lot about sustainability, it can mean many different things, depending on who you talk to, from meaningless to being so important that it affects day-to-day management. For this article, sustainability is defined as "meeting our own needs today without compromising the ability of future generations to meet their needs".

Something that is clear is that the move to sustainability is being driven by consumers and it's having a big impact on purchase decisions, with 78% of Australians now willing to pay a premium for sustainable products[1]. They are actively seeking more sustainable options and changing their own behaviour, and expect growers, manufacturers, retailers and governments to do the same.

For our industry to continue to thrive long term, we must build an in-depth understanding of what we can do on farm to meet the sustainability expectations of today's consumers.

The values driving consumer behavioural change

The modern consumer wants to eat to make the world better.

At the SIAL Paris trade show in late 2022, the message to food innovators was clear: it's not enough to just be healthy or to have a great tasting product or just to be sustainable. You need to do *all* of that and be affordable at the same time. Future brand success will depend on offering this combination of benefits that today's conscious consumers are seeking.

Consumers today are driving a change in the market where food must be healthy, taste great and be sustainably produced.

Online research by Mintel[2] has revealed climate change, air quality and plastic pollution were consumers' top three environmental concerns in 2022 at 46%, 35% and 33% respectively.

Inflationary pressures, the war in Ukraine, supply chain challenges and rising input costs have triggered dramatic global change over the past two years. This is driving consumer interest in 'circularity', i.e., waste minimisation and extending the life of everything we consume through repair, reuse, remanufacturing or upcycling. This is reflected in the ways consumers are changing their behaviour[2], with nearly 60% buying products in recycled packaging in 2022, more than 50% planning meals at home to avoid wasting food and 50% buying fewer new clothes.

Sustainability reporting and goals

Consumers are looking to manufacturers, retailers and government to prioritise sustainability as well as to horticulture and agriculture. Environmental, social and governance (ESG) reporting is now standard practice for major corporations, particularly in the food and beverage sectors, and ESG considerations have become a priority for our industry's trade customers.

The United Nations has developed sustainable development goals as part of its 2030 Agenda for Sustainable Development. These 17 SDGs, which the UN describes as "an urgent call for action by all countries - developed and developing - in a global partnership", are designed to tackle inequality, health and education, economic growth, climate change and preservation of our oceans and forests.

The Australian macadamia industry is working on a sustainability position and practices, guided by the work of the International Nut and Dried Fruit Council (INC) and Hort Innovation.

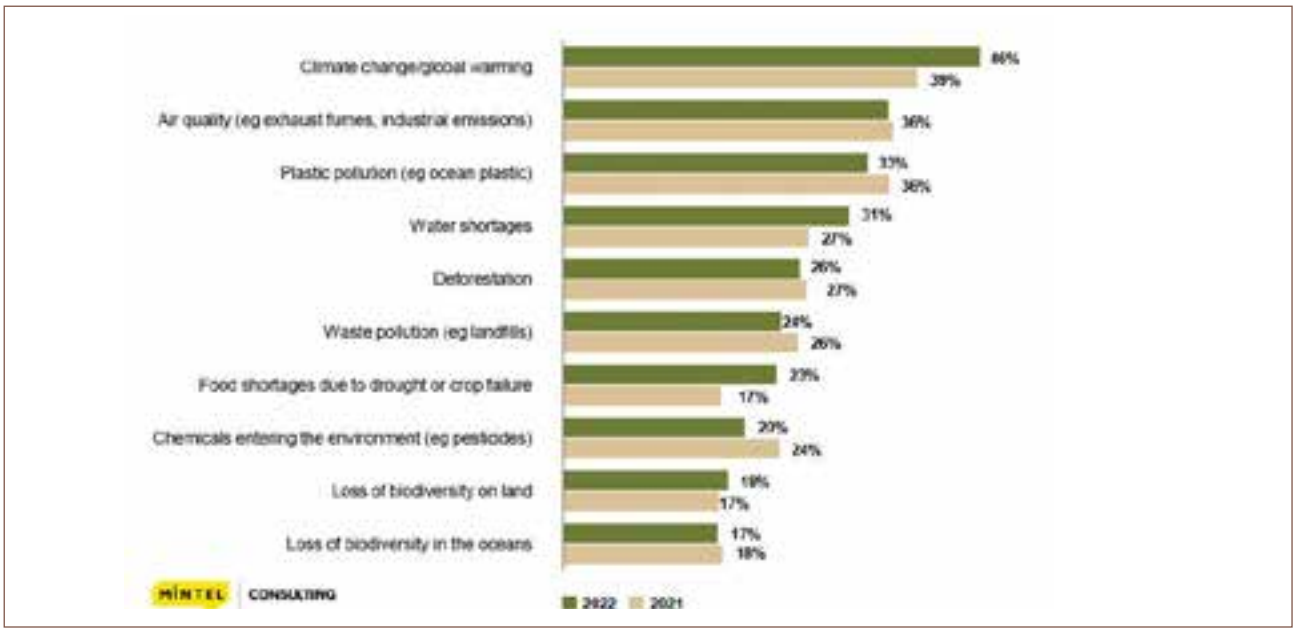

Figure 2. *Environmental concerns of consumers in 2021 and 2022.*

INC has identified five United Nations SDGs that the global nut industry can positively impact:

SDG #2: ZERO HUNGER
SDG #3: GOOD HEALTH AND WELLBEING
SDG #12: RESPONSIBLE CONSUMPTION AND PRODUCTION
SDG #13: CLIMATE ACTION
SDG #15: LIFE ON LAND

Closer to home, Hort Innovation invested in understanding what sustainability means to consumers to develop an Australian-grown Horticulture Sustainability Framework. It focuses on four areas:

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

Figure 3. *Hort Innovation has developed a sustainability framework for Australian horticulture.*

The macadamia industry in Australia is currently working on formalising its sustainability framework, and it is worth noting that we are working from a solid base.

- **Home ground advantage:** Australia is the perfect macadamia growing environment.
- **Perfect NRS record:** 100% compliance for 24 consecutive years in the Australian Government's National Residue Survey – the program that screens crops for chemical pesticides and environmental contaminants.
- **The strictest standards:** We were the world's first macadamia producer to implement rigorous quality standards and strict testing protocols that remain unmatched by any other producing region.
- **Committed to consumers:** Our industry takes food safety seriously. Growers are committed to clean and green production, and we take no risks when it comes to protecting our consumers.
- **Safety from every angle:** With sophisticated production processes, generations of knowledge about quality on farm and in factory, a commitment to reliability, sustainability and biological pest control, growers actively embrace organic and alternative solutions to control pests and reduce pesticide use.

Sustainability and trade negotiations

The global trading environment has significantly changed in recent years, much of it driven by sustainability becoming a more urgent priority. Sustainability is being increasingly incorporated into top level trade negotiations. Also known as 'green protectionism', it is a non-tariff barrier that will ultimately become a market access issue for our industry if we fail to adequately incorporate sustainable practices at a growing level.

"New generation agreements" have included specific chapters on Trade and Sustainable Development,

featuring in FTAs the EU has signed with South Korea, MERCOSUR and New Zealand, and it is currently under discussion with Australia.

Singapore, Vietnam and Thailand are discussing the development of carbon markets, while China is implementing a National Strategy of Actively Responding to Climate Change. The Singapore-Australia Green Economy Agreement is a world-first agreement that combines trade, economic and environmental objectives. It will drive collaboration on initiatives that accelerate the continued transition to best practices of sustainable agri-food systems.

Beware the greenwashing trap

Greenwashing refers to the potential for an organisation or industry to overrepresent the extent to which their practices are sustainable, and it's a trap our industry must be aware of as consumer demand for transparency grows stronger.

While we are definitely not greenwashing consumers, we need to reflect on whether our industry is guilty of internal greenwashing to any degree. Growing trees is good for the environment, but that doesn't mean changes aren't needed. Staying with the status quo is not good enough. Trading partners will demand more, consumers will demand more and as an industry we should be demanding more of ourselves.

What you can do on farm now

While it will take some time for our industry to develop its official position and associated goals, there is no need for growers to wait. Individual macadamia growing enterprises, particularly those with investors on board, will need to develop their own ESG frameworks.

There are several waypoints on this journey, such as Freshcare Environmental Certification, Reef Certification and Hort 360. There are also several actions you can take on farm now to understand how sustainable your organisation is, and these will form the basis of your organisations sustainability credentials.

Profitability: Understand the net profitability of your business, including debt commitments and green credentials.

Productivity: Understand which blocks on your farm are generating the most crop, where crop loss is occurring and the how sustainable these practices to be productive are.

Inputs: Monitor and understand the inputs in your organisation, e.g., energy, nutrients, water and chemistry.

Operations: How efficient are your operations? Are you only able to advance by stretching the capacity of current staff?

Labour: Understand the wellbeing and safety of your staff and contractors.

Risk management: How are you mitigating risks such as market trends, social licence, compliance and climate variability?

If you have all of this ticked off, you understand what consumers want, your organisation is sustainable or you're working towards it, one thing is guaranteed: more change. The sooner change is embraced, the better. The most expensive course of action is assuming someone else in the industry will take care of sustainability for you. It's everyone's responsibility and we must face it and embrace the required changes together.

To see how we are talking to the trade about the Australian macadamia industry's sustainability initiatives, take a look at our **trade website: trade.australian-macadamias.org/sustainability**

To see how we are talking to consumers, head to **australian-macadamias.org/consumer/sustainability**

References:
1 Lightowler Z, Mattios G, Yang J, Zehner,D Unpacking Asia-Pacific Consumers' New Love Affair with Sustainability, Bain.com, June 2022
2 Mintel; 8,000 online consumers aged16/18+ March2021; 16,000 online consumers aged16/18+ April2022

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Factors affecting total kernel recovery

This article is from a presentation delivered at AusMac 2022
by **Dr Rohan Orford** from **Macadamias Australia** **E:** Rohan@macadamiasaustralia.net

Being able to maximise total kernel recovery is the flagship number of growing macadamias as it is one of the determinants of the yield and profitability of the orchard. What tools or indicators do growers have to help them ensure their trees are performing to return a maximum potential total kernel recovery rate (TKR) and to help predict what TKR might be before the crop is harvested?

These are two questions that Dr Rohan Orford set out to answer in his presentation on factors affecting total kernel recovery at AusMac 2022.

The background

Rohan had a good basis for answering these questions as he had access to ten years' of data for 170 farms in South Africa and Australia. As he delved into the numbers, he discovered that as with many things in life, the answers are not clear-cut, rather involve a range of factors.

Two of the figures he had from each farm were TKR and altitude. This allowed him to come to an initial conclusion that geographic location and altitude are key determinants of TKR so that the higher farms are or the further from the coast they are in both Australia and South Africa, the lower kernel recovery is likely to be.

While this did seem to indicate a pattern that associated altitude with kernel recovery, Rohan said that this only supported between 60 and 70 per cent of cases. As he explained it, this pattern was a "pseudo correlation", which saw him on a quest to identify factors other than altitude that were also important.

Six to 12 weeks after flowering

By looking closely at and comparing figures for different farms, Rohan identified that the period six to 12 weeks after flowering was crucial in determining TKR. During this time, water availability, nutrition, solar radiation, relative humidity, diurnal (day) temperature and leaf temperature all combine to produce conditions favourable or otherwise to high kernel recovery.

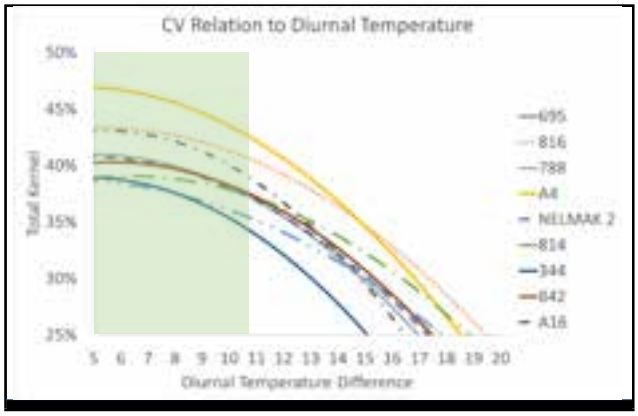


Figure 1. *TKR is higher for all cultivars in areas with diurnal temperatures below 11°C six to 12 weeks after flowering.*

Some of these elements – water availability (through irrigation and a well-mulched canopy floor), nutrition (through attention to the orchard nutrition program) and leaf temperature (though canopy management) - are all to some degree within the control of the grower. The others to do with climate are obviously "in the lap of the gods".

Of the climatic factors, Rohan identified diurnal temperature as being crucial, in particular the temperature range from 5 am to about 1 or 2 pm, with a difference of between 5 and 10°C optimal for high TKR. The key to diurnal temperature is that it is an easily obtainable and universal data parameter, and it is not as abstract as VPD, thus making it accessible to growers and other stakeholders as a handy decision-making tool.

"This difference grows the more you move away from sea level so that at a thousand metres, it can be between 12 and 14 degrees," he explained.

In turn, as shown in Figure 1, this will tend to reduce TKR. The figure shows that this pattern for all cultivars is similar in all regions, i.e., TKR is higher in areas with diurnal temperatures below 11°C six to twelve weeks after flowering. Where diurnal temperatures are higher than 11°C, TKR is lower.

Vapour pressure deficit the key

The story does not end with diurnal temperature, rather its importance is its relationship to vapour pressure deficit, the ultimate determinant of TKR.

Altitude affects diurnal temperature, which is related to relative humidity, which in turn drives vapour pressure deficit (VPD), something that changes "hourly, daily and monthly".

Rohan makes the analogy to explain the significance of VPD in a macadamia orchard by describing how it dictates the opening and closing of stomata, which are the "tellers that accept the money (carbon dioxide) coming into the bank and direct the costs (water) going out".

The carbon dioxide that enters the tree through stomata drives photosynthesis and determines the production of carbohydrates, which Rohan describes as "the currency for kernel recovery and yield".

In simple terms, the ability of the orchard to build its carbohydrate capacity is what determines TKR and income, so it is crucial for growers to do what they can

to develop this ability through good management, accepting that climatic and geography are things that cannot be controlled.

Optimum conditions for maximising TKR

By analysing diurnal temperature, relative humidity and vapour pressure deficit, Rohan identified the optimal conditions for maximising TKR (see Figure 2).

In essence, the following conditions are ideal:

- VPD between 1 and 2 kPa
- optimum temperature of 28°C
- relative humidity of 55%.

A climate map shows that these conditions apply along the east coast of Australia roughly between the Gold Coast and north of Bundaberg, at low altitudes (see Figure 3).

Application in the orchard

While growers cannot change orchard location, particularly if they are high altitudes, these findings are useful for a number of reasons, as follows:

- they indicate the importance of managing factors in the orchard that are within the control of the grower as a way of building its carbohydrate capacity and contributing to high TKR, particularly in that crucial period six to 12 weeks after flowering
- they show the importance of measuring vapour pressure deficit and managing the orchard to deliver moisture to the tree as much as is possible through irrigation and/or mulch
- they provide an indicator ahead of harvest of what TKR could be thus allowing for adapting harvest and delivery strategies.

Note. Rohan cautions that this work has not been scientifically reviewed, rather is based on his own analysis.

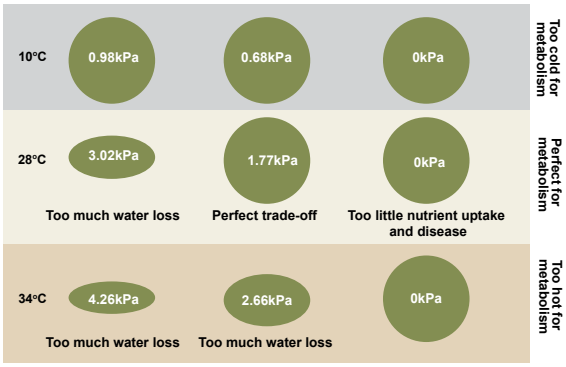


Figure 2. *A summary of optimal conditions for maximising TKR.*

Station name	Diurnal	TKR %
Broome - Airport	8.9	41%
Bundaberg - Aero	9.6	40%
Cairns - Aero	8.9	41%
Cape Moreton - Lighthouse	5.5	43%
Horn Island	6.3	43%
Mackay - M.O.	7.9	42%
Townsville - Aero	8.6	42%
Yamba - Pilot Station	9.2	41%

Figure 3. *Where optimal conditions occur for maximising TKR in Australia.*

The agtech going nuts in the macadamia industry

If we are going to collect data, we need to make sure that it is useful for making decisions on the farm. This means that we need to make sure it has the resolution and consistency to deliver tangible results where we can compare and correlate the input or practices that occurred over the season.

Harvesting is just one farm activity where this requirement for collecting useful data applies. One of the most useful harvest data sets that can be collected is to do with crop variation. By monitoring crop variations during the harvest process, the collected data allows farmers to optimise efficiency and boost yield performance. This simplifies and enhances farm management decisions with an aim to deliver the highest return per dollar of input cost.

A range of agtech supports this collection of data, including TallyOp, Corematic's harvester-mounted yield monitoring system. There are more than 30 TallyOp systems installed at macadamia farms across Australia, and the oldest one is now entering its fifth season.

Developed locally in Australia, TallyOp was designed specifically for the macadamia industry and the harsh Australian conditions. Building a system that was rugged enough to endure the sun, heat, and rain that it would be subjected to presented a few challenges for the team. Selecting technology, such as the camera and computer hardware, that was durable and yet cost effective was not an easy task. The selection had to be capable of being extremely precise in a broad range of climates and able to endure the extreme vibrations associated with being installed on a mobile harvester.

Developing an IoT (Internet of Things) solution that was powerful enough to be capable of counting at the high frequency associated with the infield work rate yet efficient enough not to need an extremely expensive and powerful computer that would not be feasible in a mobile application was another major challenge. Being a vendor-agnostic company was certainly an advantage for the team when they faced these hurdles, as they had access to a wide and varied range of equipment and were able to solve this with a mixed-provider solution.

Variation, tree by tree

Used primarily for the live counting of harvested nuts, the computer vision system monitors everything passing through the enclosure and identifies, tracks and counts each object. With the aid of an artificial intelligence model, it classifies each object as either a 'nut' or 'other'.

By coupling this count of 'nuts' with a GPS location, the data can be referenced back to a specific location in the field. The data is then post-processed into four-metre squares and accessible by the grower as a heat map, allowing for quick and easy interpretation of results. This solution is so precise that it provides feedback close to an individual tree level. This allows trends not only to be established but also quantified as well as facilitating decision-making at management level.

To allow for ease of use, the user interface and interactive dashboard are fully integrable with existing farm data platforms to further monitor pesticide, watering, fertiliser and more. The ability to overlay data from multiple sources is a very effective way of quickly seeing the direct correlation between input costs and yield.

Another option for improved management

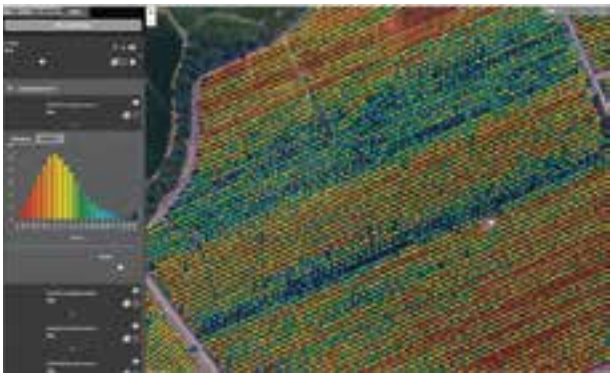
As we drive to be more efficient and effective in our decision making, the smart use of data capture will certainly be something that we all need in our toolkit. The increasing use of technology in all aspects of agriculture is something that continues to progress at a fast pace. Just like the development of TallyOp, any new technology in agriculture will, at times, present hurdles that we need to overcome.

Technology and innovation will be the catalyst of Agriculture 4.0, a part of the fourth industrial revolution. It will change the agricultural sector, making it more productive, efficient, and sustainable, which gives growers back the margin under ever-increasing demands. It could be seen in the reduction of repetitive or dangerous jobs, decreased chemical application and environmental impact, data collection and decision making, or new generations of agricultural machinery, like TallyOp.

Acknowledgment

This article was supplied by Corematic.

The TallyOp is a harvester-mounted macadamia counting system.



A heat visualisation map on the dashboard showing variations in yield (differences represented by the different colours).

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Carbon credits and sustainability

Carbon credits are often mentioned in the sustainability conversation and it's important to understand what potential exists to earn carbon credits in the macadamia industry.

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

Carbon credits: the essential facts

- One Australian carbon credit represents the avoidance or removal of one tonne of carbon dioxide equivalent.
- Projects are long term (25 years) and must fulfil newness, additionality and audit requirements. Macadamia growers cannot claim their trees or crop as these do not fulfil the additionality requirements.
- Soil carbon audit methods are very specific and not the same as your annual agronomic soil assessment.
- You must be prepared to commit for the long term and deliver year-on-year improvements.
- Once you sign up for a carbon credit project it becomes legally binding and will be registered on the title of your land.
- Penalties apply for failure to maintain carbon sequestration or emissions reductions.
- There are opportunities to be realised but think carefully before committing and beware of brokers who over-promise.

Carbon numbers

First, some numbers. The trees in an average macadamia orchard sequester around 4 t of CO^2 equivalent per hectare per year. Additionally, the crop produced is a carbon sink, and the husk, shell and kernel of an average macadamia yield sequester about 11 t of CO^2 equivalent per hectare per year. Combined, this represents around 15 t of CO^2 equivalent per hectare per year before incorporating on-farm emissions.

Looking at what this means in the larger scheme, Australia's total annual carbon footprint is around 400 million tonnes of CO^2. The macadamia industry currently has 38,500 ha under planting. If all those trees are bearing, we represent a potential offset in CO^2 equivalent around 0.15% of Australia's total emissions, which is actually significant. That's without taking into consideration the enormous potential for soil carbon sequestration, riparian zones and inter-rows.

This begs the question: why aren't growers printing money from carbon credits?

The Australian Carbon Credit Unit system (ACCU) rewards eligible energy efficiency, renewable energy generation and carbon sequestration projects resulting in a reduction of Greenhouse Gas (GHG) emissions.

Unfortunately, the system was not designed for macadamia growers to benefit directly.

While growing trees absorbs carbon, thereby offsetting GHG emissions, this doesn't qualify macadamia growers for carbon credits because it fails to satisfy a key requirement: additionality. Credits cannot be claimed for activity considered 'business as usual.' For macadamia growers, growing trees and a crop is a normal, business as usual activity, and therefore the 15 t/ha/year of CO^2 equivalent that an average orchard takes out of the atmosphere is ineligible for carbon credits under the current ACCU system.

While growers can't claim for trees, any on-farm efficiencies created are eligible. This could include reduced fertiliser use, reduced machinery emissions and increased use of renewable energy.

But the biggest opportunity for macadamia growers is in the soil. Soil carbon sequestration is eligible and the largest opportunity currently.

Other options for carbon credits and assessment

If the ACCU system isn't right for you, there are other paths to consider. These include international carbon credit schemes, such as Verra and Gold Standard. These typically have less rigid requirements but are subject to international volatility and may not be as valuable as the Australian scheme.

Arguably, a bigger opportunity for macadamia growers lies in supply chain offsetting. While macadamia processors can improve their efficiency, there is a limit to this and it's difficult for them to create a carbon sink. Growers, however, have enormous potential to sink carbon and offset the emissions that are created in all the layers above them in the supply chain.

It's important to note that this market can't be entered with just one or two carbon credits. There is a critical mass required so smaller growers would need to pool their credits to start offsetting the emissions of organisations further up the supply chain. To make this a viable system, however, an economic imperative at farm gate is needed, in the same way there is for gaining accreditations such as Freshcare that make our product more marketable.

If nothing else, it's worth investing the time to understand your entity's current carbon footprint. This is becoming increasingly important and looks set to start determining access to everything from good banking products to potential investment. Growers' green credentials will eventually matter as much as a profit and loss statement, and eventually it will be a deciding factor in market access.

The Aspirator is used to separate out light debris and to grade nuts by weight. It is available in 24", 36" & 48" widths.

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The Sizer can be used to size macadamias and as a cleaning reel. It is available with 36", 48" and 60" diameter reels.

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Automated solution for managing feral pigs

Feral pigs are among Australia's most widespread and damaging pest animals. In 2021, it was estimated that Queensland's feral pig population was as high as 2.3 million and growing rapidly. The damage pigs cause in macadamia orchards is particularly devastating as they root through the soil searching for food, uprooting young trees and destroying the roots of mature trees. They also consume a lot of nuts, with an average mature animal able to eat between 4 and 6 kg of nut-in-shell macadamia in an hour, and spread disease such as *Phytophthora*. The combined impact of this damage makes it difficult for trees to recover and produce fruit, severely impacting a grower's productivity and profitability.

Pig trapper Glen English is trialling a new method of feral pig control with the assistance of CQUniversity's Hinkler AgTech Initiative.

Australian growers have traditionally implemented a variety of strategies to control feral pig populations. These include fencing, trapping, hunting and deploying baits and repellents to deter pigs from entering orchards. However, these strategies can be costly and time-consuming, and may not be effective in all cases. Older pigs very quickly learn the location of traps and how they work, and are able to warn each other and even teach new generations how to avoid the dangers. Hunting and trapping methods can also raise ethical concerns. In the face of these issues, growers are seeking alternative control options and an innovative technology being trialled in the Bundaberg region may just be the solution.

With assistance from CQUniversity's Hinkler AgTech Initiative, trapper Glen English, owner of Guardian Knight Pest Control in Bundaberg, has imported a USA-built, 'BoarBuster' pig trapping system to trial in local orchards.

The BoarBuster is an innovative trapping system that consists of a 6 m-wide, circular steel enclosure suspended above the ground with bait laid in its centre. As Glen explains, "Feral pigs don't have many natural predators that hunt them from above, so they don't need to look up or around and this trap is outside their direct line of vision".

Because this trap is suspended, pigs can enter and leave from any direction, which Glen said is an advantage because he doesn't need to teach them to walk through a gate.

Another innovative feature of the BoarBuster is that it incorporates satellite-connected cameras and control units. This feature enables the operator to monitor the system from anywhere using a mobile phone, with a 24/7 alert system and live image feed of the cage. When pig numbers have peaked, the operator can instruct the trap to drop instantaneously.

Rather than taking up to two weeks to condition pigs to a traditional trap, Glen has been able to catch pigs in only three days.

"I have caught thirty-three pigs in one single drop of the trap, and I reckon, with the right conditions, I'll be able to increase that to fifty," he said.

The new feral pig management technology consists of a circular steel enclosure suspended above the ground.

An option for macadamia growers

With such great results under his belt, Glen is now busy deploying the BoarBuster system for many of the region's tree croppers, including macadamia growers who are desperate to mitigate the impact of feral pigs on this year's harvest.

Acknowledgment.
This article was supplied by Hinkler AgTech Initiative.

The operator can monitor the trap remotely using a mobile phone and drop it when pigs are under it (photo is from a camera that feeds video to the operator).

Assessing crop loss

Understanding crop loss and origin is one of the most effective tools growers have in making informed management decisions. Industry has efficient ways of identifying yield losses when nuts are consigned from the farm to the processor, but this does not reveal the total picture for growers. Improving orchard productivity requires an in-depth assessment of yield and loss by defect. Simply scrutinising processor consignment reports is not enough.

Understanding and quantifying in-field losses, evidence of which never makes it to the processor, is critical. Identifying the causes of rejects seen in the shed and their origin can reveal the financial losses you might be incurring and provide indicators for improved management. In short, the more you know, the more able you are to put extra money into your pocket.

There are different approaches to understanding loss, and your processor with often be able to help you choose the best option for your enterprise. The exercise might seem time consuming at first, but the information gathered will be invaluable.

Protocols for identifying and classifying reject nuts

One common protocol originated from the research project '*Establishing crop loss assessment protocols'*, completed in 2003 by Neil Treverrow from NSW Department of Primary Industries. It described three protocols for identifying in-field crop losses, differentiated by how much effort was required and the amount of information generated.

The three protocols are the full, standard and spot protocols. The full protocol analyses 300 nut-in-husk samples from each consignment, the standard protocol analyses 300 nut-in-shell samples from each consignment, and the spot protocol analyses 100 reject nut-in-shell samples from the farm's reject bin. This article describes the spot protocol.

Classifying reject nuts – a good place to start

A good place to start with quantifying in-field losses is to apply the spot protocol and take a sample of reject nuts from each reject bin.

Identifying causes is essential to understanding what orchard management decisions and investment are required to reduce rejects. As an example, high rat damage that can be quantified for the whole farm or down to a block level is an indicator that you need to focus on control measures such as baiting, harbour and resource management.

Once the 100 nuts have been categorised into defect categories and these totalled

by bin, consignment, block and overall for the farm, growers then need to apply common-sense crop loss factors for each defect. Using rats as an example again, one rat-eaten nut in the shed probably represents between two and five nuts lost to rats in the orchard.

Reject nut monitoring board

Using something simple such as the reject nut monitoring board (pictured), take

a sample of 100 reject nuts from each reject bin and then identify the cause of the damage such as rats, immaturity, machinery damage, insect stings and old nuts (see table).

Don't be misled by lightweight defects

Lightweight defects that have removed or reduced the kernel, such as vertebrate pests, immaturity, pinhole borer and dehusker or machinery damage are often underrepresented in the shed. Their weight or size makes them hard to harvest. These defects are easily blown away in the field and likely further damaged or reduced from machinery such as damaged auger flights.

The table is a guide to defect damage likely to be seen in the shed and helps with quantifying the loss back to saleable kernel loss. In all cases there are indicators of crop loss severity in the orchard and practical control measures.

What if I'm not a sorter?

Whether you consign your entire harvested load without sorting to the processor or a third-party dehusking and sorting facility, it is still important to either retain a sample for assessment or ask for a breakdown of the rejects from the third-party facility.

Many growers have moved away from numerous sorting rounds, taking advantage of the service provided by processors. This has financial, labour and infrastructure benefits, not least of which are the inevitable losses from over sorting and inadvertently rejecting good kernel.

No matter what your post-harvest process is, retaining a sample for analysis or gaining an understanding of reject from your third-party service is critical for informed management.

Sorting chart

Below is an example of a sorting guide which identifies visual characteristics of common defects, crop loss evaluation considerations and control options.

Visual	Defect	Distinguishing features	Evaluation	Control
Large holes in nuts 	**Rats**	Empty shell, large hole with distinct bevelled edges and teeth marks can be present.	1 nut in the shed represents roughly 2 to 5 in the orchard.	Rat management program with baiting/orchard clean up and targeting hotspots.
Medium to large holes in nuts 	**Fruit spotting bug and banana spotting bug** Damage before shell hardening	Large mark/hole often with black membrane. Soft sunken area - weak spot can be further damaged mechanically.	Pre shell hardening damage can be indicative of large in field losses that don't make it to shed.	Occurs October to December. In consultation with pest consultant check calibration, spray coverage and timing. Hotspot monitoring.
Small holes in nuts 	Damage after shell hardening	Smaller holes, hard to see. Small light brown pinpoint marks.	Damage after hardening often difficult to see in shed but will be apparent in factory results (damage can look like Leptocoris/ green vegetable bug.	December onwards through to harvest in thin-shelled cultivars. If you must spray, be mindful of withholding periods during harvest.
Small holes in nuts 	**Macadamia nut borer**	Round, 2 to 3mm uniform holes with clean straight edges, usually only one.	Potentially more damage in the field than seen in shed. Secondary damage such as mould can occur if left in orchard.	With pest consultant check calibration, coverage and timing. Implement bio controls. Put MacTrix cards out from November regularly, uniformly and around boundaries.
Pinholes in nuts 	**Boring beetles**	One but often many small pinholes.	Potentially more damage in the field. Secondary damage such as mould can occur if left in orchard.	With pest consultant discuss IPM cultural control measures. Remove and burn/finely chip dead or infested trees.
Holes on one end of nut 	**Open micropyle**	Physiological defect seen as singular round to oval hole at one end of nut often with a distinct white margin.	Secondary damage such as mould can occur if left in orchard. Allows entry of pests such as MNB, kernel grub and beetles.	More prone in cultivars such as 246 and H2. More frequent/rapid harvesting reduces potential for secondary damage.
Cracks/holes in nuts/shell remnants 	**Mechanical damage**	Jagged edges, uneven damage.	When seen stop equipment in field and shed, look for white kernel/shells in field.	Can be worse in some seasons due to varying shell thickness. Audit machinery, checking augers, cages and dehuskers.
Cracks in nuts/ shell remnants 	**Pigs**	Half shells or broken pieces.	Often not picked up by fingerwheels or blown out in field.	Implement monitoring program. Look for broken white nut/shells and obvious pig damage to orchard floor. Control could include fencing, baiting and/or trapping.
Cracks in nuts/ shell remnants 	**Cockatoos**	Often half shells broken along suture line.	Often not picked up by fingerwheels or blown out in field.	Scare techniques. A permit is required to shoot cockatoos.
Cracks in nuts 	**Germination**	Cracks in shell along suture line.	Secondary damage such as mould can occur if left in orchard. Germination can progress to roots/shoots developing.	Seasonal variability, some cultivars prone such as 660. More frequent harvesting reduces germination potential. Worse in dark, wet and overcrowded orchards.
Pale shells and small nuts 	**Immature**	Pale light brown shells/smaller nuts.	Often lightweight and blown away in field. Factory report levels often indicate only a fraction of actual loss. Can be due to dry conditions/out-of-season flowering/fungal diseases such as husk spot and husk rot.	Seasonal variable, reduce water stress. Improve irrigation and soil health and increase organic matter. Consider tree shaking for sticktight/husk spot control. Some cultivars more prone to out-of-season flowering, sticktights, husk spot and husk rot.
Tan brown/ oily nuts 	**Older nuts**	Tan brown/oily feel on handling.	Usually late season nuts where kernel begins to breakdown.	Consider tree shaking/remove sticktights.
Dark brown to black nuts 	**Old nuts**	Older nuts dull and black with newer nuts dark brown Often cracks along suture lines.	Potentially out-of-season nuts. Last seasons nuts pushed into ground/left behind. Significant pathogen risk, such as mould and *Salmonella.*	Improve orchard hygiene. Consider tree shaking and/or removing sticktights. Improve harvest pickup - check fingerwheels guide. Upgrade orchard floor incl. exposed roots/uneven surfaces. See the IOM guide. Worse in dark, wet and overcrowded orchards.

Why is block level data the gold standard?

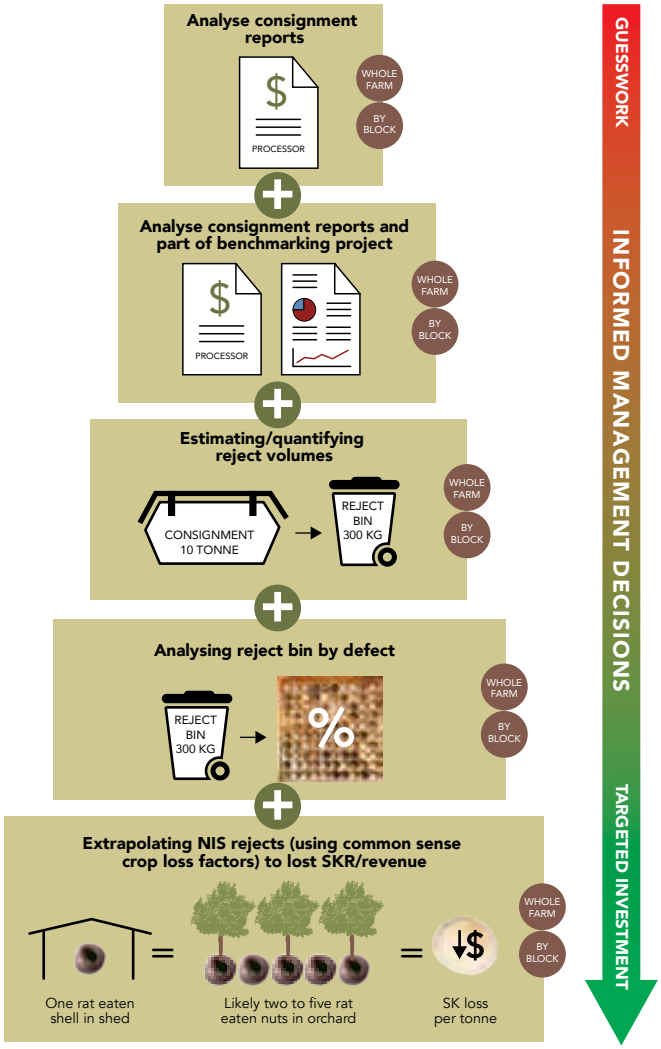
Farm level data is helpful, but the gold standard is to understand the block level origin of rejects. Block level data as opposed to consignment report data that usually represents a combination of blocks enables:

- Identification of the low hanging fruit, the easiest and cheapest on-farm strategy.
- Not fixating on the small things but focusing on what will make the most money.
- Corrective action in the block or hotspot that it is most required, concentrating your efforts.
- Understanding losses that are often localised to a hotspot, saving time and money.
- Mid-season analysis of losses that may be occurring from poorly performing harvest machinery.
- A diagnostic tool to quantify the cost benefit for next season's management decisions by block.
- Improved orchard productivity and profitability.

The graphic represents increasing levels of crop loss analysis sophistication which can be performed at each level across the whole farm, or better still, block by block:

Entry level consignment report scrutiny only shows a fraction of true loss and is aggregated block data.

Being part of the benchmarking project provides you a free farm level yield and factory loss report and the opportunity to take part in small regional groups of your peers.



Fertiliser program and irrigation keys to quality and productivity for Bundaberg grower

Gavin Lerch, Nutworks **E:** bundaberg@nutworks.com.au **M:** 0437 209 107

Anthony Sinnott's investment in soil health and nutrition and maintaining a regular harvesting schedule has paid off in improved quality and production. His orchard won the 2022 award for best quality and production for Central Queensland in the small farms category.

Name: Anthony Sinnott

Location: Bundaberg, Central Queensland

Size: 16.6 ha; 5300 18-year-old trees

Cultivars: 741, 816 and Daddow

Soil type and topography: Oakwood soil, flat terrain

Irrigation: Underground water and sprinklers (50 L/hr) on 816s, and 70 L/hr) Daddow and 741

In 2006, Anthony Sinnott bought his orchard near Bundaberg, which had previously been an old sugar cane farm that was converted to growing small crops before macadamias were planted in 2004. The orchard was privately managed for its first 12 years before Anthony moved onto the farm and took over the management himself. The 16.6 ha orchard has 5,300 trees comprising 741, 816 and Daddow cultivars. There are ten rows of each variety planted on 8 x 4 m spacings (312 trees/ha).

Anthony's orchard won the 2022 award for best quality and production for Central Queensland in the small farms category, and Gavin Lerch spoke with him about these results and what has helped him produce this winning formula.

Nutrition a focus

According to Anthony, soil health and tree nutrition are crucial. Fundamental is a good nutrition program supported by regular monitoring.

"My agronomist arranges leaf and soil tests twice a year to ensure I'm putting on the correct nutrients," Anthony said.

Elements that he has been working hard on to build up are manganese, copper and zinc, and to do this he has a program of two- to three-week fertiliser applications. Every two months, he also applies a spreadable custom blend formulated based on the nutrition status of his soils.

Other important parts of his soil health program are profiling every year and applying 2.5 to 5 t/ha of compost annually. He buys in the compost, which is recycled green waste that has been stored for 16 weeks to fully mature, and applies Metagen Digestor NP with it. According to Anthony this has improved soil health by creating a better environment for microbial life and the macadamias' proteoid roots.

He is paying particular attention to the western side of the farm where soils are poorer by applying more nutrition and compost as a way of improving yield (the larger amount of 5 t/ha compost is applied to this area).

"I also apply two tonnes per hectare of dolomite once a year as soil pH is low, and this has the added benefit of making magnesium and calcium available for the tree," he said.

Pruning and shaking by contract

While Anthony owns most of the machinery necessary to complete tasks in the orchard, including having a harvester that he shares with another grower, he does use contractors for the labour-intensive process of pruning.

There has been a concerted effort to establish an orchard floor that is even and harvestable.

Anthony has invested in post-harvest shed facilities to retain nut quality and profitability.

"We also get in a tree shaker once a year, as early as possible after the nut season is finished, to clean up any nuts left in the trees," he said.

As with a number of farms in the area, mistletoe is an issue, and he is continually working on cutting it out of the 816 cultivars.

Keys to quality and yield

Anthony identified three key aspects of his farm management strategy that have contributed to his excellent results for yield and quality: his attention to nutrition, his harvesting schedule and soil health and his irrigation system.

An important part of Anthony's management is irrigating trees using an automatic controller to ensure a high level of water use efficiency.

The farm's nutrition program, developed with a consultant and supported by regular monitoring, is the first the first part of Anthony's program that he believes has improved his orchard's performance. Part of this is concentrating on lifting the nutrition status of the poorer soils in the orchard as this is where good gains are to be made in yield and quality.

The harvester is a double-row pinwheel machine with a dehusker capacity of 1.8 t of nut and a speed range of between 3.2 kph over 7 kg/tree and more than 6.5 kph for 2.5 kg/tree nut drop.

"I concentrate on completing harvesting rounds every 14 to 18 days to help with maximising quality," he said.

The third aspect of his management regime is having access to irrigation water and automatically scheduling applications.

"My MAIT irrigation system allows me to monitor with the use of soil moisture probes, and I have an irrigation schedule that starts and stops my pumps and changes valves over between blocks," he said.

Anthony also emphasised that it is important to source as much information from as many as people with experience as possible.

"I work closely with the local processor, Nutworks, and listen to advice from experienced consultants and other growers.

Plans for the future

Anthony said that his plan is to maintain his focus on nutrition and soil health, regular harvesting and scheduling irrigation applications as a way of maintaining his above-average results.

"And, like all growers, I will continue looking for ways to minimise my growing costs," he added.

Tree removal rejuvenates older orchard

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Growers: Claire and Pat Wilson

Orchard: Twisted M, Como/Kin Kin, East of Gympie

Size: 8 ha, 2600 trees

Cultivars: Older plantings – 344s in 1986, 246s and older 741s in 1992, and younger 741s in 2000 on 9 x 4 m spacings. Newer plantings (post 2016) include Daddow, 246, 741s and MCT1 on 8.5 x 3.5 m spacings

Soil type: Sandy soil

Irrigation: Hand watering for initial tree establishment

Twisted M in the Como/Kin Kin area east of Gympie is one of the best performing macadamia farms in the Gympie growing region. A regular feature in the industry benchmarking awards, the farm has consistently produced figures of between 38 and 40 t a year and has a long-term average of 4.75 t/ha (NIS @ 10 %).

The farm has been owned and managed remotely for 31 years by Bruce and Pauline Maguire, who have now passed the baton to their daughter Claire and her husband Pat Wilson, who live on the property with their two children, Archie and Billie.

Pat and Claire Wilson and their children Archie and Billie. The Wilsons have recently embarked on a program of orchard renovation, which includes removing rows of older trees to improve productivity.

Younger trees to combat decline of older trees

In recent years, tree health has been declining, particularly that of the huge, older 741s whose production has also been affected because they flower

A comparison of the inter row after Energex had removed a row in October 2021 (left) and its recovery by January 2023, where the orchard floor has good ground cover and trees are healthy.

Row removal showing stumps (intersected by Energex tree removal to create light, drainage and access).

Diverse inter-row planting after row removal.

and fruit only at the very tops of the canopy. Another issue to emerge in the orchard as trees have grown taller is that the grass on the orchard floor has struggled because of shading, which has resulted in the sandy soils eroding and causing washouts and root exposure.

Accompanying the decline of tree health was a decline in production, and it became obvious that a different approach had to be devised for the farm to be able to sustain a family. Methods such as selective limb removal were not viable on such a small scale. Bruce and Pat had already begun the renewal process by planting two small blocks in 2016 and 2019 with the aim of introducing newer, higher kernel recovery varieties to offset the decline in the older trees.

According to Pat, this decision to go the step further to tree removal was the result of a lot of consideration of a number of factors.

"You really need to look at what suits your farm, rainfall and your budget," said Pat, who works off-farm in the mining industry while managing the farm.

Orchard rejuvenation through tree removal

As part of their ongoing research into management options, Bruce and Pat also had looked at tree and row removal through a contact from NSW, Ray O'Grady, and they visited farms that had undergone this process.

While they had not made any decision about this option, they were finally forced to act when in October 2021 Energex removed 80 trees which were obstructing the powerline. According to Pat, this started the whole process of tree and row removal on the farm.

"It is hard to remove trees, but you just need to get your head around that it's going to be better for the farm in the long term. With the trees declining, it was now or never," he said.

As well as removing trees under powerlines, Energex severely cut back others in a brutal cross-section of the blocks. This was followed by Pat removing another 165 trees as a trial using a 1-in-2 or 1-in-3 row removal pattern, with all timber chipped for future use in orchard floor repair.

This has effectively created 18 m inter rows in some areas, and this space has been used to create much needed wide drainage swales and to improve light interception. The orchard has typically been skirted relatively high and access-hedged biennially and Pat now uses a Kubota super lightweight out front harvester so access for harvest once the trees relax into this space shouldn't be an issue.

Heavy rains damage orchard floor

In early 2022, the farm was hit with very heavy rain around the time that Gympie flooded. This caused massive washouts and damage to the orchard floor and access tracks. Fortunately, Bruce and Pat were able to access disaster funding from the Queensland Government to repair the damage caused by the heavy rain.

They set about laying 1000 m^2 of Sir Walter turf under the dripline and moved 400 m^3 of soil that had been washed into gullies, spreading it back onto the orchard and focusing on areas where root exposure was worst.

They then spread 200 t of mulch, 125 t of chicken manure, and 30 t of gypsum and sowed seed in the new, wider inter rows. Good spring rains helped to get this all bedded down and growing well.

Plans for 2023

Pat said they will continue to spread 27 t of gypsum and 125 t of manure as part of the regular nutrition program, supplemented by liquid urea and 'Panda' foliar applications.

After all this intervention in the space of just over 12 months, they expect the production will be reduced in 2023.

"We are hoping to see improvements over the next two years, and if so, we will continue to remove rows over the coming years," he said.

Monitoring will also be important and to this end, a number of trees have been tagged and will be checked over time to document the change in form and production.

Award winners share their farming philosophy

Paul Moosberger, consultant and grower liaison, MWT Macadamias, Lismore

Careful attention to management over the long term and being able respond to issues as they arise have paid divideds for Ian Macleod and partner Caroline, who won the 2022 award for the best quality, large farm category in the Northern Rivers.

Growers: Ian and Caroline Macleod, Waila Macadamias

Location: Mororo, Clarence Valley

Size: 37 ha, 13,000 trees from 12 months to 22 years old

Cultivars: Mostly A cultivars with 800 Hawaiian cultivars

Soil type and topography: Sandy soils on a clay base

Irrigation: Dripline for supplementary irrigation. Water sourced from on-farm storage. Scheduled using GDot soil moisture sensor.

Ian Macleod and partner Caroline took out the 2022 award for best quality, large farm category in the Northern Rivers. Their 85 ha farm, Waila Macadamias, is situated at Mororo, mid-way between Grafton and Lismore. Until 1999 the farm was used to grow sugar cane; since then, Ian has gradually been developing the macadamia orchard to the point where there are now 37 ha of 13,000 trees ranging in ages from a year to 22 years.

Preparing land and establishing trees has been an ongoing process since 1999, and Ian said that he has been refining and modifying his strategies along the way. One thing he has done since he took over the farm is to propagate his own trees for planting, which allows him to expand the orchard when it best suits him.

Ian had previously grown macadamias on the Alstonville Plateau, and based on this experience, he decided to only plant high percentage kernel recovery cultivars. This means that the orchard is composed of mostly assorted A cultivars along with 800 Hawaiians with every third row being a pollinator.

While original plantings in the orchard were at 7 x 4 m spacings on mounded rows, the newer trees are at 8 x 4 m spacings, which Ian said allows for better drainage of rows. Drainage is essential as soils are

high in salinity. He has not had to establish vegetation in the inter rows as the existing native and introduced grasses provide good ground cover and organic matter. Traffic in the inter row is kept to a minimum to reduce compaction.

Management philosophy for quality

When asked for his management philosophy, Ian said there was no secret.

"Just trying things and sticking with what works best is what guides me," he said. "Sometimes these decisions get made for you."

He explained that the key elements that guide his orchard management to ensure quality production are as follows:

- variety selection
- orchard layout
- adequate drainage
- irrigation and monitoring water requirements and use
- pest monitoring and getting control measures in place on time
- agronomy – checking soil and tree requirements and adjusting fertiliser programs to suit
- pollination – cross pollination and using native and honey bees
- harvesting and dehusking frequency
- having a good relationship with those he works with, i.e, contractors, processors, consultants, and farm workers.

Ian said he pays a lot of attention to soils and agronomy and has found synthetic blends of fertilisers give the best results on his soil type and micro-environment. Soils tests are regularly completed by Nutrien's Ag Solutions and mixes are adjusted to growth stages of the trees.

Pest management is determined with the assistance of MWT consultants and the use of contractors to apply chemistry. Ian stressed that timing and coverage are critical, with his recent results bearing this out. In 2021, his USK was 1.13% and in 2022, 2.8%. The farm has historically had medium levels of flower caterpillar so consideration of the impact on native bee activity at flowering has also been crucial in determining applications of chemistry around flowering periods.

His two finger-wheel harvesters allow pick up of nut to be done when the opportunity and weather permit, and a recent upgrade to his dehusker means that he can process nuts immediately, which contributes to ensuring quality. Sorted NIS is only stored for a short period on the farm and supplied to the processor in bulk loads.

Drought and fires prompt major changes

Since the orchard was established in 1999, Ian's approach had resulted in production slowly growing so that in 2018 NIS yields were 80 t at 40% TKR.

In 2019, however, yields start to decline and in 2020, during and following the drought and major bushfires in the area, production dropped dramatically to about 9 t of saleable NIS. According to Ian, while the trees did produce a reasonable crop during this time, shells were very thin, and nuts were small.

Some of the younger trees in the orchard. Ground cover in the inter rows is provided by local native and introduced species.

Drainage is important on the orchard's sandy soil, which is high in salinity. This new drain has been installed in preparation for an expansion of the orchard.

"Dehusking produced snow-like piles of husk and no matter how much we adjusted our machinery, shells would splinter," he said.

As a result of the 2020 drought, Ian knew that some radical decisions would have to be made if he wanted the orchard to return to its previous production. A key outcome was the decision to irrigate using run-off water harvested from the orchard and captured in dams. Dripline has been installed under the mature trees only, and water requirements are monitored and managed using a GDot system. This ensures water use can be adjusted to the capacity of his on-farm storage.

Another issue that arose at the same time was that of a huge increase in feral pig numbers. The cause of this was extensive bushfires in 2020 that damaged the surrounding native forest. Looking for food, significant populations of feral pigs discovered the orchard and began feeding on nuts and damaging trees and inter-row areas. Ian's response was to install 3 km of exclusion fencing in early 2021.

Dripline has been installed on mature trees, and irrigation applications are scheduled using a GDot soil moisture monitoring system.

A four-head dehusker with stick and air sorter has resulted in significant improvement in productivity so that Ian can now process 10 t of NIS a day.

Returns justify decisions

While installing the fencing and the irrigation was not a cheap undertaking, the decision has certainly paid significant dividends. The irrigation development process is ongoing, but with what he has already installed and with feral pigs completely excluded from the orchard, NIS production skyrocketed from the previous 9 t in 2019 to 70 t NIS in 2021 and over 95 t in 2022.

Another decision that has contributed to improving productivity on the farm is to do with dehusking. In 2021 Ian updated the farm dehusking plant to a four-head machine with stick and air sorter. This now means he can process about 10 t of NIS in a day, a significant improvement in shed productivity.

Where to next?

Ian said that he continues to have faith in the future of the macadamia industry.

Evidence of this faith is that he already has new areas drained and mounded to continue planting. Irrigation will only be added to new plantings when trees are about five years old. He has around 5000 trees in the farm's nursery, and when they are ready, they will be added to an already viable and productive farming operation.

Visiting wild macadamias on the Gold Coast

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The original H2 tree - 100 years old and still going strong

There are few better ways to appreciate the potential growth of a macadamia than to visit one of the few venerable trees that have been lovingly protected over time. It is even more interesting when the tree has provided most of the rootstock for an entire industry.

The original H2 or Hinde tree is still alive (see more on the history of the tree in the *News Bulletin,* Spring 2021). The current owners of the historic "Colliston" orchard were kind enough to allow AusMac 2022 participants to visit this tree as part of the MCT field trip on 7 November 2022.

A busload of 40 people drove up the Nerang Valley to a property just below the Hinze Dam. At this point, the Nerang River is dammed to form the massive Advancetown Lake. This is the main drinking water supply for the Gold Coast but came at the expense of flooding irreplaceable habitat for macadamias and many other species. The H2 tree, on the edge of the old orchard, is a large, spreading tree with long, strong branches and an open canopy. After some recent care and attention and plenty of rain, it is still bearing nuts, both singly and in clusters.

H2's chloroplast DNA (DNA inherited from the mother tree) is present in the rootstock of several million Australian orchard trees, and although H2 has fallen out of favour as a production cultivar, most orchards probably also have a few bearing H2 as a result of failed grafts.

MCT Executive Officer Denise Bond holds the tag identifying the original H2 tree, flagged by industry stalwarts Surrey Bogg and Ian McConachie. Photo: MCT

At around 100 years of age, H2 still bears clusters of nuts. Photo: Mel Caccianiga

The orchard suffered a few decades of neglect, with many of the trees dying of fungal attack. Those that remained were nearly smothered by Brazilian cherry trees and cats claw creeper. The current owners have done an excellent job at rescuing the surviving macadamias. There is still a mixture of *M. integrifolia, M. tetraphylla* and hybrids of the two species - a feature that made this orchard one of the earliest opportunities to compare traits of the different species in an orchard setting.

Although development of the Gold Coast has destroyed much of the original macadamia habitat, remnants survive in the creek valleys of Wongawallan, Pimpama and Cedar Creek close to the southern extent of *M. integrifolia* habitat. These lower altitude Gold Coast sites – the area that produced H2 - are not currently represented in any ex-situ collections. One of the jobs for the new wild macadamaia arboretum is to help fill in such gaps in the collection.

A big thank you to H2 field trip hosts James and Kylie Neilsen pictured here with Paul O'Hare (left) and Denise Bond (right). Photo: Mel Caccianiga

M. tetraphylla flourishing in the Numinbah Valley

After visitng the H2 tree, we wound our way around Advancetown Lake to rejoin the Nerang River in the Numinbah Valley. As the elevation increased, the temperature dropped and we entered *M. tetraphylla* habitat. In some areas, macadamias were visible along the river's edge or in small remnant patches. The best view, however, was at the stunning Natural Bridge section of Springbrook National Park.

The Numinbah Valley is a natural fortress for the rich biodiversity of sub-tropical rainforest and, thankfully, there are landholders in the valley who recognise that *M. tetraphylla* is part of this ecosystem. The MCT will try to support these people in maintaining and restoring this important refuge.

How to be a wild macadamia champion

- 40 new champions signed up at AusMac – head to www.wildmacadamias.org.au to join them
- Notify MCT of any opportunities to feature wild macadamias – like this park at Wollongbar:

M. tetraphylla included in new Wollongbar Parkland

Wollongbar is in the centre of the Northern Rivers macadamia-growing region, but a new park development featuring local rainforest trees did not include a macadamia. The MCT was able to rectify this by providing a locally endemic *M. tetraphylla*. Many thanks to Ballina Council for planting the tree and providing a sign.

Local M. tetraphylla *at Wollongbar district skate park rainforest garden*. Photo MCT

- Include questions about macadamias in your Trivia games, for example:

Q: Where do macadamias come from?
A: Australia

Q: How many macadamia species are there?
A: Four

Q: What is the rarest macadamia species?
A: Macadamia jansenii – it's as rare as the Wollemi pine

Q: How many layers protect a macadamia nut?
A: Two – a hard brown shell covered by a green husk

Looking west across Cave Creek to the lookout where an M. tetraphylla *grows*. Photo MCT

2022's most exciting macadamia product innovations

Jacqui Price, Market Development Manager,
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It's always fascinating to discover new products featuring macadamias, and we're pleased to share the most exciting finds from last year. The pandemic caused a general slowdown in product development, but the quality of new products remains high, serving as a reminder of the premium cues macadamias bring to a product and their versatility across flavour profiles, product categories and markets. Here are the products that caught our eye in 2022.

Major brands innovate with the luxury nut

Spotting macadamias in a big brand launch is always a thrill, as it helps more consumers discover the indulgent qualities of macadamias.

Häagen Dazs 'Green Craft' Macadamia Soybean Ice Cream (Japan)
Initially a limited release, this ice cream enjoyed a nationwide online rollout in Japan thanks to its popularity. Primarily a plant-based ice cream, it catered to growing demand for a dairy-free Häagen Dazs alternative.

Uncle Tobys Goodness Bowl Indulgent Flakes Salted Caramel and Macadamia (Australia)
This macadamia variant of the Goodness Bowl range is described as 'a scrumptious start to your morning'. Macadamias are a fitting addition as they simultaneously deliver on indulgence and health.

McDonalds White King macadamia pie (Japan)
For 15 years, McDonalds has featured triangular chocolate pies on its autumn Japanese menu. A crispy, flaky pie crust with a rich filling, in 2022 the white chocolate version received an upgrade with macadamias added to the creamy filling.

Kikkoman Coffee and Cocoa Macadamia Milk (Japan)
Kikkoman macadamia milk has featured on our list for three years, thanks to new flavour variants. Made from Australian macadamias, with origin flagged on front of pack, last year two new seasonal flavours were added to the line-up – coffee and cocoa.

Beverage boom continues

Macadamia milk has been a popular addition to the dairy alternative scene for several years now, but 2022 saw it used in more innovative ways.

milkadamia Milk Tea (USA)
A lightly sweetened, ready-to-drink beverage that blends black tea with smooth macadamia milk, this launch taps into the increasing popularity of milk tea, especially among younger consumers.

I'm Good Meal Red Bean Drink (South Korea)
This nutritional meal replacement drink is available in single serves for on-the-go consumption. Containing a blend of red beans and nuts, including macadamias, it can be enjoyed hot or cold.

VEYO Plant-Based Drinking Yoghurt (Vietnam)
This offering is Vietnam's first plant-based yoghurt drink. Made by fermenting the milk of macadamias, other nuts and soybeans, it's available in peach, yuzu orange and strawberry.

Fresh flavour pairings

Demonstrating how well macadamias pair with both sweet and savoury profiles, a number of snacking and confectionery launches featured macadamias combined with adventurous flavours.

Rainbow Nuthing Flavoured Crispy Macadamias (China)
Featuring whole macadamias in a crispy coating, these snacks demonstrate the growing popularity of kernel in China. Three new flavours were launched last year: Japanese Wasabi, Thai Sour & Spicy and Japanese Seaweed.

Patons Turmeric Macadamias with Coconut in Milk Chocolate (Australia)
A block of smooth milk chocolate with turmeric-roasted macadamias, coconut and a hint of lime, this product brings a fresh twist to the classic macadamia and chocolate combination.

Lotte Macadamia Truffles with Amaou Strawberries (Japan)
A limited edition indulgence comprising macadamias coated with feuilletine in strawberry white chocolate. Macadamias add crunch and balance to the chocolate's sweet and sour flavour profile.

Indigenous ingredient combinations

Macadamias are playing a role in the rise of Australian food producers bringing native ingredients into the spotlight as they create deliciously intriguing new products.

BSKT Davidson Plum and Strawberry Gum Veganola (Australia)
Made from a blend of nuts, seeds and superfruits dusted and slow roasted with zesty Davidson plum and sweet strawberry gum, this vegan cereal is 'reminiscent of stewed rhubarb and scents of sweet fruits'.

Uncle Charlie's Tastes of Country Sunrise Lime and Quandong Popcorn (Australia)
Making it easy for consumers to experience the 'Tastes of Country', this corn is popped in Australian macadamia oil to protect the taste of the Australian native flavour combinations.

Melbourne Bushfoods Native Chilli Oil (Australia)
Pairing macadamias with zesty native flavours including pepperleaf, saltbush and aniseed myrtle, this 'celebration of flavour' boasts a balance of spice that's said to make 'absolutely anything' taste amazing.

Say cheese

Last year we saw macadamias featuring in both dairy-based and plant-based cheese innovations, thanks to their naturally creamy and buttery taste and texture.

Moondarra Honey Fig and Macadamia Soft and Creamy Cheese (Australia)
A gourmet product from Australia's largest manufacturer of flavoured cream cheese, this delicacy features dried figs and honey blended through smooth creamy cheese, coated in macadamia pieces.

Grattino Grated Fermented Cheese (Germany)
A plant-based grated delicacy made from fermented macadamias and cashews, Grattino is a plant-based alternative to traditional parmesan cheese.

Notable mentions

Not every innovation fits neatly into a category, but that doesn't take away from the depth and breadth of macadamia product development discovered last year. Here are some more that were too good not to share.

Frogprince Children's Skin and Hair Care Range (China)
Skin and hair care products formulated for children's delicate skin using macadamia oil, this range targets mothers seeking natural products and includes ultra-moisturising cream, shampoo, body wash and hand sanitiser.

Kundal Nature Intensive Conditioning Perfume Dog Shampoo (South Korea)
Eco-friendly manufacturer Kundal launched a pet care range last year. Its dog shampoo was developed by pet-owning Kundal employees and contains macadamia extract to moisturise dry dog skin and fur.

Aoyagi Uiro Shirahama with Macadamias (Japan)
Uiro is a traditional Japanese steamed confectionery made from sticky rice, water and sugar. Aoyagi produced a limited edition version for summer featuring macadamias covered in warabi jelly.

Health Connection Wholefoods Macadamia Bread Mix (South Africa)
High in fibre and free from yeast and gluten, this flour mix makes a loaf of rich and nutty macadamia bread, a low-carb alternative to traditional bread.

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Celebrity Chef creates macadamia masterpieces

One of the many highlights of AusMac2022 was being able to sample chef Colin Fassnidge's creations at the Celebrity Chef Breakfast. Colin developed these recipes, which we share with you below, especially for this event. Enjoy!

Macadamia and date breakfast pudding with macadamia and lemon myrtle crème fraiche

It's not too sweet and the macadamia and lemon myrtle crème fraiche adds a unique Aussie twist you will love.

Serves 6

Ingredients

Puddings

250 mL cold water
150 mL dark rum
1 vanilla pod, halved and scrapped
250g dates, pitted
2 teaspoons bicarb soda
300 g macadamias, roughly chopped
125 g butter, softened
100 g sugar
3 eggs, lightly beaten
150 g plain flour

Macadamia crème fraiche

500 g creme fraiche
300 g macadamias, finally chopped
1 teaspoon sea salt flakes
1 lemon, juiced
2 teaspoons lemon myrtle, chopped

Method

Preheat an oven to 180°C. Put the water, rum and vanilla in a small saucepan and bring to the boil. Add the pitted dates, bicarb soda and chopped macadamias and stir through. Remove from the heat and allow to sit for 1 hour as the dates absorb the moisture.

In a mixing bowl, beat the butter and sugar until light and fluffy and sugar is dissolved. Slowly drip in the eggs while beating to incorporate them into the mixture. On a slow speed then add the flour until fully incorporated. Fold in the date mixture.

Butter a six-hole muffin tray and pour the mixture evenly into the tray holes. Place the tray in a dish of boiling water (bain-marie) and bake at 180°C for 10 to 15 minutes, or until a skewer comes out clean.

Remove from oven and allow to cool before turning out.

For the macadamia crème fraiche, combine all ingredients and refrigerate for up to six hours prior. Serve with the warm puddings.

Macadamia and halloumi fritters with maple syrup and fresh lemon

The macadamias add an amazing buttery crunch to a perennial breakfast favourite so leave them quite chunky for the tastiest results.

Ingredients

125 mL milk
2 large eggs, separated
50 g plain flour
2 tablespoons baking powder
100 g halloumi
4 green spring onions, finely chopped
200 g macadamias, roughly chopped
1 birds eye chilli, finely chopped
150 mL extra virgin olive oil

To serve
Maple syrup
1 lemon, cut into wedges

Method

For the batter, add the milk and egg yolks to a bowl and whisk together until the mixture is completely combined. In a separate bowl, whisk the egg whites until soft peaks form. Place the flour and baking powder in an electric mixing bowl and mix while slowly adding the egg and milk mixture, until just combined to make a batter (do not overmix it). Add the halloumi, spring onions, macadamias and chilli to the batter mixture and lightly mix to combine. Remove the mixing bowl and add the whisked egg whites, one third at a time, lightly folding through as you go.

To cook, heat the oil in a frying pan over a low heat, and add one large portion of the mixture to the pan (about 1/3 cup). Cook for 3 minutes on each side until golden brown then remove and place on paper towel to absorb any excess oil. Repeat with the remaining mixture.

To serve, drizzle with maple syrup and add a squeeze of lemon juice.

Tip: For light and fluffy fritters, ensure the batter is not overmixed.

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Probiotics to help defend crop-pollinating honey bees from common diseases

Georgina Binns, Research Officer, Macquarie University **| E:** georgina.binns@hdr.mq.edu.au

Researchers plan to provide bees with immunity-boosting probiotics to increase defence against common infections

Researchers plan to provide bees with immunity-boosting probiotics to increase defence against common infections.

Macadamia growers all understand the importance of the role of honey bees and native bees in pollination in the orchard, and how crucial it is to ensure populations continue to survive and thrive.

One of the threats to pollination is exposure of pollinators to diseases. A research team at Macquarie University is working to improve the ability of one pollinator, the honey bee, to fight off some of the worst honey bee diseases. The team is doing this by developing an economical and chemical-free probiotic treatment to help boost resistance of honey bees with the aim to increase resistance to common bacterial and fungal hive diseases that are the main causes of global population declines. Infectious diseases, such as European foulbrood and chalkbrood, cause devastating impacts on food crops from the loss of pollination services.

The importance of this research is underlined by the fact that each year a significant proportion of hives is lost to diseases, pests and other events. The Australian Honey Bee Health Survey 2019 reported that commercial beekeepers lost an estimated 19% of hives during the previous year from these causes. This loss translates to significant costs for Australian growers of pollination-dependent crops, such as macadamias and almonds, with 65% of Australian agricultural production relying on pollination by bees.

Probiotics to fight diseases

Probiotics are made from naturally occurring beneficial microorganisms that have health benefits when ingested. Probiotics have been found to maintain digestive heath, boost the immune system and increase production in cattle. Because these 'good bacteria' are naturally occurring, they will not be dangerous to bee health, with the research team specifically targeting bacteria beneficial to honey bees.

Existing bee probiotics only target one disease at a time, but the team aims to develop a general probiotic that will raise the overall immunity of bee colonies.

"Multiple diseases infect hives simultaneously and it is challenging to predict which disease might spread across hives. Our team will create a broad-spectrum approach to disease resistance instead of looking at just one singular infection," said Dr Fleur Ponton, an expert in gut microbial symbionts.

Probiotics are chemical-free and cost-effective products for Australian beekeepers and growers that can be easily implemented into their systems.

The honey bee plays a major role in our ecosystems through the process of pollination, which is vital to ensuring food security. This is why supporting bee wellbeing is key to maintaining ecosystems and human health. According to Hort Innovation Australia, pollination-dependent crops in Australia are worth an estimated $6 billion a year. The direct annual contribution by honey bees is thought to be more than $3.85 billion.

Developing a source of probiotics for bees

The research team, led by Dr Fleur Ponton, and including insect and bee experts Associate Professor Ajay Narendra, Dr Théotime Colin, Dr Darsh Rathnayake and microbe expert Dr Sasha Tetu, will look at a variety of ways to deliver the right probiotic mix to hives.

"We are aiming to include probiotics into healthy supplemental feeds for bee colonies. Feeding colonies is a common practice already in place in many countries but that is less developed in Australia," Dr Ponton said. "Beekeepers in Europe, Africa and North America often feed supplemental food patties containing pollen, vegetable proteins and sugar mixtures to hives. These mixtures do not usually contain probiotics just yet."

As well as developing supplements, the project will assemble and store a collection of probiotic strains in the team's lab at Macquarie University. In the future, these strains could be tested against new emerging diseases.

A good memory for successful pollination

Stressors such as pesticides, parasites and diseases disturb how well bees pollinate crops through their effects on memory and behaviour. Bees need to navigate from their hive to the food crop and back, which means they need to remember how to find the hive. How well they learn their way back to the hive contributes to the success of their colony and their pollination services.

The research team intends to understand not only how probiotics can enhance resistance to multiple common infections, but also how these treatments can help increase their cognitive abilities, which will in turn, help them to become more successful pollinators.

Acknowledgment

This research is funded by Hort Innovation and Macquarie University. The research advancement will ultimately support the Hort Frontiers Pollination Fund which aims to ensure sustainability through cutting-edge research in pollination and practice.

Macadamia disease reporting and disease diagnostic clinic platform

The macadamia pathology research team at the University of Queensland has developed a 2-in-1 platform for growers and agronomists to report the occurrence of disease in macadamia orchards and as a simple sample submission form for disease diagnostics.

Why disease reporting?

This platform provides an easy way for the macadamia Integrated Disease Management team to capture information and respond to disease threat as required. Macadamia growers and industry consultants are also able to provide information on the estimated impact of any diseases they observe in their orchards.

Annual reporting is valuable in the it can support the values of monitoring data, disease risk forecasting and decision for an economically and sustainable disease control strategy.

Disease Diagnostic Service

When reporting the occurrence of a disease, users can also upload images of disease symptoms, which can help with early detection, diagnostics, and appropriate management actions to reduce risks of economic loss.

For more information, scan the macadamia pathology QR Code.

MC21001: An integrated disease management approach for the Australian macadamia industry **(Macadamia IDM)**

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Growers helping to accelerate the development of new superior cultivars

Bruce Topp, Mobashwer Alam, Max Cowan, Craig Hardner, Joanne De Faveri, University of Queensland and **Dougal Russell, Rod Daley** and **Grant Bignell,** Department of Agriculture and Fisheries

Three-year-old seedling trees at the Alloway progeny field trial.

Snapshot

- The *National macadamia breeding and evaluation* program (MC19000), which began in December 2019, aims to develop superior cultivars to suit growers in all major production regions. As well as focussing on yield, other desirable characteristics being screened for include smaller tree size, compact nut drop, self-fertility, disease resistance, precocious cropping and adaptation to warmer climates.
- Progeny field trials are where new selections are first made. Recently these trials have been planted on Queensland grower's properties as far north as Emerald and Rockhampton. Two new progeny field trials will be planted on northern NSW grower sites in 2023.
- The research team is looking for more growers who are willing to be involved by allowing new selections to be established on their farms as a way increasing the number of seedling trees they can screen.

The *National macadamia breeding and evaluation* program (MC19000) commenced in December 2019 with the goal to develop superior cultivars with a range of desirable characteristics to suit growers in all major production regions, both now and in the future. In addition to a strong focus on increased yield, a range of other desirable characteristics are included such as smaller trees, compact nut drop, self-fertility, disease resistance, precocious cropping and adaptation to warmer climates.

Since 2011 the breeding program has planted 12,846 trees in progeny field trials. Grower trial sites account for 46% of these plantings and they are making a significant contribution to the development of profitable cultivars for the Australian industry.

The purpose of the progeny field trials is to evaluate populations of seedling trees and then to select the best performing trees. The seedlings are produced by cross-pollination of parents that we have selected for their general high performance or because they are outstanding for particular characteristics. For example, we have recently been using parents with compact nut-drop patterns to introduce this trait into our new cultivars.

Four-year-old seedling tree at Childers progeny field trial.

Each of the seedling trees in the trial are genetically unique, and as a result exhibit differing production and quality traits such as NIS yield, kernel recovery, tree size and shape, and pest/disease tolerance. We evaluate each tree, select the best performers and propagate them for further testing with greater numbers of each new selection.

Currently there are six progeny field trials on growers' properties, ranging in size from 637 to 1,473 trees per site (see table). All current plantings are on Queensland sites, but two new trials will be established in northern New South Wales in 2023. Having trials with a range of climatic and management conditions is important in allowing us to select elite performers with wide adaptation. In particular, selecting high performers at warm climates such as Emerald and Rockhampton provides us with cultivars adapted to warmer conditions than presently experienced in the major production regions. This is preparing the industry for climate change in traditional growing regions and could also expand the geographic range of macadamia production in Australia.

Location	No. of trees*
Alloway	1,473
Childers	637
Emerald	693
Maryborough	1,144
Pine Creek	690
Rockhampton	1,318
Total	**5,955**

* Total of seedling progeny plus comparator trees.

Table. *Six progeny field trials planted at grower properties from 2018 to 2022.*

As an example of the new material, the best performing four-year-old seedling tree at Childers produced 7 kg NIS (@1.5% MC) with a total kernel recovery of 41.9%. A second tree produced 6.7 kg NIS with 43.0 kernel recovery. Trees of these selections have now been propagated on Beaumont rootstock for further evaluation at the cooperating grower's site.

Grower cooperation for these progeny field trials has been a key factor that has allowed the breeding program to dramatically increase the number of seedling trees we can screen. The increased number of trees allows us to select more intensely for each trait resulting in new cultivars with higher performance. Further progeny field trials will be planted in coming years, and we are keen to hear from any growers who may wish to be involved.

For further information please contact Professor Bruce Topp b.topp@uq.edu.au

Information

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Acknowledgment

The *National Macadamia Breeding and Evaluation* Program project (MC19000) 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 and the University of Queensland have also co-funded the project through the Queensland Alliance for Agriculture and Food Innovation (QAAFI). We thank the growers and managers of our field trials, Clayton Mattiazzi Hinkler Park, Adrian Walsh FNC, Johan Oosthuizen Alloway Macadamias, and Daniel Manson and Sibelle Goncalves RFM.

Does planting macadamia trees at higher density increase yield? Find out what the computer simulation says

Inigo Auzmendi and **Jim Hanan,** Centre for Horticultural Science, Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland **P:** 07 344 32702 **E:** i.auzmendi@uq.edu.au

Snapshot

- Modelling and simulating plant growth are growing in importance as research tools in agriculture and horticulture. Queensland researchers are using a simulation model to test how density influences yield by 'growing' a virtual tree and reproducing the light environment in an orchard.
- The model simulates processes influenced by external factors such as the light environment of individual leaves, as well as internal plant processes like photosynthesis and carbohydrate distribution.
- The results show that planting trees at higher densities does not always lead to increased yield per hectare and demonstrate the complex combination of factors in an orchard that affect yield.
- Researchers will compare results from simulating tree growth with in-field results from trials at Bundaberg as a way of optimising the benefit from both research methods.

The field of computational modelling has advanced significantly in recent years as information technology, in-field data and plant modelling software have been cleverly combined to develop greater confidence in models, including a visual twist!

Using simulations has the benefit of allowing researchers and industries to quickly test ideas before committing to long-term trials. While in-orchard research is still required to gather the data needed to draw conclusions, simulations can help to point out the potential for further research to better understand the effects of orchard design and management on production levels.

The QAAFI team for horticultural plant physiology and modelling is collaborating with horticultural researchers in the Queensland Department of Agriculture and Fisheries (DAF) to better understand how orchard design and management practices affect the growth and yield of macadamia trees. This work is part of the *National Tree Crop Intensification in Horticulture program (AS18000).*

The team uses the simulation of the annual growth of individual tree organs above ground, that is, stems, leaves and fruits, to mimic the growth of a virtual tree over a growing season. The orchard environment is replicated by simulating a group of trees to better understand the effects of planting density (trees per hectare) on yield (tonnes of nut-in-shell, NIS, per ha).

Planting density

Last year, the team presented a virtual macadamia tree to study carbohydrate distribution and branch autonomy (*News Bulletin*, Summer Edition, 2021). In this article, they describe the results of simulating orchard yield by 'growing' a virtual tree surrounded by several other trees, reproducing the orchard light environment (see Figure 1).

With an aim of the AS18000 Program macadamia research to increase understanding and knowledge of how planting density influences yield, the simulations complement field-planted trials by allowing to test a wider range of planting densities. These results could be later used to conduct a comparison analysis of associated profitability (yield/quality) and sustainability.

Figure 1. *Visual 3D representation of a virtual macadamia orchard at around 6 years after planting, before simulating tree growth and yield during one season. The ground surface (grey) corresponds to the central tree. The canopy includes stems (dark grey) and leaves (green). Image adopted from Auzmendi and Hanan (2020).*

Simulating orchard yield

Using a virtual canopy created from in-orchard tree measurements, the model simulates processes influenced by external factors such as the light environment of individual leaves, as well as internal plant processes like photosynthesis and carbohydrate distribution. The virtual orchard grows day by day throughout a growing season, in a similar fashion to a real orchard. By placing several trees together in a virtual orchard scenario, the result of the interaction of several factors produces a simulation of the orchard yield under varying planting density scenarios.

By simulating the growth of individual organs and then combining them at both the individual tree and orchard levels, the team was able to investigate trends that may seem counterintuitive or difficult to explain. For example, higher planting density increased orchard yield if trees were not planted too close together. When planting density was too high, a yield decrease was observed (see Figure 2).

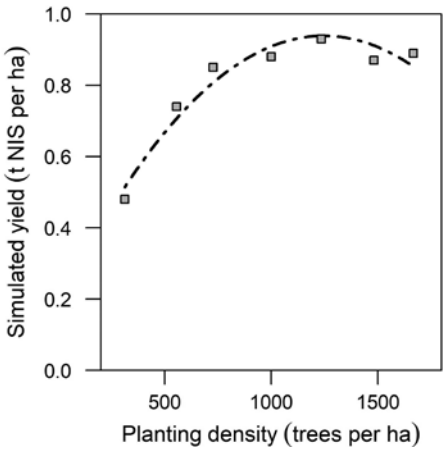

Figure 2. *Relationship between simulated yield and planting density in virtual macadamia orchards. Macadamia growth during one season was simulated with seven different planting densities ranging from 300 to 1,600 trees per hectare.*

Implications of higher planting density and future work

The simulation results show that planting trees at higher densities does not always lead to increased yield per hectare. Beyond the actual numbers, the trend simulated and presented in this article demonstrates that an orchard is undoubtedly more than just a collection of organs or trees, and that the dynamics of the entire orchard system have a significant impact on yield outcomes.

In an experimental orchard with three different planting densities established in the DAF Bundaberg Research Facility, current work focuses on discovering which planting density has the highest yield potential or the highest yield at the lowest cost. The process includes applying different management practices that have successfully been trialled in-orchard to increase yield, in the context of the already known and simulated limitations of increased planting density.

The simulation results will be compared with in-field results from the macadamia planting systems trial in Bundaberg, aiming to maximise the synergy between these studies. The comparison also will allow testing the potential of computational simulations for input into orchard design and management practices. With this in mind, future planting density recommendations should consider not only these simulations, but also specific orchard characteristics such as cultivar, soil and climate details that our current model does not account for.

While this project is expected to demonstrate the possibilities of simulation as a tool for increasing the understanding of orchard density to benefit both research and industry, there are several other questions to which simulations may be applied in the future. These include developing an understanding of the differences in architecture (branching patterns, shoot length, leaf area, flowering, etc), light interception and yield between cultivars, tree shapes and sizes.

Information

This work commenced as a part of the *Transforming Subtropical/tropical Tree Crop Productivity (AI13004) project* and is continuing as a component of research within the *National Tree Crop Intensification in Horticulture Program* (AS18000), funded by the Hort Frontiers Advanced Production Systems Fund, part of the Hort Frontiers strategic partnership initiative developed by Hort Innovation, with co-investment from Queensland's Department of Agriculture and Fisheries and Queensland Alliance for Agriculture and Food Innovation - The University of Queensland, and contributions from the Australian Government.

Reference

Auzmendi, I., & Hanan, J. (2020). Investigating the effects of planting density and tree size on yield through functional-structural modelling. *Acta Horticulturae*, 1281, 523-532.

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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					
Chlorantraniliprole	PER89353	Fall armyworm	• Product containing 350 g/kg chlorantraniliprole: 18 g product/100 L + 15 g active/100 L non-ionic surfactant/ wetting agent • Product containing 200 g/L chlorantraniliprole: 30 ml product/100 L + 5 g active/100 L non-ionic surfactant/ wetting agent	10	All states and territories except VIC
Indoxacarb	PER89278	Fall armyworm	• Product containing 300 g/kg indoxacarb: 25 g/100L	42	All states and territories except VIC
Methomyl	PER89293	Fall armyworm	• Product containing 225 g/L methomyl: 1.5–2 L/ha • Product containing 400 g/kg methomyl: 0.84–1.13 kg/ha • Spray ground mulch/soil surface only	Not required when used as directed	All states and territories
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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