

**AUSTRALIAN**  **MACADAMIA**  
**SOCIETY**

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# Like all good dinosaurs THERE COMES A TIME...

T-ROSS Burgess is NUTS about who's filling his dinosaur shoes!



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*Front cover. Daryl Wake from 'DarNic Park', Rosedale, north of Bundaberg, is one of a growing number of macadamia growers who are using tree shaking to speed up harvest. It is playing a valuable role in orchard management, as Daryl describes on page 37.*

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Thanks to our industry partners



## 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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## What's On

DATE	EVENT	LOCATION	CONTACT
May	Norm Greber and AMS Awards of Excellence nominations open		AMS: 1800 262 426 office@macadamias.org
Fri 16 July	Norm Greber and AMS Awards of Excellence nominations close		
<b>MacGroups</b>			
Tues 13 July 9am – 12.30pm and 1pm to 4.30pm	Northern Rivers (Plateau), NSW		
Wed 14 July 9am – 12.30pm and 1pm to 4.30pm	Northern Rivers (Coastal), NSW		
Thurs 15 July 9am – 12.30pm	Mid North Coast, NSW		AMS: 1800 262 426 office@macadamias.org <a href="https://australianmacadamias.org/industry/events">https://australianmacadamias.org/industry/events</a>
Tues 20 July 9am – 12.30pm	Glass House Mountains, Qld		
Wed 21 July 9am – 12.30pm	Gympie, Qld		
Thurs 22 July 9am – 12.30pm and 1pm to 4.30pm	Bundaberg, Qld		
Mon 26 July Fri 13 August	AMS Board nominations open AMS Board nominations close		AMS: 1800 262 426 jolyon.burnett@macadamias.org
Tues 17 August Wed 18 August	AMS Board meeting AMS Board meet and greet	Lismore Northern Rivers	AMS: 1800 262 426
Wed 25 August	Australian Macadamia Handlers Association (AMHA) meeting	Brisbane	Jacqui Price Marketing Manager 0424 107 731 jacqui.price@macadamias.org

## CEO's report



In February, the AMS announced a crop forecast for the 2021 season of 50,770 tonnes in-shell @ 3.5% moisture (54,440 tonnes in-shell @ 10% moisture).

As always, conditions have been variable. The Mid North Coast of NSW was hit by severe flooding and a number of members' orchards suffered significant damage and crop loss. The Northern Rivers experienced good rainfall over the season, contributing to a strong forecast. However, rain is continuing and causing some losses, some challenges and delays to harvest.

Most of Queensland appears to be experiencing favourable conditions. Across most growing regions, and overall, nut size is bigger in most regions although thicker shells are likely to reduce kernel recoveries. A mid-season crop report will be provided in May/June 2021.

Members will be aware that farm gate prices have softened since the 2020 season. This was not unexpected given the strength of the Australian dollar against the US dollar on which most nut trading is based. To maintain our international competitiveness some correction was required. It is important to remember where prices have come from and a check of the AMS website will show an in-shell price of \$1.50 in 2007. But it does clearly indicate, especially for those who have entered the industry in the last 10 years, that prices do fluctuate, often driven by forces beyond the control of growers, processors and the AMS.

It is also a good reminder that productivity remains the most important driver of enterprise profitability and improving tonnes per hectare is within the reach and control of all growers, no matter where your orchard is, how old your trees are or the financial resources available to you. Some improvement in yield can almost always be made by improving management decisions. This is discussed in the Maccelerate fact sheet (available on the AMS website or by phoning 1800 262 426) and by Dr Chris Searle in the most recent round of MacGroups.

At an industry and global level, it is essential that demand for macadamias in global markets is stimulated. Keeping demand ahead of the rapidly growing global

supply will help mitigate increasing price volatility. The AMS has driven the development of the Voluntary Marketing Fund to support the World Macadamia Organisation in its task of market development. We have had strong support from handlers and processors, most of whom have included the option in the supply contracts to contribute to the Fund.

If you have not opted-in to the Voluntary Marketing Fund I urge you to contact your processor NOW and do so. The value of your orchard and the value of your crop literally depend on it.

These developments at a global level are mirrored at a national level. Almost everything in the industry has changed: the way we grow, who is growing, where we grow, how we handle drying and dehusking, ownership of processors, our relationship with Hort Innovation, the market and aspects of government regulation.

However, during the last decade, there have been few changes to the AMS structure and the way it operates.

The Board is conscious that we need to keep evolving the AMS to ensure it remains representative of the industry and able to deliver meaningful services and products to members and the industry at large. Work is under way to consider membership, regional support and representation, board composition, service delivery, how we can get our voice better heard by government and what resources will be necessary to do all this.

Over coming months, we will be asking members for their views and ideas about how the AMS could better meet your needs and expectations. It may be appropriate to move some constitutional changes at the November AGM to give effect to agreed improvements and new ideas. We hope we can count on your continued support and participation as we continue to make the Australian macadamia industry profitable and respected.

Jolyon Burnett, CEO

## Ethical employment practices part of macadamia industry's social responsibility

The AMS has signed up as a partner of the Fair Farms program, an initiative that supports Australian horticultural growers to prove their commitment to fair wages and decent treatment of the workforce through training and third party certification.

The program provides best practice standards for the fair and equitable treatment of employees in a simpler, less expensive and locally designed process that growers can use to demonstrate they conform to the law and treat workers well.

Fair Farms also supports the supply chain to meet its modern slavery reporting requirements.

Participation in Fair Farms is entirely voluntary.

Fair Farms National Program Manager Marsha Aralar said since June 2020, many growers had started the certification process, with the program experiencing a three-fold increase in the number of growers registered to participate.

"We currently have three businesses involved in the growing or processing of macadamias in Queensland and New South Wales, a promising start and a good indicator of the growing intent among members of the supply chain to demonstrate their commitment to fair and equitable work practices and eradicating exploitation," she said.

"This is a solid baseline for us to work more closely with macadamia growers to increase their participation. At its heart, Fair Farms is about giving producers easy and affordable access to the resources they need to understand and conform with various laws that underpin the fair treatment of workers.

"It's about raising awareness and building commitment to good work practices and conditions while reducing the burden of unnecessary red tape for growers."



*Marsha Aralar from Fair Farms is encouraging macadamia growers to show their commitment to fair work practices through training and certification.*

Marsha said Fair Farms, which was developed by Growcom, the peak body for Queensland horticulture, and designed in collaboration with businesses along the supply chain, was about creating a movement among those who want their produce delivered to the table after it has been grown ethically and to the highest standards.

"Consumers don't want premium wholesome foods like macadamias produced by unwholesome work practices," she said.

Learn more about becoming Fair Farms certified at [www.fairfarms.com.au](http://www.fairfarms.com.au) or call Jolyon Burnett at the AMS.

### AMS an early adopter

Jolyon Burnett, AMS CEO, says the AMS is pleased to be an early adopter of Fair Farms.

"Our customers, both here and around the world, expect Australian macadamias to be produced to the highest standards and this includes the use of labour," he said.

"Fair Farms should prove to be a valuable point of difference between Australian macadamias and those grown in countries with less stringent labour standards.

"While this program will be more relevant and more important for bigger enterprises with larger workforces, the AMS is encouraging all members to look at the program and see whether it can assist in meeting the expectations of our customers and our communities."

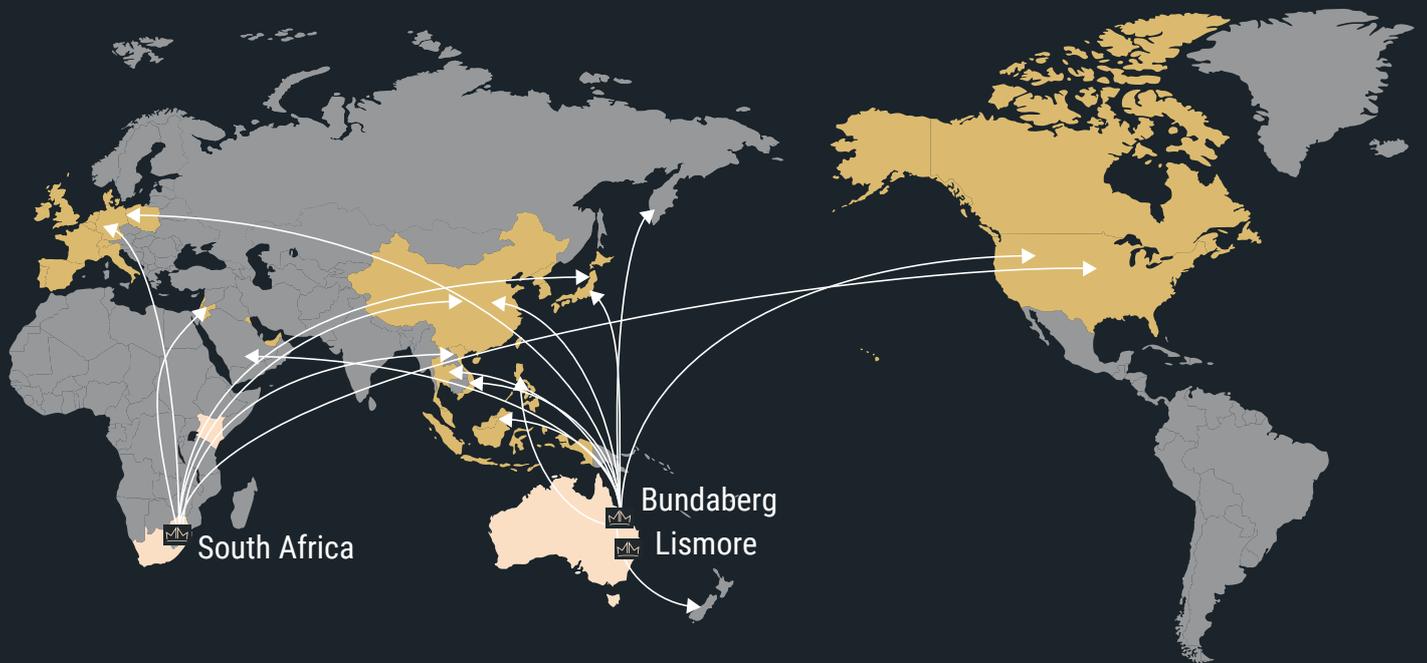
Fair Farms certification means access to a more willing and able labour force.

Domestic retailers like Aldi, Coles, Woolworths and Metcash (IGA) have accepted Fair Farms certification as meeting their ethical supply policies and many overseas retailers have similar requirements as part of their procurement policies.



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# Demand improving in key markets amid continued growth in new product launches

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



## Supply

In February, the 2021 Australian macadamia crop was predicted to reach 50,770 tonnes in-shell @ 3.5% moisture (54,440 tonnes in-shell @ 10% moisture), according to a census-based forecast produced using scientific modelling developed by the Queensland Department of Agriculture and Fisheries. However, Australia's east coast experienced extreme and prolonged rainfall during March and April.

Fortunately, the overall impact on Australia's macadamia crop appears to be minimal at this stage, despite the widespread flooding endured in New South Wales, and associated harvest delays and infrastructure damage.

While the full extent of the extended rainfall is still unfolding, in most regions the rains are expected to have a beneficial impact on mature orchards in the longer term.

The global forecast for the 2021 season is 250,000 tonnes in-shell @ 3.5% moisture, an increase of 9%.

However, this has been tempered by recent reports of weather impacting production in several growing regions. A firmer estimate will be available in coming months. Macadamias South Africa (SAMAC) have estimated their crop for 2021 at 57,834 tonnes in-shell @ 3.5% moisture.

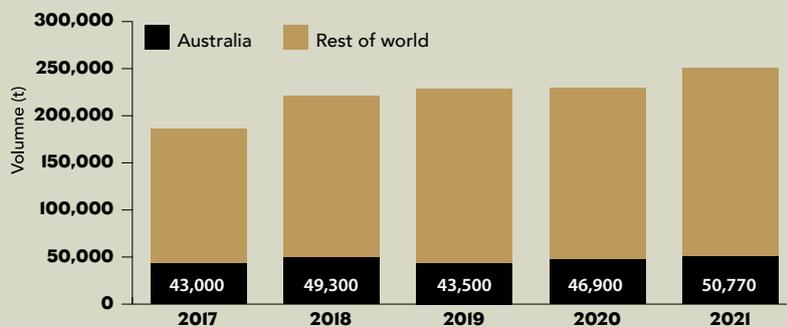


Figure 1. Global macadamia crop volumes 2017-2021 (tonnes). Source: INC, SAMAC. All volumes are at 3.5% MC.



## Demand

Overall global demand for macadamias continued to be impacted by COVID-19 in the 12 months to February 2021. However, with vaccinations on the rise and a loosening of restrictions in several countries, the year-to-date import data (July to February) is showing promising improvements in key markets, particularly Europe and China.



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



### Australian sales

Australian kernel sales in the 12 months to February 2020 were up 1% compared to the prior year, driven by solid sales in the domestic market, Japan, Korea and Europe.

Australian in-shell sales were 9,609 tonnes, a significant increase on the prior year. This was in part driven by the faster post-COVID economic recovery in China and a strong Chinese New Year result.

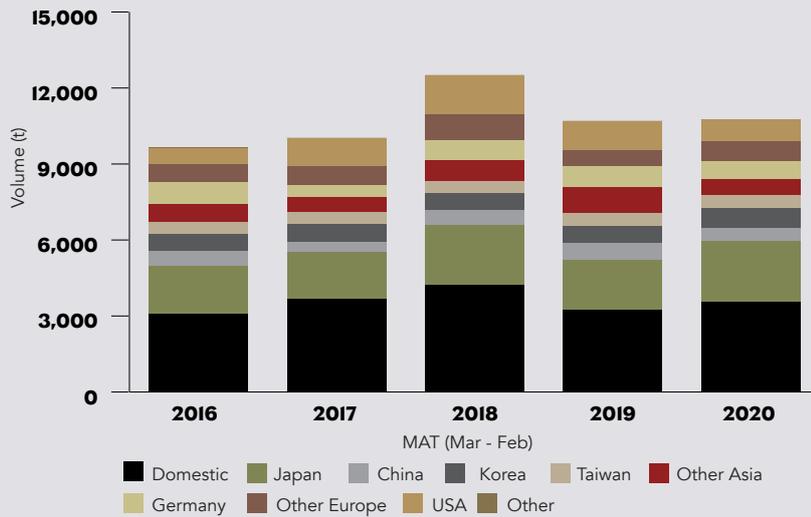


Figure 3: Australian macadamia sales (tonnes) MAT March to February  
Source: AMHA. In-shell sales quoted at 3.5% MC. AMHA represents 97.5% production, sales are adjusted to represent non-AMHA members.



### Global production innovation

Total new product launches using macadamias increased 3% in the 12 months to March 2021, despite the tumultuous impact of COVID-19. The snacking category represented most of the new product development using macadamias as an ingredient at 33%, with confectionery 16%, cereals 13% and bakery 12%.

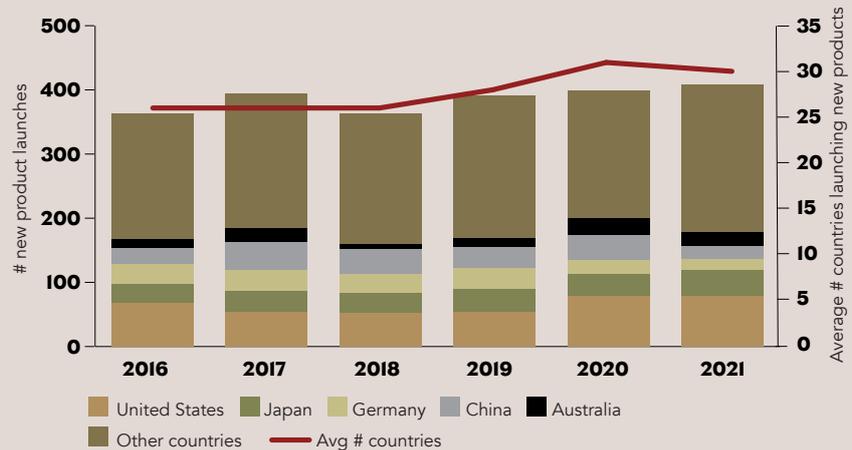


Figure 4: New product launches using macadamias as an ingredient. Number of new products (left axis) and average number of countries launching new products (right axis). MAT April to March. Source: Innova Market Insights.

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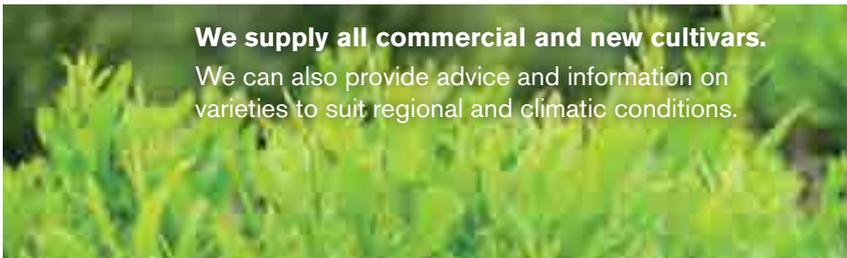
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## Leoni's orchard rounds

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Crop quality reports are positive with yields similar to 2020 and potentially higher. Kernel recoveries are lower than the 2020 high, but still above the long-term average. The industry crop forecast from February 2021 was for 54,440 tonnes in-shell @ 10% moisture.

Harvest continues steadily in northern growing regions and most of the crop in Queensland has been picked up. Bundaberg and surrounding areas appear to have missed out on much of the drenching rain that has fallen across the east coast. Within this region, the widely planted cultivar 741 has not performed well.

The situation in New South Wales has been far more challenging where sustained rain has caused harvest delays and made many orchards inaccessible for weeks.

Flooding on the Mid North Coast, Clarence Valley and Northern Rivers has caused extensive damage to farm infrastructure and created hazardous harvesting conditions. With the orchard floor so saturated, even small rain events are interrupting the harvest.

In NSW, disaster relief is available in eligible local government areas and covers most growing regions. Application can be made through the Rural Assistance Authority ([www.raa.nsw.gov.au](http://www.raa.nsw.gov.au)) and close on 31 October 2021.

In Queensland, recovery grants and rebates are available through the Queensland Rural and Industry Development Authority ([www.qrida.qld.gov.au](http://www.qrida.qld.gov.au)). The AMS continues to lobby for recovery relief backed by your submissions when surveyed, so keep the conversation open.

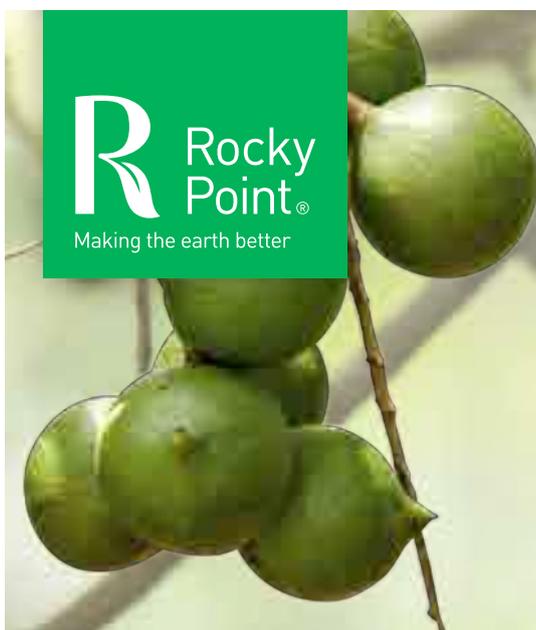
At MacGroup events in March this year, we spoke extensively about the nuances of cultivating macadamia which is essentially a wild crop. Unlike other crops

that have been through generations of domestication, macadamia are only a few generations from the wild with embedded survival and adaptation traits.

This struck a chord with many growers who were likened to zookeepers. Just as zookeepers attempt to help wild species thrive in unnatural settings, growers are in essence macadamia zookeepers.

For example, zookeepers need to approach the management of lions very differently from domestic cats. They need to understand their ecology, the environment they originate from and the other species they interact with. They need to understand basics about their physiology, the biology of how the species functions and thrives. Out of these fundamentals, zookeepers develop management strategies, followed by operational procedures.

These are similar to all the elements that growers require in their role as macadamia zookeepers, but so often, the fundamentals are skipped. The weather doesn't wait, the crop keeps developing and pests certainly don't wait. In trying to get everything done, we jump to planning orchard operations – practices instead of first principles.



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In this edition of the *News Bulletin*, growers will find plenty of stimulating reading about some of these ecological and physiological fundamentals. See page 51 for a better understanding of the ecophysiology of macadamia focusing on the orchard floor, the ecology of native bees as pollinators on page 56 and the ecology of cockatoos on page 58.

Most growers are well into analysing their consignment reports and understanding yield and loss. The gold standard is block by block analysis. Whole farm data when aggregated lacks the origin of both yield and rejects and hides many of the contributing factors. Block level data allows quick identification of 'low hanging fruit', but also not fixating on the small things and rather focusing on that which will make the most money. There is a new AMS factsheet 'Assessing Crop Loss' and as the graphic represents, it assists growers to analyse crop loss in increasing levels of sophistication and management potential.

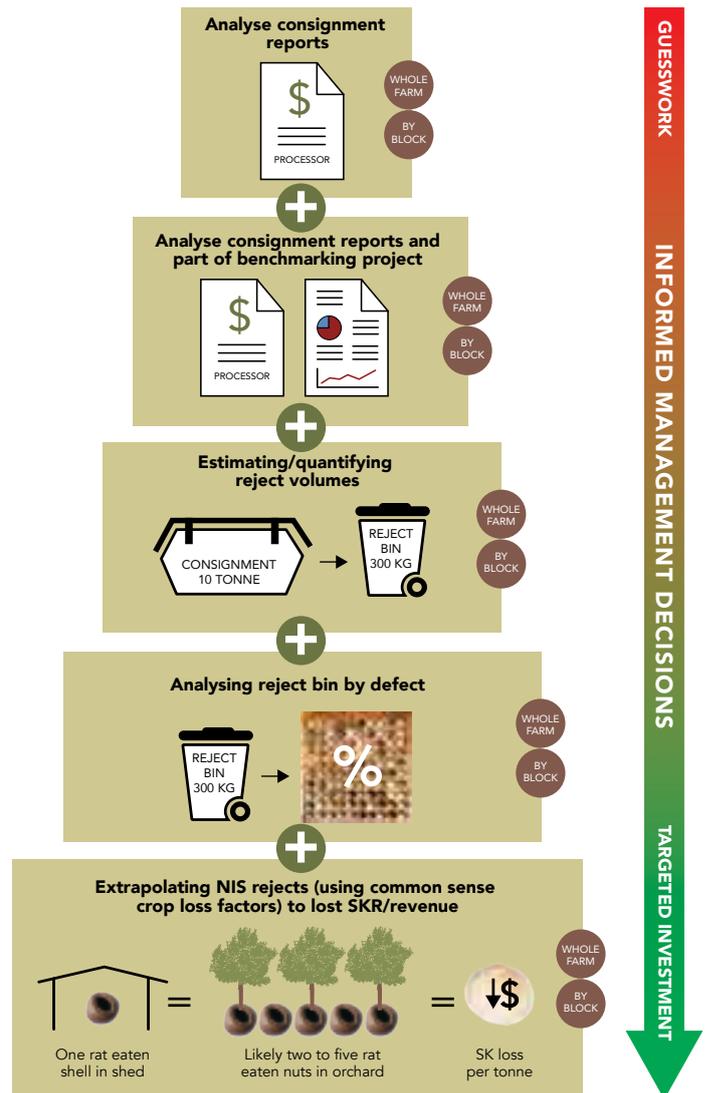
If you haven't seen a copy yet, the AMS has a new grower resource - MacAlerts. These are monthly reminders and updates based on crop phenology, the timing of biological processes in relation to the climate. While the phenology will be generic with some regional and seasonal adjustments, MacAlerts are another way to solidify crop fundamentals to assist in prioritising time and investment in the orchard.

Below is an example of the May MacAlert phenology which then leads into key reminders for managing pests and diseases, crop inputs, machinery and infrastructure, and looking ahead to the following month. We would love to hear your feedback on this new resource.

There will be a range of macadamia zookeeping information, research and seasonal updates, as well as nifty farming solutions on offer at the MacGroup events to be held in your region during July. See eNews for local details.

I look forward to seeing you there and out in the orchard.

Leoni



## Floods wreak havoc for NSW Mid North Coast macadamia growers

Extreme rainfall and significant flooding affected many New South Wales macadamia growers from mid to late March this year. The rain persisted over several weeks and heavy falls damaged orchards and farm infrastructure. Some of the worst affected were growers on the NSW Mid North Coast where the severe weather was described as a "one in 100 year event". We spoke to a number of growers to hear about their experiences of the flooding, the setbacks to harvest and the long-term implications for their farms.

### The worst harvest season experienced

Robert ('Tod') Todhunter manages approximately 12,500 trees over 55 hectares at Elanora Farm in Valla. The flood damage from the East Coast low pressure system in March came on top of months of high rainfall totals, starting in December 2020. Now, the ground is so saturated they are unable to spray, control pests, fertilise or even mow and harvest.

### Recorded rainfall at Elanora (Valla, NSW)

Dec 2020	Jan 2021	Feb 2021	Mar 2021	Apr 2021
700 mm	145 mm	335 mm	800 mm	150 mm

"This is my seventeenth harvest here and it would be the worst start, by a country mile," Tod said.

Elanora farm owner Victoria Thynne described the orchard destruction and impact on the crop from the March flooding rains as "devastating". The rains inundated much of the farm which boundaries Deep Creek and they had to rush to rescue cattle stranded on the property.

While they usually have a lot of late season cultivars, nuts have fallen early this year and many of them remain sitting in water or wet grass, unable to be picked up.

Of the 40 tonnes of nut they have harvested, kernel recovery has been good, considering, but they are concerned about higher reject levels as the wet drags on. This is likely to be made worse by the farm's heavy soils, which hold moisture and take longer to dry out.



Yarahappini Farm lost a tractor in the floods.

"The soils have served us well through the dry times, but this season it's working against us in these wet conditions," Tod said.

"Usually this is quite a windy orchard, but that's not the case this year and we haven't had enough sunny days for the moisture to evaporate."

It is a similar story for most growers in the region who have reported major orchard floor damage, destruction of farm roadways, loss of equipment, shed inundation and weeks of delay because of completely inaccessible orchards which are littered with nuts.

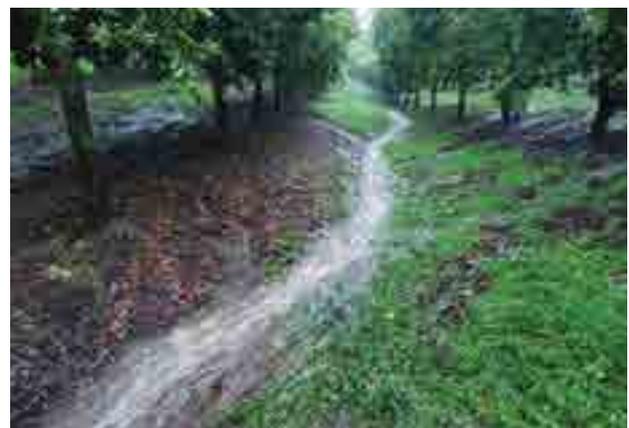
### Precious investment and hard work washes away

At Peter and Denise Ranking's orchard down the road, they manage 4,300 trees on three blocks planted on 7 x 4 metre row spacings. The orchards have been very productive, thanks in part they believe due to good volcanic soils, a strong nutrition program and plenty of bee hives for pollination.

Over the years though, light to the orchard floor has diminished and with a lack of orchard floor covering, the effects of heavy rains are exacerbated.

"At the time when this orchard was planted, this was the recommended row spacing and now it's too late, we've got to deal with it," Peter said.

The Rankings had just put the finishing touches on \$10,000 worth of orchard floor and gully remediation works thanks to a local Landcare grant co investment.



Water surges through the orchard at Noah Seccombe's farm.



*Nuts are easily lost in the soft ground.*

Unfortunately, the sheets of water running across the ground were too much for the newly formed areas. It just swept it all up, topsoil, organic material and nuts, and deposited the lot in the dam.

As well as ripping through the orchard exposing roots and eroding gullies, the rain made a mess of piles of nut husk and blood meal mulch, leaching nutrients Peter believes are sorely needed on the scoured orchard floor.

At **Noah Seccombe's** steep orchards at Warrell Creek, he experienced the same erosive activity. Under-tree mulch and topsoil was swept into the interrow and down slopes, scouring channels and leaving thick piles of misplaced organic matter.

"We were very lucky that we had the amount of grass covering on the orchard floor, which slowed the water and held onto soil to some degree, but so much just ended up in the dam," Noah said.

"The erosion is heartbreaking really, it's so much work to build up that organic matter and then it washes away," he said.

To allow harvesting through the piles of sticks, mulch and nuts, Noah pulled reo mesh behind a John Deere Gator to cut through it and spread it out, ensuring his finger wheel harvester had a chance to pick up nuts. While this was reasonably successful, there were nuts being pressed into the soft ground.

"We spent about \$4,000 on new finger wheels at the beginning of the season, but the exposed roots are destroying them so they already look worse than they normally would at the end of the season," Noah said.

### **Delays add to the crop loss**

At Dymocks' 110 hectare Yarrahappinni Farm, manager **Chris Cook** and his team were three quarters through their pre-harvest clean up when the floods arrived.

"It set us back significantly," Chris said. "All the work we've been doing with our orchard floor, covering roots, adding compost, it was all undone in that week."

Like other growers, Chris found there was little that could be done at first as the ground was too wet for machinery and they risked further orchard damage.

"We had to wait four weeks for the orchard to dry out before we could get any machinery on," Chris said.

Meanwhile, **Noah Seccombe** was able to get his lighter Robmac harvester out a little sooner.

"We ran the harvester through and picked up what we could, but we had to put an extra person on the sorting line. That first pick-up was 36% saleable nuts and 8% unsaleable, when we usually achieve 41-42% saleable and 2-3% unsaleable," he said.

### **Crop loss estimates**

Noah believes he has lost 10-15% of the crop during the flood, but it is difficult to quantify as the small rain events continue, causing more delays and likely quality losses.

Chris estimates that up to 30 tonnes of nuts may have been washed away down gullies. He's been out on neighbouring farms with a bucket and shovel trying to track the losses.

For certified organic grower, **Charlie Higgins** at Valla, his 2,000 tree orchard is on some of the steepest country, with some trees planted on slopes up 20 degrees. He estimates that he's lost 20% of his crop by not being able to pick up nuts.

"My rejects are basically double what they were last year, and my commercial grade is double what it was last year too, because the nuts have been on the ground far too long in the wet," he said.

"At the same time, some of the nuts this year are the biggest I have ever grown. I've actually had nuts jam the de-husker because they are too big!"

### **Orchard tasks keep piling up**

Back at Elanora, Tod and Victoria spoke of continuing delays not just to harvest, but the knock-on effects for all operations.

"It's got to the point now where the ground is so wet, that any rain, even 10 mm has the effect of 100 mm and sets us back a week, because the soil is just saturated," Tod said.

"Which operation do you prioritise? Our grass has grown so quickly while we haven't been able to get out there, it's the question of mowing above the nut first or harvesting first," Tod and Victoria debated.

By running the mower, they risk pushing nut into the ground, but the nut is very difficult to harvest out of such long grass. By running the harvester, they risk compaction without being able to pick up all the nuts. And every time they turn around, the grass has grown more and they have missed other crucial operations like rat management and fertiliser applications.

They had seen a lot of evidence of rats early on, but it has been just too wet to even put out baits, let alone

consider other burrow management options which have been keeping rat populations down in the orchard.

"This orchard is unique for the number of kangaroos we have. We have hundreds landlocked on the property and have been unable to keep their numbers in check. With the ground so soft, they cause a lot of damage with their heavy tail and paws," Tod said.

"Between funnel ants excavating their nests, rats and kangaroos, it's like the surface of the moon."

Chris Cook said that harvest has been progressing slowly due to the excessive contamination causing machinery damage and frequent bogging.

"The harvest is coming in full of mud and sticks, which slows the dehusking right down and then slows the harvesters," Chris said.

"It pushes the whole thing back to worse than a December harvest. There are massive flow-on effects from all of this. We're getting bogged up to three times a day, so we've got to be very careful where we go," Chris said.

"We're lucky in that the orchard has some steep areas and some flat areas, so we're able to pick and choose the best ground, but there are probably 30 hectares where we haven't been able to get into at all yet, so that's going to be terrible," he said.

One of the knock-on effects for Noah, who was hoping to be able to get a tree shaker into the orchard soon, was skipping their usual Ethrel spray.

"It was just impossible to get the heavy sprayer through the orchard, so we had to give it a miss," he said.

These growers have all missed crucial crop protection and fertiliser applications because their orchards are inaccessible, leading them to consider what the long-term effects will be.

### What worked and didn't work

Taking stock of damage after the floods, Charlie saw clear differences between recently pruned orchards and those which had not been pruned for two to three years. The grassed areas slowed the flow of water and dispersed it far better than other non-grassed areas.

"There was a huge difference in the areas I had pruned, it was as plain as day," Charlie said.

Noah made the same observations, after seeing the difference in pruned trees in precarious sites after previous rain events.

"We either remove the tree completely or prune it back significantly because grass below those trees is essential," he said.

Noah is also considering replacing older sub-surface drainage in parts of the orchard which no longer worked during the inundation. After replacing the drains, he plans to do some profiling in the rows to direct water flow towards the grassed drainage line.

Chris said they had been adapting their machinery over the past 10 years to better manage adverse weather

conditions. As an example, they purchased two 4.8 metre wide Toro mowers to make mowing faster and more efficient.

"The idea is that when rain is coming, we can get out and mow the whole place in two days, so we'll be able to get out on it quicker after the rain event," he said.

"We were geared up for it, but when you get that much rain, it doesn't matter how much gear you've got," Chris said.

As well as damage to the orchard, they also lost other farm infrastructure.

"We lost one tractor and a couple of pumps that were in irrigation sheds that we thought were high and dry, but it turned out they weren't high and dry enough," Chris said.

Victoria had just purchased a second Monchiero harvester at the start of the season, hoping to make the operation more efficient, but with the rains it has just sat idle.

She wondered whether investing in another small harvester to give access to the orchard earlier would have been better.

"Who could predict what the season would bring? In previous seasons, the second Monchiero would have been extremely valuable," she said.

"We've missed so much, fertilising for instance, we'll have to change our whole program and follow the harvester to fertilise now," Tod said.

"There's so much nut down that really anything we need do in the orchard will have to follow the harvester for a while."

Many of the growers we spoke to had to juggle staff and find shed jobs for machinery operators during rain delays. They couldn't afford to lose the skilled staff, who are hard to come by in the area and a combination of both full time and some part time staff with flexible working days was helpful.

All the orchards suffered extensive farm road damage, further delaying operations. Council roads leading to the properties were also damaged, holding up critical deliveries, nut pick ups and access for equipment repairs.

"It will probably cost about \$50,000 alone to repair the roads here," Chris said.



Yarrahappini Farm under water during the March rains.

## Necessity leads to innovation

The extremely steep slopes at Charlie Higgins' Valla farm made harvest hazardous both to him and the orchard. He could get his finger wheel harvester into accessible areas, but even then, he risked orchard damage on the steepest sections and when making sharp turns.

This was especially the case in some areas with short rows where using the harvester wasn't an option.

Not wanting to lose more of the precious crop, Charlie remembered a nifty piece of equipment he had seen at a recent field day, a manure vacuum.

"Picking up those large 'style zero' nuts, without resorting to hand picking, was really important and I had to find another way," Charlie said.

Purchasing the Green Pro Manure Vac for \$5,000, he has already picked up 2 tonnes of nuts that he couldn't get to otherwise.

The machine has a small Honda motor that runs the vacuum and an electric tipping function to empty the bin.

"It's got an eight-metre hose connected to a bin that's roughly the same size as a 400 kg field bin which I've hooked to my small tractor, so you don't have to go in with your harvester," he explained.

"I was doing all the steep ground and tight turns so that when it does dry out, I can get the bigger machines on to pick up the rest."

Charlie guides the vacuum manually, picking up everything that the funnel is pointed towards, including leaves, sticks and nuts. He runs it at full throttle, with nuts being lighter than manure.

To tow this simple piece of equipment, he recommends an ATV or something similar that is powerful enough to pull the fully loaded vacuum trailer back to the shed.



The steep slope of the orchard has been a challenge to harvesting after the floods.



While the ground is drying, Charlie Higgins has been able to pick up some nuts with this lighter vacuum machine.

Charlie can pick up a load in around an hour but admits it is hard work. He empties the bin onto trash tables to remove all the debris before it goes into the sorting shed.

"It's more than paid for itself already when I'm getting \$6.50 per kilogram for organic nut," he said.

"I think I'll be using it a lot more, particularly towards the end of the season to do that final clean up."

## Long-term damage unknown

All the growers are uncertain about the implications of this severe weather event for the health of their orchards over the long term.

"In some places, up to half of the root system of the tree is exposed to the air. Once the soil moisture drops, those roots will die and then have to regrow, and the trees will suffer because of it," Noah explained.

They are also worried about the potential for increased Phytophthora infection. The water mould has had far more opportunity during this rain event to migrate and proliferate.

"There's no doubt the trees will struggle with their reduced and damaged root system," Noah said.

Victoria expressed concern about how the orchard would stand up to the rest of the season.

"After the flooding has eased, you look at the trees with relief and think 'oh, they've done pretty well', but then you start to see the longer-term effects and consequences," she said.



Erosion damage is widespread after the flooding, like this wash out at Noah Seccombe's macadamia farm.

She has a relatively new block of younger five-year-old trees on an exposed site and wonders about the long-term effects of trees being blown over and having to be pulled up again.

### What's next for growers

Looking forward, Peter is planning on getting an excavator in to clear the dam (a process he is familiar with after doing it just two years ago during the drought) and restarting the erosion mitigation works. He recently purchased a new Tuffass spreader and will be using it to cover exposed tree roots as soon as he is able.

For Noah, dam repair is critical as the erosion has undermined his dam wall.



Yarrahappini Farm.



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All growers were planning or had already carried out repairs and stabilisation of farm roads.

These repairs and orchard operations are eligible for disaster relief assistance through the Rural Assistance Authority for growers who meet eligibility criteria.

### Special Disaster Grants – Storms & Floods

Disaster recovery grants of up to \$75,000 are now available to primary producers in LGAs affected by the NSW storms and floods that occurred from 19 February 2021 and from 10 March 2021. The LGAs are Clarence Valley, Coffs Harbour, Kyogle, Lismore, Nambucca Valley, Port Macquarie-Hastings and Richmond Valley.

The Special Disaster Grant - Storms & Floods is designed to help primary producers pay for immediate clean-up and repairs to infrastructure.

#### Eligible claims may cover:

- a) Hiring or leasing equipment or materials to clean premises, property or equipment.
- b) Removing and disposing of debris, damaged goods, materials including injured or dead livestock.
- c) Repairing or replacing fencing and/or other essential property infrastructure.
- d) Purchasing and transporting fodder or feed for livestock.
- e) Replacing livestock.
- f) Replacing lost or damaged plants, salvaging crops, repairing or restoring fields.
- g) Repairing, reconditioning or replacing essential plant or equipment.
- h) Maintaining the health of livestock.
- i) Paying additional wages to an employee to assist with clean-up work (above and beyond normal wage expenditure, ie. day-to-day staffing).
- j) Repairing buildings (except dwellings, unless they are used for staff accommodation).

**Can I use the grant to buy replacement machinery and plant that was damaged?** Yes, you can use the grant to cover the repair or replacement costs of agricultural equipment.

**Can I claim the loss of income?** No, the grant cannot be used to reimburse the loss of income.

**Can I claim for the hours I spend on cleaning up and repairing the business?** You can claim for third parties including independent contractors to help with clean up and repair. When it comes to paying staff, the time of owners or shareholders in the business cannot be claimed. You can, however, claim the hours of employees who have no ownership role in the business, where you can show that those hours are above standard day to day wages and can be explained on the basis of cleaning up and repairs in relation to the natural disaster event.

For more info and to apply, go to: Special Disaster Grants – Storms & Floods ([nsw.gov.au](http://nsw.gov.au))

# support

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## Many hands make light work: meet the service providers working behind the scenes of a Bundaberg tech trial

**Megan Woodward**, Journalist **P:** 0487 352 859 **E:** hello@meganwoodward.com.au

In the Summer 2020 edition of the *News Bulletin* (pp. 59-61), we shared the latest on an innovative technology trial being undertaken at Red Rock Macadamias near Bundaberg, in collaboration with Suncoast Gold Macadamias.

With the aim to promote new partnerships between technology providers in the name of greater industry outcomes, the trial focuses on monitoring the effect of various products on tree stress mitigation.

In this article, meet some of the key service providers about the role they are playing in the research, and the value they've found in working together for the benefit of the Australian macadamia industry.

### **Aerobotics: drone imagery and interpretation with artificial intelligence**

Founded in South Africa in 2014, Aerobotics was launched into the Australian market in 2019.

Successfully combining aerial drone imagery with machine learning, the Aerobotics platform is sold as an 'intelligent tool for agriculture', specifically to maximise and protect production in tree crops orchards.

Australian General Manager of Aerobotics, Dr Yoav Yichie, said that while the company is relatively new to the macadamia industry in Australia, their technology has gained positive traction with growers.

"We've done projects in northern New South Wales and other growing regions, and also service a number of Queensland growers," Yoav said.

"Essentially, we're able to help growers better manage their operations by using our tree insights to identify underperforming areas in their blocks and get the most out of data analytics.

"At a high level, for example, growers receive canopy volume information for each tree and block, which allows them to spray the right amount of chemical mix per canopy size or execute pruning."

The Aerobotics team heard about the trial being led by Paul Hibbert from Suncoast Gold Macadamias and approached him to offer their services.

"Suncoast Gold has a keen interest in understanding how many trees their growers have, and we have an interest in exploring new product development options to help macadamia growers work within an integrated platform," Yoav said.

"Growers have a number of ag tech platforms available, so including different companies in one experiment has allowed us to evaluate and combine the value of the tools available."

"This isn't a project where there is a crossover or duplication. It's a true collaboration. It's brilliant."

### **Key benefits/attributes**

Aerobotics uses sophisticated algorithms to calculate leaf chlorophyll levels and canopy size for every tree in the orchard, as well as identify and quantify variance.

These calculations are based on multispectral, or red-edge images as well as high-definition RGB (red, blue, green) images. The images in this project were collected by Bellamish Aerial Imaging Solutions.

*At Red Rock Macadamias near Bundaberg, drones were used as an eye in the sky to calculate leaf chlorophyll levels and canopy size for every tree in the orchard, as well as identify and quantify variance.*

### Quick assessments

"We give every tree a GPS coordinate, which the farm manager can navigate to using our mobile scouting app, Aeroview InField. That way, the grower can ground truth the findings and consult with his or her agronomist on the actions needed," Yoav said.

"Then, management zones can be generated, downloaded as variable rate maps, and uploaded to tractor monitors to apply fertiliser and other applications precisely where needed."

### Application data

Fertiliser and chemical applications are important components of farming, but growers do not want to over or under spray for both financial and environmental reasons.

"Our technology is a useful tool for quantifying precise values and justifying operational decisions when it comes to chemical applications. The real benefit of this is seen in the reduced costs," Yoav said.

"There are big savings to be made as the data gives the grower the ability to apply exactly as per the tree's size and volume instead of blanket spraying. It allows them to allocate resources more accurately and efficiently.

"The same data can also be used to identify what parts of the block may need more or less watering.

"One of the main reasons growers rely on our data is to build irrigation and fertiliser programs that prevent waste."

### Tree health

Using a multi-spectral sensor, tree health is mapped by picking up on reflectance from the canopy.

"A health value for each tree is then available to the grower and the health improvements can be tracked from when treatment begins," Yoav said.

"This also allows the grower to compare treated trees with non-treated trees to see the difference – positive or negative – and make more informed decisions.

"Looking at every tree in a property can be overwhelming for farm managers, so they can decide to compare and benchmark their property on the block level, it is highly actionable information."

### Tree counts and missing trees

"Tree counting is a time-consuming but necessary job and aerial management can alleviate this challenge," Yoav said.



Aerobotics' Aeroview platform is a planning, monitoring and control centre for farms. An intuitive display enables growers to make decisions from their data that can protect and increase production.

"Using remote sensing, we can count every tree on a farm with at least 97% accuracy. The grower can export a report of his or her tree counts and missing trees for inventory management and nursery orders. This saves labour costs and reduces the margin of error.

"Growers generate significant amounts of data, but our platform helps them to use it effectively and act on the results."

The information garnered by Aerobotics is then analysed in the Farm in One software alongside the other data collected to assess tree performance.

### Farm in One: farm management software

Farm in One is a farm management platform that is described as a 'multi-tool farm app for your daily operations'. iPhone or Android compatible, the app can run both offline and online.

Unlike other platforms that will only work with the developer's own software, Farm in One's point of difference is its ability to tackle multiple subscriptions to different programs and combine all the data coming in to offer the user an overarching view of everything happening on farm.

Built by HTM Complete based in Atherton in Far North Queensland, Managing Director Fabian Gallo said the platform has been built off the back of farmer feedback.

"Farmers are using anywhere up to a dozen or more different programs at any one time to gather data so they can best manage and monitor their crop," Fabian said.

"But what we kept hearing time and time again was the overwhelming task to be able to compare that data or collate it in one place when the programs wouldn't 'talk' to each other.

"We could see the need to be able to offer farmers the ability to use their data more efficiently. We've attempted to build something where all data from the day to day running of a farming operation can be funnelled into the one place, from staff management to irrigation control to chemical intake to plant sensors to drone mapping."

The HTM Complete team has worked with Suncoast Gold for around 10 years on automation projects and were invited to take part in this latest project to test the platform's ability to talk to other device systems.



The positioning of sap flow sensors is important to get accurate information. They should be placed in line with the direction of sap flow and in an area that's free from grafts and blemishes.

### Key benefits/attributes

While the platform is only 18 months old, Fabian Gallo said the trial with Suncoast Gold has allowed them to work on best-fit integrations with the platform and gain valuable feedback from growers who are using it.

"Farmers have got to deal with so many different jobs in the day and time is money. When you're juggling decisions on farm, then having to look at five or more separate programs to make another decision is not the most efficient way to operate.

"We've simplified the complexity of it and the feedback on the trial is that it's very user friendly."

### Savings through controlled management

The Farm in One app assists growers to automate irrigation and fertigation management, monitor soil moisture, farm weather and crops, set up spray schedules, map the farm, and assign task management to workers.

Fabian said these features offer multiple savings to users, whether that's saving water through farm irrigation management or saving energy by minimising pump usage by analysing the data and only watering when needed.

"Obviously, it also offers opportunity to save on product usage with the fertigation management tools, which in turn assists with environmental gains because growers are using less water and chemicals. It saves paperwork too because everything is available via the app as well as backed up in the cloud," Fabian said.

"The big savings though are time, stress and money which is incredibly valuable to any industry, but especially in agriculture and horticulture."

### Real time feedback and drone adaptability

"Growers are telling us the ability to interact with the data in real time is a major benefit of what we've developed," Fabian said.

"For example, sap flow sensors can 'talk' to the imagery data a drone may have pulled in, and then a suggestion will be made around setting a differing spray schedule.

"All those different elements of farming that are ordinarily used in the field are still there, but our program manages these instantly and sends the feedback through to the grower.

"What's new with the platform is that it is implementing the drone data in a way that the grower can use instantly and take feedback from the drone as well.

"Drones usually provide a feedback report of course, but with Farm in One, the grower can interact and display the different images against the data other programs have provided to them.

"This ensures that the grower has control of what they're doing and how they're using their devices."

### Rimik: state of the art communication

Rimik is the company facilitating the communication of data being fed to Farm in One via the Telstra mobile network and LAN connections through modular on farm equipment and cloud-based applications, as well as providing the sap flow and soil monitoring technology.

Rimik's association with the trial came about through word of mouth based on their work on a nearby avocado orchard in Bundaberg where they had installed a semi-industrial style monitoring and automated control system.

Director Luke Hogan said Rimik supplied the Red Rock trial with a standard 4G monitoring system in the company's first macadamia specific project.

"Rimik has been operating in Australia for more than 40 years, developing and manufacturing soil pressure instruments and more recently telemetry equipment for remote monitoring and control," Luke said.

"We've done extensive work with tree crops, but this is our first direct involvement with macadamias, and it's been a great insight into industry needs.

"One of the key reasons we were engaged was to test how quickly data could be provided to collaborating partners, so in this case, testing the compatibility and ability for Rimik to handle the hardware and communication methodology and then funnel that to the Farm in One platform for use.

"Fundamentally, we are engineers and manufacturers with the ability to give the required information to farmers and agronomists to allow them to make timely decisions."

### Key benefits/attributes

#### Sensor information (moisture probes and sap flow capability)

Luke said sap flow and soil moisture sensors show in real time what is happening in the tree and in the soil.

"This is an important aspect of trying to assess the level of stress that the trees are under," he said.

"For instance, on a rainy day we may see the soil moisture rise in the upper levels of the soil (every 10 cm of profile is measured down to 80 cm) and the sap flow may slow considerably, and this means growers can access the monitoring information live from the farm showing the sap flow of each treatment and the soil moisture at various depths.

"It is considered that if the tree is still trying to access moisture throughout the resting period of an evening then it is potentially in stress. This can then be compared to what is happening in the soil at the time and the weather data, particularly vapour pressure deficit."

Luke said installing the sensors is simple but recommends seeking advice if it's your first time placing them.



Rimik's data node system takes information from multiple sensors and communicates it to the Farm in One program.

"There's no reason why anyone can't put them in, but growers need to be mindful of the technique, so they don't get erroneous data," he said.

"For instance, inserting the soil moisture sensor into an oversized hole in dry soil isn't going to work. In addition, orientating and positioning the sap flow sensors on the trunk of the tree is important.

"They need to be placed in line with the direction of sap flow and in an area that's free from grafts and blemishes that can affect moisture flow in and around the sensor.

"As newcomers to the macadamia industry, we did a lot of work to ensure we have the sap flow sensors all working properly and looked carefully at where to place them to reduce variability from tree to tree, for example placing sensors on same side of every tree.

"The main thing to have at the front of your mind is taking out as many variables as possible because you need to be as comparable and consistent as possible."

While the technology is well known, Luke said sap flow monitoring has been much more research specific to date but with greater industry acceptance, can offer greater insight to tree management.

"Of course, using sap flow alone will only tell some parts of the story but it does work as a great tool when combined with moisture probes and other monitoring technology," he said.

"It's such a great indication of moisture and nutrient flow so growers know whether the tree is getting what it needs to provide good growth and good fruiting, as well as early indications of potential problems.

"When growers start out using this technology, my advice is to try and pick average trees – not the best and not the worst – and get a baseline from there."

#### **Modular units fit for purpose with scalability**

Rimik's telemetry range is built on a modular design, which means users can add modules to get more capacity.

"For example, growers can remove the modem module and put in a radio allowing the unit to be integrated into a secure farm network or add a module to connect another sensor. We're trying to maximise flexibility for growers and ensure that whatever equipment a grower



*Soil moisture sensors show what is happening in the soil in real time.*

might have now, we can supply or design a module that will work with that, so there's no need to go out and spend up on something completely new," Luke said.

"Our largest site in Queensland has 30 base units, used for monitoring all manner of sensors and control pumps, valves and other electrical circuits. It's spread over the whole property and we have retained all existing equipment.

"Some irrigation control systems in Victoria can have up to 100 units on site with capacity for an irrigation operator to independently manage a group of five to 10 roving (mobile) units operating on the same supply channel as other groups.

"We like to think this offering has options for small scale single units such as this trial, up to large scale operations.

"Our 8 port DN300 series is required for complex tasks such as flood gate opening or in this case, multiple sensor connection (4 x sap flow plus 1 x soil moisture), but for a single sensor or a latching solenoid valve that needs radio, 3G or 4G, we have the smaller and less expensive, 4 port DN200 series.

"With the DN300 and DN200 series, monitoring and scheduling is operated locally, so growers can work it at a level that suits them, whether that's a simple logging unit, a unit within a radio network or a standalone (3G/4G) unit. While access to monitoring and control is set up in the cloud, if growers lose communications, the system keeps ticking along performing monitoring and control functions according to locally stored reading and operating schedules.

"The technology has the ability to monitor almost any sensor and control all manner of fixed equipment. Units can be powered by mains connection or totally independently with batteries and solar recharge."

#### **Information access and ease of use**

The modular system is easy to change or update, so a user doesn't need to remodel or buy more units if they need it to perform a new function. A grower can simply add or remove a module, configure the channels and be running again in a small amount of time.

"Like the sap flow system, our remote monitoring and control units can be pre-configured so they are easy to install, but we'd suggest some guidance for initial placement, whether that is directly with Rimik, a local installer or your electrician or on-farm technician," Luke said.

"No matter where our units are on farm, they are accessible online (excluding units configured as log only) so the grower can get it do what it needs it to do – whether that's adding a new sensor, adjusting the calibration of a sensor, connecting a new valve or changing the irrigation scheduling.

Rimik's online platform is available for simple interaction with its field units and other integrated devices. It is designed for those growers who need quick and simple access to manage their equipment and operations.

Where growers are looking for higher level agronomic and decision-making tools, Luke encourages the use of other online platforms such as Farm In One which utilises direct access to the Rimik API for real time data transfer.

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# A fertiliser and soil bacterium that increase the growth of macadamia seedlings

**Dr Marta Gallart**, Griffith University, **Dr Chanyarat Paungfoo-Lonhienne**, The University of Queensland, and **Professor Stephen Trueman**, also from Griffith University **P:** 07 3735 7719 **E:** s.trueman@griffith.edu.au

The interrelationship between macadamia plant health and orchard floor biological diversity is a growing field of study. Macadamia trees start out in a relatively sterile growing medium in the nursery, with the aim of suppressing potential disease pathogens. Many products are being sold which 'stimulate' microbiological activity, but efficacy data is usually taken from crops other than macadamia and broad assertions made. In this research trial, the team at Griffith University and The University of Queensland analysed macadamia seedling growth with the addition of inorganic nitrogen, organic nitrogen and a specific soil bacterium.



Dr Marta Gallart and her colleagues are investigating ways to improve the growth of macadamia seedlings.

Dr Marta Gallart and her colleagues have been investigating different nitrogen fertilisers and a growth-promoting bacterium from Australian soil for their capacity to improve the growth of avocado and macadamia trees.

Their initial results show that a combination of growth-promoting bacterium and a mixture of inorganic and organic fertiliser can improve the growth of macadamia seedlings.

Their research was conducted under the Cooperative Research Centre Project, *Eco-friendly fertilisers for sustainable farming*.

A bacterium isolated from Australian soil, SOS3 (NCBI ID: 1926494, Sustainable Organic Solutions Pty Ltd), increases the growth of rice, sugar cane and kikuyu grass. Our team has investigated whether the same bacterium can improve the growth and nutrient use efficiency of avocado and macadamia trees.

We have conducted research with seedlings in glasshouse trials and with mature trees in orchards. Here, we report promising results from glasshouse trials on macadamia seedlings.

## Methods

We germinated cultivar 741 nuts and transplanted the seedlings into 7.5 L pots containing macadamia potting mix. The supplier, Rocky Point Pty Ltd, kindly provided a base potting mix that was free of added nitrogen so that we could add our own nitrogen fertiliser treatments. Cultivar 741 was used because fresh nuts from the rootstock cultivars, H2 and Beaumont, were not available at the time of study.

We separated 100 seedlings randomly into four treatments and a control (Table 1). Control plants received no nitrogen other than what was present in the base potting mix. Nitrogen at standard rates was added to the four treatments as either urea or as a nitrogen-equimolar combination of urea and poultry manure-based organic fertiliser (ecoNPK™). Within each nitrogen treatment, 20 plants received no bacterium and 20 plants received bacterium. The SOS3 bacterium was incorporated into the potting mix using zeolite as a carrier.

We equalised the concentrations of phosphorus and potassium across treatments using monocalcium phosphate and potassium sulphate. Pots were supplied twice with a micronutrient solution containing boron, copper, iron, magnesium, molybdenum, sodium and zinc.

We grew the seedlings in a glasshouse with 30% shade cloth. The plants were dissected after 28 weeks

Fertiliser treatment	N form	N (g/L)	Bacterium level	Bacterium in zeolite	No. of plants
Control	Nil	0	-	-	20
Inorganic N	Urea	1.34	-	-	20
Inorganic N	Urea	1.34	+	10 g/pot	20
Inorganic N + ecoNPK	Urea + EcoNPK	1.34	-	-	20
Inorganic N + ecoNPK	Urea + EcoNPK	1.34	+	10 g/pot	20

Table 1. Nitrogen (N) fertiliser and bacterium treatments used for macadamia cv. 741 seedlings.

into three samples (leaves, stems, and roots), which were dried at 60°C before weighing. Fine roots and primary roots were divided and weighed separately. We analysed subsamples of leaves and roots for nitrogen concentrations. Plant nitrogen uptake was calculated by multiplying dry mass of the leaf and root tissue by their corresponding nitrogen concentrations. Microbial-biomass nitrogen in potting media was determined after the fumigation of samples with chloroform.

### Seedling growth

Total seedling biomass was highest in the two treatments that combined inorganic nitrogen with ecoNPK (Fig. 1). Of these two treatments, growth was higher when SOS3 bacterium was added to the potting mix.

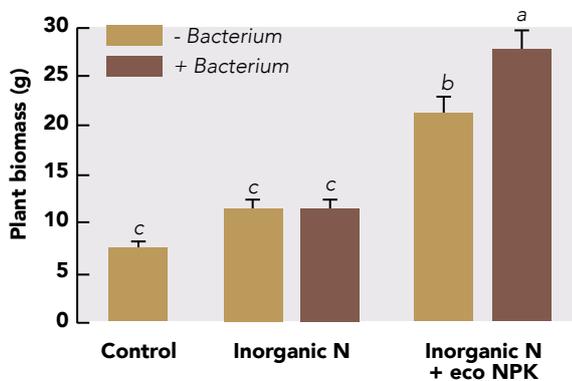


Figure 1. Biomass of macadamia cv. 741 seedlings fertilised with urea (Inorganic N) or urea and organic fertiliser (Inorganic N + ecoNPK). The potting mix had no added bacterium (- Bacterium) or added bacterium (+ Bacterium). Means with different letters are statistically different (ANOVA and Tukey's HSD test; P<0.05; n=20).

The combination of inorganic nitrogen with ecoNPK increased leaf growth and stem growth (Table 2). The SOS3 soil bacterium increased fine-root growth when it was applied in combination with inorganic nitrogen and ecoNPK, and this was also associated with increased leaf and stem growth.

The combination of inorganic nitrogen and ecoNPK doubled the nitrogen uptake efficiency of seedlings when compared with inorganic fertiliser alone (Table 2). Adding SOS3 bacterium to inorganic nitrogen and ecoNPK tripled the nitrogen uptake efficiency of seedlings when compared with inorganic fertiliser alone.

Microbial biomass nitrogen was much greater when SOS3 bacterium was added to inorganic nitrogen and ecoNPK, when compared with inorganic fertiliser alone. Microbial biomass, composed of bacteria and fungi, decomposes soil organic matter and makes nutrients available to plant roots.

### Conclusions

A combination of inorganic and organic nitrogen was more effective than inorganic nitrogen alone for growth of macadamia seedlings. Adding SOS3 bacterium to the combination of inorganic and organic nitrogen increased growth even further and greatly improved nitrogen use efficiency. The results suggest that organic nitrogen and growth-promoting bacteria should be trialed more widely in macadamia nurseries to accelerate growth and reduce nutrient loss from potting mix.

### Where to from here?

We now know that seedling growth can be improved by organic nitrogen and growth-promoting bacteria. The next step will be to work out whether these findings can be translated into effects on mature trees. Our team is currently testing the effects of inorganic and organic nitrogen fertilisers, in combination with the SOS3 bacterium, on the growth, nutrient uptake, yield, and fruit or nut quality of avocado and macadamia trees in commercial plantations.

### Acknowledgements

This research was funded by Cooperative Research Centre Project Grant CRCPFIVE000015. We thank Rocky Point Pty Ltd for providing base potting mix without added nitrogen and SOSBio Pty Ltd for providing ecoNPK fertiliser and SOS3 bacterium. We thank Joel Nichols, Tracey McMahon, Santi Krisantini and David Appleton for their assistance.

Fertiliser treatment	Bacterium level	Leaf dry mass (g)	Stem dry mass (g)	Fine root mass (g)	N uptake (mg/g)	Microbial biomass-N (mg/kg)
Control	-	2.8 ± 0.2d	0.8 ± 0.1d	2.2 ± 0.2c	3.6 ± 0.2d	4.4 ± 1.5b
Inorganic N	-	5.5 ± 0.3c	1.1 ± 0.1cd	2.7 ± 0.3bc	6.5 ± 0.6c	6.3 ± 0.5b
Inorganic N	+	5.1 ± 0.4cd	1.4 ± 0.1c	3.2 ± 0.4bc	6.6 ± 0.4c	7.1 ± 1.4b
Inorganic N + ecoNPK	-	11.0 ± 0.9b	2.4 ± 0.2b	4.4 ± 0.5b	13.3 ± 1.4b	24.8 ± 3.5ab
Inorganic N + ecoNPK	+	13.9 ± 1.0a	3.2 ± 0.2a	7.0 ± 0.7a	19.0 ± 1.3a	41.1 ± 9.0a

Table 2. Growth and nitrogen uptake efficiency of macadamia cv. 741 seedlings, and microbial biomass nitrogen, in response to nitrogen fertiliser and bacterium treatments. Means (± standard error) with different letters within a column are statistically different (ANOVA and Tukey's HSD test; P<0.05; n=20).



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# Options for soil erosion control in older, dark orchards

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Torrential rain in the New South Wales North Coast and South-East Queensland in recent weeks has been a stark reminder about managing soil erosion in macadamia orchards. Justine Cox and Jeremy Bright review the current recommendations for reducing soil movement in orchards and outline their latest research including different mulching options to lower the risk of sediment and nutrients moving into water ways.

Soil erosion in macadamia orchards has been identified as an environmental and production issue in the Northern Rivers region of NSW for several decades (Firth 2003). The erodible red Ferrosol soil is vulnerable to movement in this sub-tropical climate which is prone to intense rainfall and storms.

Ground cover plants have been shown to be the most effective way to reduce soil loss, with research demonstrating that Smothergrass (*Dactyloctenium australe*) reduced soil loss by 99% (Reid 2002). Trials showed that the grass slowed the amount of water and soil moving down slope, trapping soil and bound phosphorus while reducing the volume of water runoff and accompanying dissolved nitrate. For more information on using Smothergrass to reduce erosion, see Quinlan et al. (2008).

In older orchards with large trees and close spacings, however, there is often insufficient light to support ground cover plant species, making alternative erosion management strategies necessary. Ideally the trees in these orchards should be pruned back to a manageable height that will allow light on to the orchard floor, with

minimal impact on yields. Pruning should be coupled with a drainage management plan that ensures water is diverted away from the tree rows and instead flows through the orchard along designated grassed watercourses.

Our research into the sources of soil erosion in macadamia orchards has found that stemflow, the water funnelling down the trunk during rainfall, concentrates high velocity water at the base of the stem. This intense water flow moved 3.8 tonne of soil per hectare per year, for an orchard with 8 x 4 metre spacing, detaching and displacing soil particles more than two metres from the base of the trunk (Cox et al. 2010).

Once soil particles are detached, they are at greater risk of being moved out of the row by blowers and sweepers. Research to quantify this movement measured 2.5 tonnes per hectare per year of soil movement due to blowers and 1.3 tonnes per hectare per year caused by sweepers.

To counter the soil movement, our recommendations prioritise protecting the soil surface, ideally with ground cover, as well as implementing a well-designed drainage management plan. In orchards where ground cover is not possible, adding mulch is a useful alternative. Adding an organic mulch that covers the soil surface under the trees will improve soil health in the long term. As the mulch breaks down, it will add organic matter to the soil, assisting with nutrient and soil moisture retention.

The longevity of mulches varies considerably depending on their properties. Compost will break down quickly due to its usually fine particle size, but woodchip containing large particles that have not undergone any decomposition process will break down more slowly, protecting the soil for longer. An ideal mulch for macadamias in the Northern Rivers region will allow upslope surface water to move through the mulch material without causing significant disturbance to the mulch.

The Clean Coastal Catchment (CCC) project, funded by the NSW Government's Marine Estate Management Strategy, is conducting further research to evaluate soil erosion control in macadamias.



*The compost is spread by a side delivery belt spreader.*

The aim of the CCC project is to reduce the risk of sediment and nutrients moving off farm into water ways in the lower catchment. We are currently examining the efficacy of several different mulch options as well as erosion sox.

The trial treatments include:

1. green waste and cow manure compost applied at 5 cm thickness
2. double ground wood mulch applied at 10 cm
3. tree limb removal (to open canopy and increase light to orchard floor), with the tree limbs then mulched and applied under the trees at a thickness of 10 cm
4. erosion sox with a non-biodegradable casing, containing soil and organic matter, wrapped around the tree trunks
5. bare soil control.

The mulch in the trial has been applied in strips either side of the tree row, spread from the tree trunk out to two metres either side, to a total width of four metres, to protect to the drip line and harvest area.

Mulch height over time is monitored to capture losses due to settling, decomposition and harvest effects, assessing how long each mulch lasts and the extent of erosion due to upslope surface water flowing into the mulches.

Soil and mulch height is monitored with a laser meter from a fixed point, measuring soil losses (and gains) in the radial area around the tree. Measurements are taken from points at 30 cm and 1 m distances from the trunk. The impact of the different mulches and compost on soil fertility, soil health and root density will also be assessed.

The Clean Coastal Catchment project is also monitoring on-farm soil and water quality on two commercial macadamia farms, one on the Alstonville plateau (Ferralsol), and the other on the coastal flood plain (Vertosol).

For further information about this research, contact Justine Cox at [justine.cox@dpi.nsw.gov.au](mailto:justine.cox@dpi.nsw.gov.au) or see <https://www.dpi.nsw.gov.au/agriculture/water/clean-coastal-catchments>.

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The erosion sox contain a mix of soil and organic matter inside a non-degradable casing, with the aim of reducing soil erosion due to stemflow.



One treatment involves removing tree limbs to open the canopy and increase light into the orchard floor, plus returning mulched limbs to the surface.



The laser meter is placed on top of a permanent erosion pin to measure soil and mulch movement.

# Know your responsibilities under Reef protection regulations

The Reef protection regulations are Queensland laws that address land-based sources of water pollution to the Great Barrier Reef. This includes industrial and agricultural sources of nutrient and sediment pollution. These regulations already apply to graziers, cane growers and banana producers, but are expanding to include grain and horticulture producers.



### What areas are affected?

Regulations apply to all six Great Barrier Reef regions - Cape York, Wet Tropics, Burdekin, Mackay Whitsunday, Fitzroy and Burnett Mary.

### What are the main sections of regulation?

- Horticulture producers are officially required to keep records as of 1 December 2022.
- Primary producers need to comply with industry specific minimum practice agricultural standards.
- As of 1 June 2021, new or expanded cropping and horticulture activities on five hectares or more that do not meet the cropping history test will require an environmental authority (permit) before work

can take place and all regulated industrial land use activities must meet new discharge standards.

- While farm nitrogen and phosphorus budgets only apply to sugarcane producers currently, they will most likely be required in horticulture soon.

### What are the time frames?

The new regulations started on 1 December 2019 and are being rolled out over three years. The progressive application for different industries and regions is based on improved water quality management priorities.

### What is required in terms of record keeping?

Records are required to show that activities are in accordance with minimum agricultural practice standards.

Under the new regulations, there are three types of records that need to be kept by producers:

- General records (must be made within three days of the relevant activity taking place and include who carried out that activity and where; and must be kept about any agricultural chemicals, fertiliser and mill mud or ash used).
- Minimum standard records (including farm nitrogen and phosphorus budget records, currently for sugarcane growers only).
- Primary documents (leaf or soil tests, fertiliser contractor print outs, or fertiliser or agricultural chemical invoices).

There is no specific format required and many producers will already be recording this information using industry developed forms. Records must be kept for at least six years.

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### Do I need to worry about BMP compliance?

The minimum practice agricultural standards are tailored to each industry. They all focus on retaining nutrients and sediment on-farm to prevent and minimise run-off and improve water quality.

While following relevant BMP in horticulture is only required from December 2022, it is recommended that growers start using Growcom's Hort360 program.

### Should I be considering nutrient budgets?

While nutrient budgets for nitrogen and phosphorus only apply to sugarcane currently, they are likely to apply to horticulture soon.

Initial farm nitrogen and phosphorus budgets must be prepared by an appropriate person, such as an agronomist, and must then be reviewed every five years. Producers can prepare and review their own farm nitrogen and phosphorus budget if they have the relevant experience and qualifications through a recognised program.

### What are the requirements for new/expanded cropping and horticulture?

From 1 June 2021, new or expanded commercial cropping and horticulture activities in the relevant regions on five hectares or more that do not meet the cropping history test, will require an environmental authority (permit) before any work takes place.

A cropping history applies when activities have occurred during three out of the last 10 years (with at least one of the years being in the last five years) and the cropping history test includes ALL types of crops.

Producers undertaking new cropping or horticulture activities are also required to meet minimum practice agricultural standards where prescribed.

Activities on between five and 100 hectares will have a simplified application process, but activities on areas over 100 hectares will need to make a site-specific application to determine any tailored conditions to manage water quality risks for the newly cropped area.

### Where can I get more info?

Visit [www.qld.gov.au/ReefRegulations](http://www.qld.gov.au/ReefRegulations) for more information and register to receive an information pack and receive regular updates. You can also email [officeofthegbr@des.qld.gov.au](mailto:officeofthegbr@des.qld.gov.au) or phone 13 QGOV (13 74 68).



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## Reef ready at Rockhampton



*Henrik Christiansen has taken a proactive approach to changing Reef regulations, becoming one of the first macadamia growers to become Hort360 Reef certified.*

**Farm:** Fitzroy River Plantation

**Grower:** Henrik Christiansen, MacField Farms

**Location:** On the Fitzroy River, near Rockhampton, Queensland

**Farm size:** 300+ hectares of mature trees

**Irrigated:** Fully irrigated

Rockhampton grower, Henrik Christiansen is taking a proactive approach to changing Reef regulations, recently becoming one of the first macadamia growers to achieve Hort360 Reef Certification.

"We wanted to get a health check on the farm and make sure we had our baseline systems right, so that we could keep doing our best to protect the environment," he said.

"It also meant we would be prepared for any future Reef regulation changes and requirements."

Growcom's Hort360 Reef Certification provides a credible certification pathway for horticulture growers to demonstrate their environmental stewardship and industry best practice standards in the Great Barrier Reef catchments. The process involves a self-audit and then a third-party audit.

The Hort360 Reef Certification specifically focuses on water quality outcomes while maintaining an alignment

with existing food safety quality assurance and environmental systems. Within the certification there are four key management practice areas – nutrient, sediment, pesticide and water.

Henrik said the final audit took about a half a day and was made easier due to the farm's well-established record keeping system and Freshcare accreditation.

He advised growers to have well established records in line with Freshcare requirements before tackling the Hort360 Reef Certification.

Some of the farm records used in the Hort360 Certification process included the spray diary, soil and plant tissue test results, the nutrient plan, fertiliser application records and calibration and irrigation records.

"We have our farm records on Conservis, which is an electronic record keeping system, but there are 1001 ways it could be done, including on paper," he said.

Henrik said the two major areas of focus for Reef certification were managing nutrient run-off and sediment run-off.

"It's about understanding where the water runs over your property, having good orchard floor coverage and controlling the main drains with run-off control mechanisms to slow that water movement off the farm, as well as managing all aspects of nutrient use," he said.

"This could include anything from considering soil and plant tissue test results when making rate, application method or timing decisions to making sure the fertigation pump is calibrated."

Fitzroy River Plantation uses annual soil testing and quarterly leaf tissue testing, along with professional advice, to guide nutrient use.

"We consider the full spectrum of nutrients and use a range of sources to apply what is required, including compost, soluble fertilisers and granular fertilisers," Henrik said.

"We generally take the 'apply less, more often' approach and look to time any broadcast fertiliser applications to seasons when the risk of heavy downpours is low so that we are reducing the run-off risk."

Henrik said while the requirements of the Hort360 Reef Certification were in line with their business values and they did not need to make many changes, the auditing process was valuable in helping to identify areas for improvement that wouldn't ordinarily come up.

"Having this certification has put us in a good position, because I think it's only a matter of time before Reef regulations become more complex," he said.

"If you have good record keeping systems and you're Freshcare accredited, this is an easy next step.

Compliance Item	
<b>Management</b>	Property map Documents and records
<b>Internal Audit</b>	Internal audit
<b>CAR</b>	Corrective Action Record
<b>Nutrient</b>	Test results and or crop monitoring records Fertiliser and soil additive application record Hydroponic nutrient solution monitoring record Calibration Record (fertiliser/ fertigation)
<b>Sediment</b>	Soil conservation Run-off management
<b>Pesticide</b>	Preventive pest and disease control program Pest and disease monitoring record Pre-harvest Spray / Chemical Application Record Calibration Record (pesticide)
<b>Water</b>	Maintenance and Service Record Water management program

Nutrients, sediment, pesticides and water are four key areas to focus on for Hort360 Reef certification.



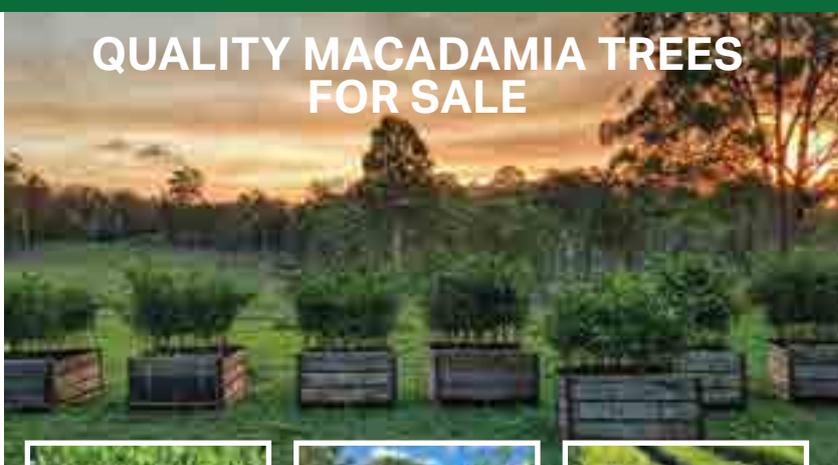
Fitzroy River Plantation is an established orchard on the Fitzroy River near Rockhampton.



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## Big toy for studying orchard water and input losses

**Dr Janine Conway** Technical Officer, Maroochy Research Facility, Department of Agriculture and Fisheries, Queensland **E:** [Janine.conway@daf.qld.gov.au](mailto:Janine.conway@daf.qld.gov.au)

An odd contraption has started a tour of macadamia orchards. It is a rainfall simulator, a concoction of tubes and cords designed to deliver rain-like droplets at customisable intensities. The simulator is at the heart of a study into the movement of water through orchards and that water's capacity to carry away soil and associated chemicals such as valuable nutrients.



*The rainfall simulator's droplet generator heads and pressure gauge.*

The Queensland Government funded study, "Enhancing the export credentials of Queensland tree cropping systems", is being run by scientists of the Horticulture Systems Agronomy section of the Department of Agriculture and Fisheries (DAF).

The study aims to gather information on water loss from orchards, as well as soil conservation, and the efficiency of nutrient and pesticide application. This will assist in validating the industry's 'green' image, enhancing domestic and export market opportunities. The knowledge will also identify areas where help is needed to meet reef water quality objectives in Great Barrier Reef catchments.

### Beginnings of a big job

The first orchards to participate in the study are in the Burnett-Mary catchment. The simulator can be set to mimic a variety of rainfall types, from gentle to intense. For this work, the simulator is being set to a moderately intense rainfall, equivalent to a 1-in-10-year event, which comes to around 75 mm/hr for this location.

At the same sites as rain simulation, the group is investigating the properties of the underlying soil. A combination of soil physical, chemical and biological properties are being measured, to investigate links between the water dynamics and the crop and inter-row groundcover.

The lab and field tests on soil and run-off include biological decomposition rates; pesticide concentrations; soil density; water infiltration; root mass; soil organic matter; soil moisture; cation exchange capacity; groundcover proportion; and nutrient concentrations.

Dissolved nutrients are being measured separately from those attached to particles, and organic nutrients are being measured separately from those in mineral form. This is to obtain information on the speed of availability of the nutrients present, and the forms most resistant to being washed out of the orchard by water.

The testing is being carried out by a variety of Queensland Government organisations, including Department of Environment and Science Chemistry Centre, the Department of Resources, and the Department of Agriculture's soil health laboratory and Bundaberg Research Station.

Each site is divided into three zones: under-canopy, inter-row, and a transition zone between these two (around the drip-line). The understanding and assistance of collaborative growers has been key to designing and implementing the most useful possible study. They have enabled the team to compare high-yield blocks to low-yield blocks. For the duration of the project, growers are measuring yields separately for each site. This will enable the ultimate number crunch: examination of the crucial relationships between orchard productivity, soil health and run-off.

### First results and onward

The very first results are in. On the first property to participate, nutrient cycling ability was found to be highest in higher yield blocks. Also on this property, valuable soil nutrient concentrations were highest in the under-canopy zone and transition zones, which were also found to be the zones with the lowest groundcover levels and thus the greatest vulnerability to erosion.

While these initial results may be simply intuitive to many, they are the beginning of measuring important orchard characteristics with standard methods. The big deal about this is that these standard methods can be used to understand more than what is happening in just one block at one time. They will enable accurate comparisons of the costs and benefits to immediate and distant parts of the landscape – orchard, catchment and reef.



Luke Griffin and Sushil Pandey from DAF record run-off from a rainfall simulation.

Fair comparisons will be able to be made of different conditions (e.g. soil type) on run-off, and of different commercial management practices such as inter-row cover planting, under-tree mulching, time of spraying, or canopy management practices.

This will also open the possibilities of assessing whether those benefits are the same for different climatic regions, or at different parts of the orchard management year, or at different stages of the orchard's life.

Such assessments may be able to be done by growers for their own orchards, to aid management decisions. And this new knowledge will enable agronomic solutions to be developed to increase industry economic, social and environmental sustainability.

The DAF team hopes to study orchards in other macadamia growing regions in Great Barrier Reef catchments.

This team and the Australian Macadamia Society are also surveying macadamia growers in the next few months about orchard floor management and nutrient application. This will provide valuable information about how findings from our initial field-based research study may relate to a wider group of commercial growers.

For growers who are interested, this information could also be used to compare practices through anonymous benchmarking.

If you would like to contribute to this short anonymous survey, please contact the AMS.

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# Tree shaker benefits – more than a quicker harvest

Anne Currey, AMS Communications

Tree shaking technology has come a long way since the first machines were introduced to tree crops in the 1960s. Today's shakers are sophisticated machines fitted with sensors and padded heads, so they are much less likely to damage trees than in the past.

A growing number of orchard owners and managers in the industry are using tree shakers, including Daryl Wake, who bought a machine last year, and Scott Norval from RFM, who has been using shakers for five years. We spoke with Daryl and Scott about their experiences and why they have incorporated these machines into their harvest programs.

Both Daryl and Scott made it clear that tree shakers are not used simply to speed up harvest and their reasons for incorporating them into the orchard system are more complex. These include improving orchard hygiene, decreasing harbour for pests and diseases, reducing harvest costs and allowing after-harvest operations to be started sooner than normal.

## Technology improvements encourage adoption

Daryl, who is based at Rosedale north of Bundaberg, imported a new Shockwave Sprint machine directly from the Orchard Machinery Company in the United States.

Importing the machine to his specifications cost more than \$280,000 including expenses for an international broker, freight, customs, GST and insurance.

"We chose the OMC because of its reliability, the way the machine is made and because of how sturdy it is," he said.

In the past, growers have been concerned that shakers could damage trees, but developments in the technology mean that they are less likely to damage or strip the bark from them.

Daryl explained that the shaker head for his machine is fitted with bead filled airbags and a silicon-lubricated rubber skin which clamps on to the tree trunk. This design helps to reduce friction so that there is less risk of damage to the tree.

Scott, National Manager – Macadamias with RFM at Bundaberg, has had five years' experience with using a tree shaker. RFM initially began with a trial to establish that the technology had potential in the orchards they manage.

From harvesting about 25 ha a year, they now use the shaker on an area between 50 to 60 ha a year on a rotational basis, and they have used it successfully on all cultivars.



Daryl Wake chose this OMC Shockwave Sprint tree shaker because of its reliability and sturdy build, importing it from the US last year.



The cab of the tree shaker is well designed for ease of operation.

"It's now a standard part of our orchard production cycle targeted to specific cultivars that are prone to sticktights or sections of the orchard where we want to finish harvesting quickly so we have time to get in and do other things," Scott explained.

## Shakers and orchard management strategy

According to Scott and Daryl, incorporating shakers into the orchard management strategy has provided several benefits. For Scott, the key advantages have been compacting harvest, which provides a handy buffer and allows him time to devote to important orchard management activities such as pruning and profiling.

"In one of our orchards, we had 20 per cent of it pruned by June last year after using the shaker," he said.

As growers are extremely busy during winter and into spring, any equipment or process that improves efficiency is a bonus.

Allowing improved management of sticktights, particularly in cultivars such as 816 and Daddow which are susceptible to the condition, is also important.

Through trial and error, Scott established that timing affects how much nut is recovered. With 816, and Daddow to a lesser extent, he explained that using the shaker in May, when he would prefer to harvest those cultivars, means that he has been able to achieve between 85 and 90 per cent clean up.

"If you shake them from July and into August, however, you will get them fairly clean," he said.



*RFM is using this tree shaker on rotation in 50 to 60 hectares of macadamia trees, compacting harvest and improving the management of sticktights in varieties such as 816 and Daddow.*

He is now experimenting with ethephon to see if that will allow them to strip the trees in early May.

Scott added that there were significant 'flow-on benefits' in stripping nuts from the trees using the shaker.

"By cleaning all that nut and old husk out of the tree, we have certainly had a huge reduction in husk spot pressure and, while we haven't quantified it, I think we could be looking at 10 per cent extra production as a result.

"I don't think it actually grows more nuts, rather there is no loss of production because it allows us to finish harvest sooner and gives more time to prepare the tree," he said.

Daryl agreed that the shaker has been an important addition to his orchard management toolkit for reducing the impact of husk spot and pests such as rats and cockatoos, and for allowing more time for other orchard jobs.

He uses the shaker on 816, 741, 344 and Daddow.

"It cleans up the tree, leaving no or very little nut in the off-season for rats to feed on and for husk spot to breed in and affect the next crop," he said. "And by doing this, we can get our compost on two or three months earlier, we can prune earlier and build up tree health quicker for nut set."

Using the shaker has also done away with the last two harvest rounds, which were necessary but yielded less nut than the previous rounds. Financially this has been a bonus as it means Daryl has done away with the labour costs and compaction associated with these last passes as well as the wear and tear on his harvester, sweepers and mowers. He estimated that the shaker brings down about 3 to 4 kg of nut per tree.

This year, he is also using the shaker earlier, at the end of May, rather than late June - early July to help conserve soil moisture.

"We need to put on as much compost as early as we can to try and make the most of the little soil moisture we have, using Ethrel 12 to 14 days before we shake to drop the nut," he said.

### Spreading costs

Daryl decided to follow a strategy of spreading the outlay and costs of investing in the shaker by providing a contract service to other growers as it would be impossible to justify the cost otherwise.

While it can be operated faster, Daryl shakes about 1,600 trees a day (10 hours) at a cost of \$1.75 per tree.

"You can do a lot more than that, but you run the risk of barking trees or damaging irrigation," he said.

### Early days

While shakers have been used in almonds and pecans for several decades, it is still early days with macadamias, and there are issues to be worked through.

Scott believes one of these issues relates to orchard design, particularly where irrigation lines are laid, as there is a risk of damaging them when moving the shaker through the rows and grabbing trees.

He has been experimenting with ways of managing irrigation lines, and on one orchard has replaced the lateral lines and configured them so they are on alternate sides of the tree and are hung on stainless steel droppers.

"This means you aim at the poly pipe and push it away with the head of the shaker, with the result that it is much faster than in an orchard where you are dodging irrigation all day," he said.

Maintenance, as with all farm machinery, is also important.

"The machine has to be well maintained so the pads and heads are in good order with the right grip strength suited to the girth of the tree and to the variety," he said.

Ethephon is often applied before tree shaking although it is not essential. This needs to be carefully planned with attention to weather forecasts and mixing it at the correct rate for each cultivar as this will vary. It is also important to check whether your cultivars will respond to ethephon application as this will vary as well.

Daryl cautioned that the machine is heavy and leaves tracks in orchard rows that the nuts will sit in if the ground is wet. These can be swept out, but he has found that the tracks will remain until the rows are profiled or an effort is made to fill them in.

"As well, we don't shake if the tree trunks or the orchard floor is wet or if it is raining as there is more potential for barking trunks," he said.

### The bottom line

Shakers have significant advantages, not only as a way of ensuring almost every last nut is harvested, but also as a tool for improving orchard hygiene and allowing time to complete other important orchard management tasks at one of the busiest periods in the annual calendar.

## Northern Rivers trial pays off

**Last year, Tree Carers Pty Ltd brought an OMC Shockwave tree shaker used in the almond industry in southern Australia to identify its potential in the Northern Rivers.**

We spoke with Managing Director Dash Forghani to find out how the trial went.

"While we planned our schedule to shake around 20,000 trees, we ended up completing 43,000 trees in 20 orchards in a rough triangle between Lismore, Ballina and Byron Bay," he said.

This season, Dash is planning to bring three shakers to NSW. One will be a wheeled machine, one will have tracks, which allow for it to be used on sloping areas and he is still deciding whether the third machine will be wheeled or fitted with tracks.

The experiment last year looks like it was worth the risk, with growers as far south as Port Macquarie adding their orchards to Tree Carers' shaking schedule for this year's harvest.

Dash sees the main benefits of tree shaking as the removal of sticktights and preventing the spread of husk spot disease, which costs the macadamia industry around \$10 million a year.

"It also substantially reduces the need for applying fungicides, removes nuts before they start deteriorating

in quality and reduces the length of the harvest period," he said.

Dunoon grower, Jamie Williamson, trialled Tree Carers' tree shaking service last season.

"I trialled the tree shaker on 1,200 trees as a late season attempt to free up sticktights and clean up the trees. I didn't expect to pick up the nuts due to too much debris but to my surprise, I was able to harvest without too much difficulty," Jamie said.

"On a tree block that was basically finished, I managed to pick up one more tonne of nuts, so I will be doing my whole orchard this year."



*Tree Carers is expanding its tree shaking service this season, following successful trials last year.*



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# Bottom line benefits of tree shaking

Anne Currey, AMS Communications

Compared to the Bundaberg and Gympie regions, the generally more undulating terrain and smaller size of many farms in the Northern Rivers and Mid North Coast regions present some additional challenges for growers using tree shakers, but this does not mean their benefits are not being recognised.

Chris Cook, who manages an orchard at Yarrhapinni near Nambucca Heads, experimented with tree shakers for several years before deciding in 2019 to invest in a second-hand Shockwave Monoboom made by the Orchard Machinery Company.

In the last three years, he has become more familiar with the tree shaker and how to use it most effectively.

Northern Rivers growers Greg Jones and his father, David, became interested in tree shaking technology six or seven years ago, when they decided to investigate the features of models made in Europe and the United States.

At that time, opinion was divided on how effective tree shakers were with reports of damage to tree trunks. It was after a trip to Bundaberg in 2019, which included checking out tree shakers being used by Scott Norval and Peter Costi, that Greg and David decided to test the waters and use the services of a contractor last year, rather than jump in and buy a machine.

## Management flexibility

Chris has no question that buying a tree shaker has contributed greatly to his bottom line and improving orchard management.

He trialled a tree shaker in 2017 and immediately saw the advantages. After travelling to southern Australia to check out shakers used in the almond industry, and to California, the decision almost made itself, and in July 2019 he took delivery of the OCM Monoboom.

Chris says using the shaker gives him greater flexibility with managing and timing tasks in the orchard.

The harvest period in the Mid North Coast region can be a drawn-out affair lasting until November, particularly if the weather is wet, and anything that enables it to be shortened contributes significantly to reducing costs and improving management efficiency.

"After buying the shaker, we thought we'd do 1,000 trees in the first year and see how we went from there, but we forgot to stop and did 18,000 instead," he said.

"It did a great job, shortening our harvest period and giving us a next level of management flexibility enabling us to prune in June, traditionally the middle of harvest for us."



Greg Jones says tree shaking means an earlier finish to harvesting and a cleaner orchard.

## Shaking pays off

Greg has no doubts that deciding to use a contractor last year after harvesting all the nuts they could paid off.

"All the 849s were hanging up there, lovely and green, and they just wouldn't come down, a result we suspected of two years of drought mucking up their metabolism," he said.

"We shook for two days and another nine tonnes of nuts came down, all perfectly beautiful and top quality, which were worth \$7 or \$8 a kilogram."

For Greg and David, this was a sound investment. Previously, these nuts would have stayed much longer in the trees and more harvest rounds would have been required to pick them up with a consequent decrease in quality.

For the \$8,000 to \$9,000 it cost to hire the machine for two days to shake the 849s, the return was \$63,000 of nuts. While they would have received some income for these nuts, Greg estimated their decreased quality would have almost halved the per kilo price they received.

The story for Chris was similar, who said that one of the biggest benefits is that "we can harvest what we produce".

He explained that around 15% of the nuts are often not picked up because they are left in the tree, such as sticktightns.

"The extra 15% we harvested as a result of shaking meant that the machine paid itself off in a matter of weeks," he said.

Greg agreed with Chris that the earlier-than-normal finish allows for management flexibility.

"Instead of doing rounds in August and September and maybe dribbling on to October, we were finished by the end of July, which really helped with the limb removal on one of our eight hectare blocks," he said.

And because the harvest finished earlier than would have been the case, the harvester had a final

maintenance and was up on blocks, decreasing wear and tear on it and other associated equipment.

“You’re no longer tying up tractors for trailers and having people in the sheds; it just shortens your year so you can get straight on to limb removal and all the other jobs you have to do,” he said.

**Cleaning out trees**

Another big advantage for the Joneses, who used the tree shaker on David’s Hawaiians, was that it cleaned a lot of “mess”, such as old nuts, leaves and timber, out of trees, which they hope will lessen the risk of husk spot in the future.

Chris agreed, saying that he had noticed the same thing. While it is only a gut feeling, he believes shaking is helping to slowly reduce the incidence of husk spot.

While Greg did not use ethephon on the trees before shaking them, he said this was because it had been so dry previously meaning the trees were under stress. He was also uncertain about when the contractor would arrive.

It was a similar story for Chris, who found it too dry to apply ethephon last year and this year’s wet conditions making it too hard to get the timing correct between application and harvest.

The message appears to be that while applying ethephon before shaking is by far the best option, this is not essential.

**Orchard terrain**

Greg and his father’s farms are on very flat terrain so it is unlikely that they will need a shaker with tracks fitted. However, Greg is planning ahead and getting trees ready for shaking in the future.

“We don’t have many bent trees or trees with low forks, which are a problem for tree shakers. That’s why we have been pruning up and getting rid of some of the problem trees,” he said.

A clean orchard floor also makes a big difference to the result, so it is a good idea to harvest before shaking and clean up any sticks that might be lying around.

Chris has the opposite issue from Greg and David in terms of terrain, with many of the trees on Arapala planted on steep and undulating areas.

While the conventional wisdom is that shakers cannot handle this, Chris said that the Monoboom has worked out well because of its better weight distribution for traction on hills and in the wet.

One of the myths that Chris dispelled based on his experience is to do with whether tree shakers have a negative impact on tree health. While acknowledging that shaking is a “violent” action, he said that in the last five years they have seen no negative effects on tree health or damage to trees.

“We have noticed that they do bark around one tree in a 1,000, but this doesn’t kill them,” he said.

**The bottom line**

Chris strongly encourages anyone considering buying a tree shaker to investigate them.

“It is a good idea to see one in action first and to investigate styles available as you don’t want to damage trees,” he said.

Using tree shakers is now a firm part of Chris and Greg’s orchard management approach, with Chris shaking around 40,000 trees a year and Greg choosing high priority blocks.

They both agree that shakers have brought big advantages in improving harvest management and orchard hygiene and, importantly, the bottom line.

**Disclaimer: The AMS advises growers who are considering purchasing a tree shaker to complete their due diligence. Ensure you view the shaker in action, talk to other growers who are using the model you are considering, and thoroughly investigate the styles available.**



Growers are finding tree shaking is useful for reducing husk spot and pests while allowing more time for other orchard jobs.



Tree shakers must be well maintained so the pads and heads are in good order with the right grip strength to suit the variety and girth of the tree.

### Tractor-mounted option

A tractor-mounted machine is an option for growers who would prefer something smaller and less costly. Allen Morgan, Australian distributor for Monchiero products, has been selling the VL08 shaker to growers of nut crops, including macadamias.

This tree shaker mounts onto the tractor, and other than operating through the PTO, the machine is self-contained.

"This means it can simply be attached to a tractor and then stored in the shed when it is not needed," said Allen. "It is also a cheaper option than a self-propelled machine, selling for around \$65,000."

Allen has sold four units to macadamia growers and says the shaker's cost and convenience make it attractive to smaller and mid-size growers (up to 10,000 trees) who would struggle to justify the investment in a larger, more expensive tree shaker.

The VL08 has a telescopic arm that operates at 90 degrees to the tractor. The tractor driver uses a camera mounted on the arm to guide it to the right spot on the tree. The machine then automatically clamps, shakes and releases, with the shaking operation taking between three and five seconds, depending on the vibration speed, which is determined by the operator.

Pads of different softness can be fitted, to the shaker. These pads, which comprise two layers of rubber, have a grip surface of about 200 x 200 mm on the tree, which is designed to decrease friction and reduce the potential for damage to the trunk.

Allen said that if a tree is producing, a shaker can be used on them.



*This tractor-mounted tree shaker from Monchiero is an option for growers looking for a smaller and less costly machine.*

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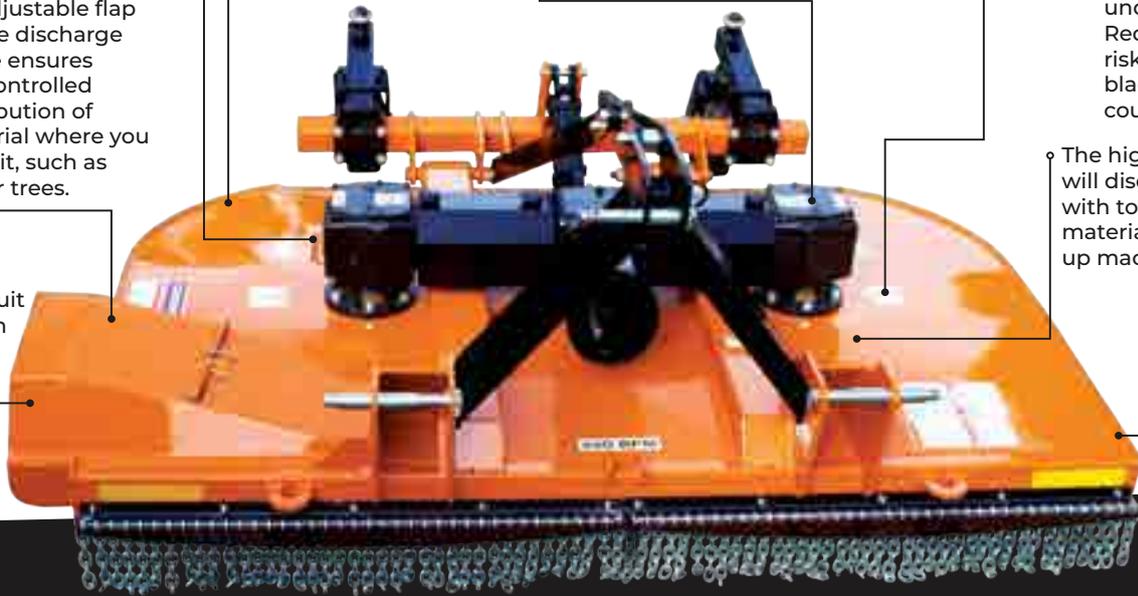
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# WOODS

## Simple solutions for nut drying

**Leoni Kojetin** Industry Development Manager, AMS **M:** 0433 007 925 **E:** leoni.kojetin@macadamias.org  
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*"Limitation makes the creative mind inventive."* **Walter Gropius**

Finding simple, innovative and cost-effective solutions is all in a day's work for most farmers. This feature profiles some low tech, low cost ideas utilising everyday on-farm equipment.

### Nally bin drying

Once nuts have been dehusked and sorted, significant quality can be lost in holding them on farm. This simple drying solution uses a basic 240V extractor fan mounted on a plywood board lid fitted on a standard bin. The sides of the bin and lid are pallet wrapped and you have an instant and effective mobile drying silo.

Nut quality research shows that airflow of at least 1m<sup>3</sup>/second is the target to ensure nuts have constantly reducing moisture content. On a small scale this can be achieved without major silo infrastructure.

#### You'll need:

- any field bin such as standard 780 L Nally bin
- a simple 240 V extractor fan
- plywood lids cut to bin size
- pallet wrap.

#### The how to:

Use a single or stacked bin, such as the standard Nally bin, which holds approximately 400 kg NIS. These bins are robust, easy to clean, multi-purpose and can be easily moved around with a pallet jack or forklift. Their modular nature makes them simple to stack, store and potentially dry batches simultaneously.

Cut a lid for each bin (or stack of bins) out of plywood approximately 19 mm thick. Any lighter and the plywood can warp and any thicker the lid gets very heavy.

In the centre of the plywood board, cut a hole and mount a basic 240 V extractor/exhaust fan which costs roughly \$200.



Growers can make their own mobile drying silo by mounting a basic extractor fan on a plywood board lid fitted to a standard Nally bin.



Pallet wrap the sides of the bin and any open sections between the stacked bins and make sure the exhaust fan is extracting air.

The size of the exhaust fan will determine how many bins you can stack but two stacked bins are quite manageable. With single bins and shallow bed depths, even a large bathroom exhaust fan from Bunnings can be used but only when the nuts are relatively dry.

With the lid on the field bin, pallet wrap the sides of bin and any open sections between stacked bins. You can also seal the lid down onto the bin with pallet wrap.

Ensure the exhaust fan is extracting air rather than blowing air, as this seals the pallet wrapping onto the bin as opposed to blowing the wrapping apart and dissipating the air. Remember the fan is drawing air up through the nut bed so it is important to stack the bins on a dry surface with nothing blocking the air flowing into the bottom of the bin.

Using chalk, write the date, block and cultivar on the lid so you know what is in each bin. The chalk easily wipes off with a damp cloth ready for next time.

In the off season, store the lids flat as they can warp with summer humidity, making it harder to get a good seal again next year.

## Accreditation scheme delivers consistency and transparency

**Darren Burton**, KLAS Co-ordinator, AMS **M:** 0415 664 335 **E:** [klas@macadamias.org](mailto:klas@macadamias.org)

In 1980, the Australian macadamia industry led the world in adopting the first standardised method of nut-in-shell sampling and kernel evaluation to determine the quality and value of macadamias produced at farm gate.

This standardised system of testing provided growers and processors with a clear and transparent process to determine grower payments. Just as the industry has grown and evolved over the past four decades, so too has the system of nut-in-shell sampling and kernel evaluation.

However, the key aim remains the same – to provide growers and processors with a transparent system of testing that is used consistently across the industry.

The Australian Macadamia Society (AMS) set up the Kernel Laboratory Accreditation Scheme (KLAS) in 2016. This accreditation program allowed nut-in-shell (NIS) buyers and independent testing laboratories to become AMS accredited testing laboratories.

Scheme rules were developed, documenting standards and procedures for NIS sampling, kernel assessment and grower reporting. Participating laboratories are required to adhere to the standards and procedures set out in the scheme rules.

In the same year, the Kernel Assessment Manual (KAM) was developed, containing pictures of every category of kernel defect and setting out how they are classified as either premium, commercial or reject kernel.

As part of the accreditation program, laboratories must follow the standards set out in the KAM.

### Staff training

A key element of accreditation requires laboratory staff to attend annual training events to ensure they maintain the necessary knowledge and skills for undertaking kernel assessments.

Held at the start of the season in April each year, the world class training program aims to ensure that all kernel laboratories are classifying kernel in a consistent manner as set out in the Kernel Assessment Manual.

Each year, approximately 60 staff from 13 accredited laboratories take part in this training.

### Inter-lab testing

KLAS accredited laboratories take part in annual 'round robin', inter-lab testing designed to ensure minimal variance in assessment and subsequent reporting.

To do this, each laboratory receives five NIS samples from the same batch and they are required to undertake a kernel assessment and report their results back to the AMS and an independent auditor.

The auditor then analyses the data to determine the degree of consistency in the results from these laboratories. The round robin results have shown a high degree of consistency between all accredited labs over the life of the scheme.

### Independent audits

All laboratories undergo a biennial third party audit to confirm they are operating in line with the scheme rules which cover quality parameters, procedures and processes.

The auditor verifies compliance with sampling, drying, weighing and assessment procedures. Laboratory equipment is also assessed for calibration of balances, masses and ovens, ice point thermometer checks and recorded documents.

### AMS accredited laboratories

For a full list of AMS accredited laboratories, go to the AMS website at [www.australianmacadamias.org](http://www.australianmacadamias.org)

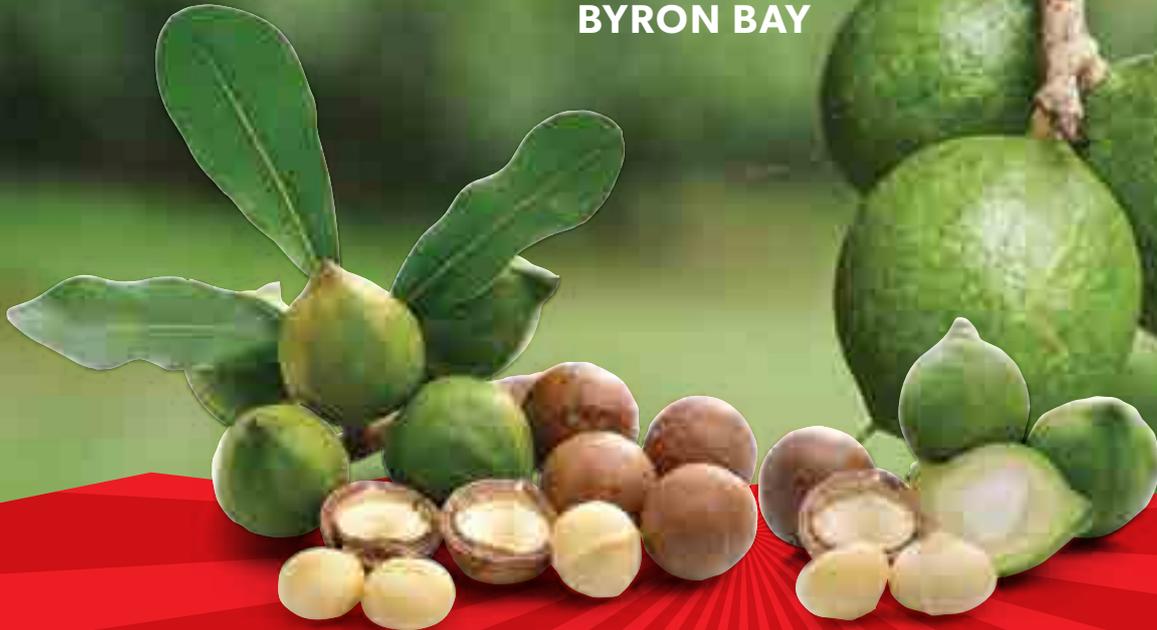
For further information about the Kernel Laboratory Assessment Scheme, contact KLAS Co-ordinator, Darren Burton, at [klas@macadamias.org](mailto:klas@macadamias.org)



*Members of the KLAS Steering Committee prepare kernel samples for this year's staff training.*



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# Macadamia ecophysiology enlightening management Part 2: The orchard floor

Leoni Kojetin, Dr Chris Searle, Dr Theunis Smit and Armand Smit

Macadamias are only a few generations from the wild and understanding how they have adapted over millennia to their environment is essential to unlocking the tree's potential. This series overviews the unique ecophysiology of macadamia and uses this lens to inform management of an essentially wild crop. This article explores a critical aspect of production, the orchard floor.

Part 1 gave an overview of macadamia's natural distribution in Australia, their position in the subtropical rainforest canopy and how their physiology has been shaped over time, their ecophysiology. These insights lead to better understanding of your orchard and management outcomes. (If you haven't read Part 1, see the Autumn 2021 issue of the *News Bulletin*, (pp 49 - 55).

## How macadamia have been shaped over time

### Climate

Subtropical rainforests with distinct dry periods (winter) and warm, wet, humid periods (late summer).

### Geology

Largely volcanic soils, inherently fertile and slightly acidic and to a lesser extent, alluvial soils.

Often shallow, rocky topsoils leached or eroded and potentially phosphorus binding, contributing to reduced nutrient availability.

### The rainforest

Macadamia occupies the mid-level rainforest 'canopy layer' - humid, light limited with moderate temperatures and little wind. Macadamias compete for light, water, nutrients and space.

The rainforest floor is typically covered in organic matter breaking down and releasing nutrients.

### Key adaptations

Vegetatively biased and utilising favourable conditions to regulate flushing.

Canopy that channels rain down branches and concentrates water around the trunk base.

Scavenging and anchor root system with majority shallow dense fibrous roots adapted to uptake limited water and nutrient from the soil profile.

Thick waxy leaves that limit water loss, are shade adapted and photosynthetically limited.

Irregular bearing with crop load adjustment strategies regulated by available resources.

## Emulating a rainforest orchard floor

The traits described at left are hard wired into the tree's genetics. Without intensive breeding and domestication, the best strategy to capitalise on these traits is to work with nature and not against it. Emulating a rainforest orchard floor, as much as is practicably possible, is proving effective for the growers who have gone down this path.

The foundation we cultivate our crop on is the orchard floor so management of this aspect is critical. Problems created by poor orchard floor management have been written about extensively. Many traditional macadamia under-tree areas were hard, barren environments, swept free of all organic matter to maximise nut pickup. Over time, this had led to a decline in soil structure, reduced water infiltration, lower soil water and nutrient holding capacity and more compact soils with less available oxygen.

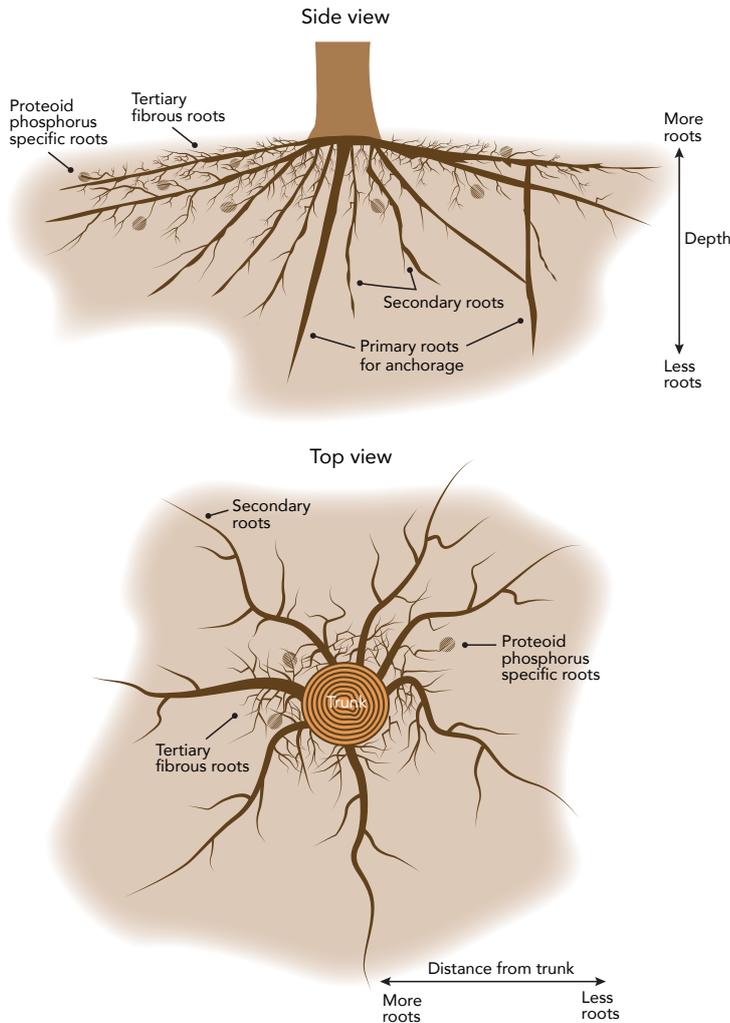
Combined with erosion, root exposure to heat and drying conditions, the traditional orchard floor is a far cry from the rainforest conditions under which macadamia evolved, resulting in declining tree health, reduced yields and compromised environmental outcomes.

## Macadamias have a specialised root system

Roots are often neglected when it comes to orchard management as it's often a case of 'out of sight out of mind'. Roots are critical to productivity and root health is often the difference between a highly productive orchard and one that is struggling.

Macadamias roots have evolved to provide the trees with sufficient nutrition and water in a challenging environment. They are also unique among the cultivated tree crops in that they are able to produce proteoid roots to extract phosphorus from the soil when there is little available.

Producing and maintaining a root system is energy expensive, and it is estimated that well over 50% of all energy a plant produces goes to root production and maintenance. The more favourable (or similar to the rainforest system) the conditions for root growth, the more productive and profitable each tree in the orchard will be.



**Macadamia root characteristics**

**Anchorage roots**

These roots run horizontally initially and then vertically or at shallow angles away from the trunk. Secondary and fibrous tertiary roots are able to utilise large areas of shallow soil for water and nutrients while the primary root system provides anchorage.

**Scavenging and efficient roots**

Fine fibrous roots exploit the thick leaf litter on the rainforest/orchard floor. They are highly efficient at extracting nutrients, taking up water and distributing it. Root exudates dissolve and absorb nutrients.

**Shallow and dense roots around the trunk**

Most macadamia roots are located within the top 40 cm of the soil surface in a dense mat that decreases with distance from the trunk.

**Specialised proteoid roots**

Small bottle brush shaped roots form to extract phosphorus. These roots are short lived (6-8 weeks) and are energy intensive to produce.

**Critical hormone production**

Roots produce hormones which act as signals for a range of vital plant functions. This critical interaction between root tips and shoot tips regulates many basic plant processes.

**Roots respire so oxygen is essential**

Carbohydrates produced from photosynthesis can only be used as energy to maintain and grow new roots in the presence of oxygen. This process of respiration relies on soil oxygen supplies to function properly.

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## Management examples: critical ecophysiological orchard floor principles

Understanding traits and adaptations aids growers in making better management decisions and directing resources. Here are three simple examples in orchard floor management that are essential to exploit the nature of macadamia, increasing productivity and securing orchard resilience.

### 1. An orchard floor rich in organic matter

One of the most basic ways to emulate the rainforest is by actively incorporating organic matter into the orchard floor. The benefits of improving this aspect of orchard management cannot be overstated. It is a key to optimising root/tree health, maximising yields and providing a safeguard against changing or extreme climatic conditions.

The **rainforest floor** has a thick layer of organic matter in various stages of decay.

The **journey of decay** supports an ecosystem where material is progressively broken down into smaller particles and eventually into **humus**.

On the **orchard floor** organic matter plays a critical role in soils' **chemical, biological and physical** properties.

#### Chemical benefits:

Negatively charged organic matter holds positively charged nutrients such as Ca, Mg and K. **This increases soils CEC (cation exchange capacity)** and inherent fertility.

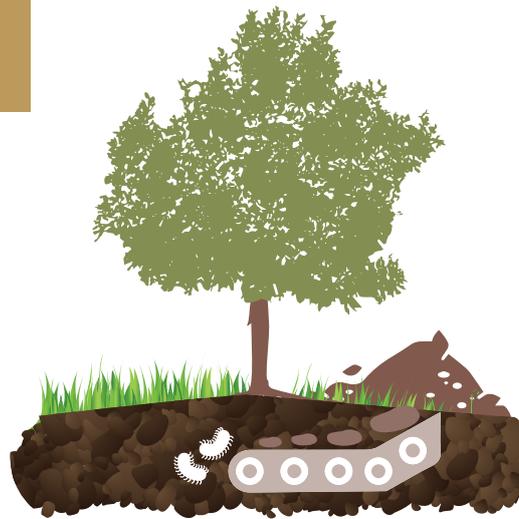
Soil organisms decompose organic matter, providing a **slow-release source of nutrients** such as N, P and S.

Organic matter improves the **soil's ability to resist pH change** (buffering capacity).

#### Conveyor belt effect

The **breakdown of organic matter** from large pieces down to humus **sustains the soil microbiome**.

As with any ecosystem, a constant supply of **varied food sources** enables a **diversity of beneficial microbes to proliferate**.



#### Biological benefits:

Organic matter provides food for a range of **beneficial soil organisms** from earthworms to fungi and bacteria.

As these organisms break down organic matter, they **release nutrients, increase porosity and improve soil structure**.

**This suppresses disease and aids resilience to pests.**

#### Physical benefits

Humus **binds soil particles** together, providing structure. **Good structure** improves **soil aeration, water infiltration and holding capacity** (retaining moisture in sandy soils as an example).

Organic matter creates **favourable root growing conditions** by **stabilising temperatures, increasing porosity and improving respiration**.

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## 2. Maximising the placement of inputs

Understanding macadamia root architecture allows for the efficient placement of inputs such as fertilisers, water and organic matter in the areas where they are best taken up. This understanding allows growers to better match inputs to the tree's requirements. It also assists in management practices as well as the purchase of orchard equipment. When designing an irrigation system, this knowledge ensures growers obtain the best return from the water they apply.

Macadamia's **anchor root** system allows them to efficiently explore large areas of shallow soil. They also have a **dense fibrous root** system, primarily in the **top 40 cm** of the soil that declines with **distance from the trunk and depth**. The absence of this shallow root network can be indicative of **unfavourable root conditions and disease**.

Roots have **low hydraulic resistance** and are efficient at withdrawing limited water from the soil profile. Macadamia are suited to **smaller, more frequent irrigation** and nutrient applications which minimise losses.

In **water limiting** situations, placing **water close to the trunk** (zone of highest root density) maximises uptake. Watering this zone ensures roots in this **critical area** are **maintained** and able to respond when water becomes available. **Emulating trunk flow** takes advantage of macadamia's natural adaptations.

The presence of specialised **proteoid roots** which are adapted for the uptake of phosphorus can indicate **phosphorus limited or bound** conditions.

Elements that are **less mobile** in the soil such as Zn or  $\text{NH}_4^+$  (ammonium) are best **banded close to the trunk**. Elements **partially mobile** in the soil such as Ca or Mn can be placed **further from the trunk**. Elements that are **mobile** in the soil such as Mg and  $\text{NO}_3^-$  (nitrate) can be **broadcast** more widely.

**Smaller and more frequent fertiliser applications** reduce the potential for large amounts of mobile nutrients such as N and B to be leached below the fibrous root zone. **Evenly placing nutrients close to the trunk** maximises uptake and efficiency.

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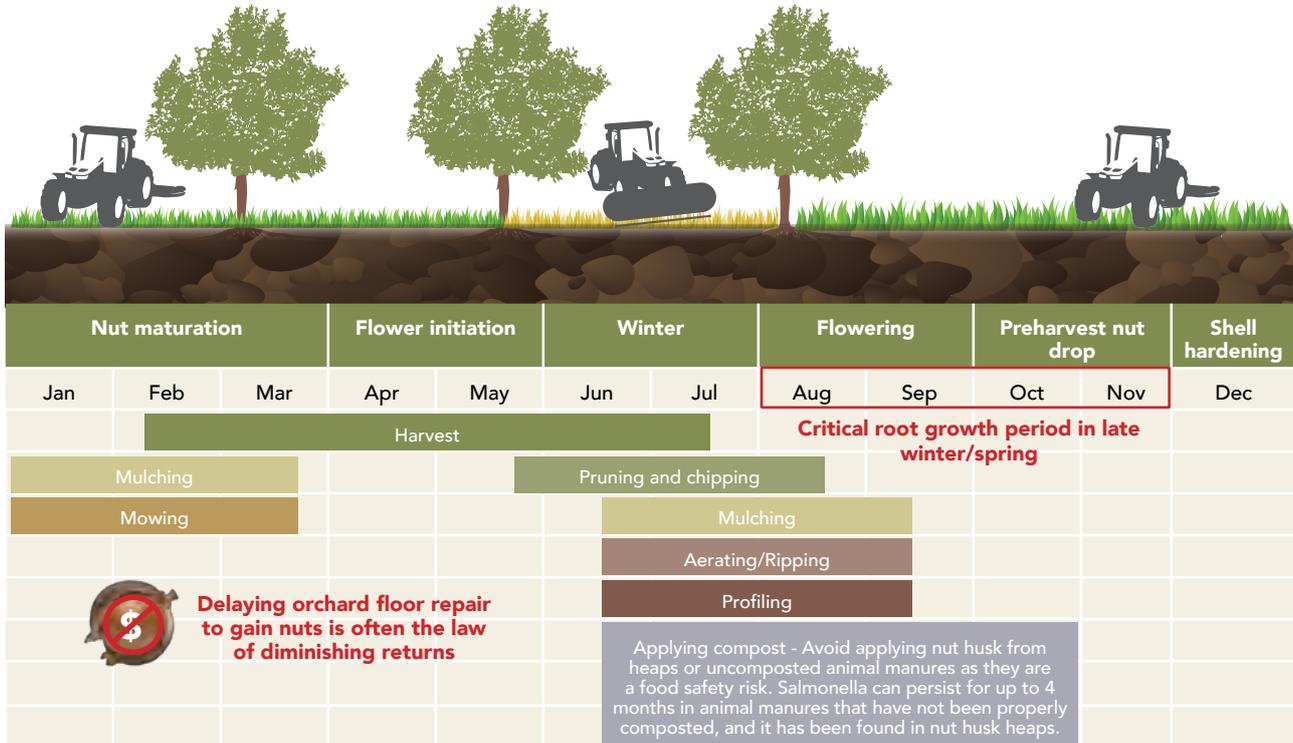
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### 3. Getting the timing right

As with many operations, timing is crucial to success. Maintaining the orchard floor and applying organic material following harvest must be timed in relation to both the phenological and management calendar. Organic material must be applied as soon after harvest as possible to maximise the critical root growing period in late winter and spring. Delaying orchard floor repair and these applications to gain few nuts in later, less efficient harvest rounds is counterproductive.

The post-harvest period is a conflict of several important activities. Developing a management calendar, block by block, allows operations to flow smoothly, particularly when operational windows are small, there are machinery limitations or contractors are required.



When applied to the soil, organic matter is ‘unstable’ and not bound to the surface so it can easily be washed or blown away. The longer the material is on the orchard floor in an undisturbed manner, the greater the likelihood that the breakdown process will occur and roots can emerge through the soil surface into the material, anchoring it down.

One method of improving the effectiveness of any application is to use a soil aerator and a soil profiler. In this case, organic material is applied post aeration, allowing particles to drop into aerator slots where it not only becomes incorporated in the soil but the organic matter also assists in channelling water deeper into the soil profile.

A profiler can then be used to move all the interrow organic matter and soil that accumulates during harvesting back under the tree. When conducted in the driest months of the year in July/August, this minimises the risk of erosive rain washing away disturbed soil and loose organic material. These operations have not been shown to have a detrimental effect on root health as long as they are not done too aggressively and undertaken during the cold dry winter months when Phytophthora is inactive.

Stay tuned for the next instalment in this series in the Spring 2021 issue of the *News Bulletin*.

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# What food sources do stingless bees need when macadamia is not flowering?

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We are finding out more and more about how important cross pollination is for crop production in macadamia. Many growers now have permanent hives of stingless bees on farm for macadamia pollination, but what do these bees visit when macadamia is not flowering? This article reveals which plants the native stingless bee, *Tetragonula carbonaria*, visits for pollen in different seasons and how growers might supplement hives with these plants in macadamia orchards.

Stingless bees on farms require year-round plant sources of nectar, pollen and nest materials to maintain hive health. Our previous research found that colonies of *T. carbonaria* sometimes starve in orchards with few alternative floral resources whereas hives in forests survived and hives in urban gardens multiplied. We know that stingless bees need a variety of plants in their diets to thrive, what we don't know is which specific plants are most favoured during the different seasons.

## Using genetics to identify hive pollens

Our team identified which plants are used by stingless bees in macadamia orchards using a molecular technique known as "DNA metabarcoding". DNA metabarcoding matches DNA from unknown samples to known DNA "barcodes" of plants or animals to determine identities. It's much more powerful than traditional methods like microscopy or direct observation of bees on flowers as it can be used on mixed samples (like hive pollens) and can detect plants that would otherwise be hard to observe such as very tall trees or rare plants.

We used this technique to identify pollens from 57 *Tetragonula carbonaria* hives in macadamia orchards at seven sites on the Sunshine Coast and in Bundaberg each season for two years.

## Plant sources of stingless bee hive pollens

We identified more than 300 different plants in stingless bee hive pollens, including several introduced or "weed" species and even wind-pollinated plants. There is growing evidence that bees visit over 100 wind-pollinated plant genera, perhaps because such plants provide critical nutrients for bees during periods when there are very few flowers.

Most plants we detected were in very small amounts, representing less than 1% of a colony's diet in a given season. This suggests that *T. carbonaria* in orchards forage on "many small" rather than a "few large" pollen sources, except for the target crop macadamia.

In spring, macadamia comprises 50% to 75% of hive pollens on average. This decreases each season thereafter until increasing again in winter where it comprises 31% to 42% of the hive pollens. This tells us that colonies stored macadamia pollen in spring and used it up when the crop was not flowering.

## Plants for bees

Macadamia growers may choose to plant or keep existing species identified in high abundances in our study (Table 1). Choosing plants that flower in different seasons ensures that permanent hives have access to a



Sampling pollen from a hive (left) and a tube containing DNA from two years of pollen samples, ready to sequence (right).

Species	Season	Form	Indigeneity	Life cycle
<i>Ageratum houstonianum</i> (Billy goat weed)	Year-round	Herb	Introduced	Annual
<i>Eucalyptus</i> spp.	Year-round	Tree	Native	Perennial
<i>Raphanus raphanistrum</i> (Wild radish)	Year-round	Herb	Introduced	Annual
<i>Archontophoenix cunninghamiana</i> (Picabeen palm)	Autumn	Palm	Native	Perennial
<i>Megathyrsus maximus</i> (Guinea grass)	Autumn	Grass	Introduced	Perennial
<i>Melaleuca</i> spp.	Autumn	Shrub to tree	Native	Perennial
<i>Neolitsea australiensis</i> (Green bolly gum)	Autumn	Tree	Native	Perennial
<i>Austrostipa verticillata</i> (Slender bamboo grass)	Autumn to Winter	Grass	Native	Perennial
<i>Casuarina cunninghamiana</i> (She oak)	Winter	Tree	Native	Perennial
<i>Typha angustifolia</i> (Lesser bulrush)	Winter	Cattail	Native	Perennial
<i>Macadamia</i> spp.	Winter to Spring	Tree	Native	Perennial
<i>Galbulimima baccata</i> (Pigeonberry ash)	Winter to Summer	Tree	Native	Perennial
<i>Lepidium</i> spp. (Peppergrass)	Spring	Herb	Introduced	Annual
<i>Antirhea putaminosa</i>	Summer	Shrub	Native	Perennial
<i>Celtis paniculata</i> (Investigator tree)	Summer	Tree	Native	Perennial
<i>Corymbia ptychocarpa</i> (Swamp bloodwood)	Summer	Tree	Native	Perennial

Table 1: Major sources (at least 5% of diets in one season) of pollen forage for the stingless bee *Tetragonula carbonaria* in orchards. Hives with access to a variety of food sources year-round are more likely to persist and reproduce well.

variety of resources year-round. These could be planted in unproductive areas such as edges or between crop rows if space is limited.

We found many weeds and wind-pollinated plants such as grasses, sedges and cat-tails, in hive pollens. This gives growers some easy options to manage the stingless bees on farms. These could be made available by restoring riparian zones, for example the areas along creeks, rivers and dams, or by keeping herbs and weeds for longer when they are flowering, but removing them before seed maturity.

For example, Billy goat weed (*Ageratum* spp.) was identified as a major component of *T. carbonaria* diets in macadamia orchards. As an introduced plant from South America that flourishes in disturbed environments, this plant requires careful management if used as alternative forage for bees so that it does not invade nearby native vegetation.



A stingless bee pollen forager on a billy goat weed flower.

#### Acknowledgements

Funding for this project was provided in part by "PH16000: Stingless bees as pollinators for Australian Horticulture" (with Western Sydney University) under the Hort Frontiers pollination fund. This fund is part of the strategic partnership initiative developed by Hort Innovation, with co-investment from Griffith University, University of the Sunshine Coast and contributions from the Australian Government.

We thank Sahara Farms and Macadamia Farm Management for assistance and orchard access.

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## Understanding the ways of cockatoos

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Any management of a pest is first informed by some basic understanding of their ecology.

In studying cockatoos, it is clear that they are highly intelligent and naturally curious birds. They are also long-lived and creatures of habit and they are inclined to be sociable, so when they see birds feeding as they fly past, they often drop in to join them. This combination of traits can make cockatoos a difficult pest to manage once they discover all the resources an orchard provides.

There are 14 species of cockatoos in Australia, including sulphur crested cockatoos, yellow-tailed and red-tailed black cockatoos, corellas and galahs. They are distributed across all macadamia growing regions but can become particularly problematic when other natural resources are scarce such as in drier seasons or orchards further inland from the coast.

They live in a variety of timbered habitats and feed on seeds from native and introduced plants, such as banksias, casuarinas, eucalypts and pines. They also eat grass seeds, nuts, fruit, roots and insects, particularly larvae within tree structures.

Apart from being incredibly intelligent, cockatoos have other traits that are useful to inform management strategies to reduce their presence in orchards.

### **Cockatoos have constantly growing beaks**

With beaks that are constantly growing, cockatoos are constantly looking to chew things to maintain their beaks at the correct length and condition. Wherever cockatoos land, they look to either feed or conduct some beak maintenance or both. This can cause damage to trees or farming infrastructure. Red-tailed black cockatoos in particular are known for biting off tree branchlets which not only affects the canopy but creates a messy orchard floor to harvest off.

### **Cockatoos are sociable**

Cockatoos flock and roost together in small to very large groups. Birds in the air will see birds feeding below and join them. This pattern can continue until a large flock forms at a favourable food source.

To avoid cockatoos flocking together, growers can monitor crops regularly and act as soon as the first birds arrive to scare them away. These first few birds are the most important to deter. However, any of these deterrent strategies are time consuming.

### **Cockatoos are long lived and are creatures of habit**

In the wild, cockatoos will live approximately 25 to 50 years. Over this time, they will use regular flight paths

### **Cockatoos are protected**

It is important to note that cockatoos are a protected species. Nationally, cockatoos in general are listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act. Some species are listed as 'likely to become extinct' in the wild and classed as either threatened or endangered. A permit is required in all states to shoot cockatoos and is assessed on an individual basis depending on economic damage, the specific cockatoo species and their protection status.

To find out more information including other management strategies, see the article on cockatoos in the NSW DPI Macadamia Crop Protection Guide.

and repeatedly return to good feeding areas. Detering birds before these regular feeding patterns develop can help mitigate future crop damage.

**Cockatoos have favourite foods**

Cockatoos have adapted well to feeding on commercial crops and there are seasonal periods of peak cockatoo activity depending on the available food sources. They will be attracted to an area where someone feeds them. Trap crops have been used in other horticultural settings to lure birds away to a sacrificial sown section.

**Cockatoos are scared of birds of prey**

Birds of prey, such as falcons and eagles, may feed on adult cockatoos. Consequently, cockatoos are wary of birds of prey and this fear may be exploited to scare cockatoos away using mimicking strategies. Again, these are labour intensive and time-consuming strategies but can be highly effective.

**Cockatoos are highly intelligent and naturally curious**

Because cockatoos are smart and curious, scare tactics like noises or lights tend to wear off quickly as they work out there is no real danger. A range of deterrent strategies is likely to be required with changing intervals and alternating scare tactics.

Scare campaigns are useful for unsettling the birds to the degree that they abandon their roosts, but they have

varying efficacy in the different species and across drier and wetter seasons.

Cockatoo curiosity and boredom can lead to many types of infrastructure damage including damage to the crop, tree structure, irrigation emitters and lines. Typical nut in shell damage from cockatoos will be the presence of empty cracked shells, usually along the suture line.

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 NSW Department of Planning, Industry and Environment <https://www.environment.nsw.gov.au/>  
 Environment, land water and planning <https://www.wildlife.vic.gov.au/>

**A handy tip to protect irrigation**

Consultant Chris Searle from Bundaberg advises growers to protect their irrigation system where damage is particularly severe by greasing sections of the irrigation line.

Cockatoos then find the irrigation line difficult to land on and hang onto. This can be done using a grease gun or putting grease in a plastic bag, cutting the corner (like a piping bag) and applying it onto the line.

Chris also recommends making sure the line, in particular the spaghetti tube that hangs down, is high enough that the birds can't reach it from the ground.

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# Laser system on trial



**Orchard:** DarNic Park, Rosedale, 70 kms north of Bundaberg, Queensland  
**Owners:** Daryl and Nicole Wake  
**Farm size:** 26,000 trees over 83 hectares  
**Varieties:** Mature trees are 741, 816, Daddow and 344. Newer plantings are MCT, A203 and A4.

*Daryl Wake says cockatoos not only destroy the macadamia nuts, but they damage the trees and irrigation lines.*

**Bundaberg district growers, Daryl and Nicole Wake, have tried numerous tactics to deter cockatoos over the years. The latest is a laser system they are leasing from a local rural supplier at a cost of \$2,500 a month, with limited success so far.**

“The laser system worked for the first few days, but the cockatoos worked out it was safe after that and ignored it,” Daryl said.

“It worked best on overcast or rainy days where the laser beam reflected off raindrops throughout the orchard, but those days are few and far between in Bundaberg.”

The Avix Autonomic laser units come from Dutch company, the Bird Control Group, and are distributed in Australia by E. E. Muir & Sons.

Daryl says each of the laser units costs approximately \$22,000 and he estimates they would need 24 units to totally cover the whole orchard, at a cost of more than \$500,000.

“Nicole and I discussed the costly issue of the cockatoos and decided that she would do some further research on what was currently available on the market. She came across this laser system, contacted our local rural supplier and had a system sent up from Melbourne,” he said.

“This was after hearing that these units are being used successfully in Victorian orchards to protect stone fruit from lorikeets and in some grain crops, so we decided to trial it here.

“The white cockatoos stayed away for about three days while the black ones lasted a week, but that’s about it, unfortunately,” he said.

A few years ago, Daryl tried drones to conduct random flights but found them ineffective too.

“Cockatoos do get scared by scare guns and other loud noises, but again, they soon learn it’s safe to return.

“Many of these deterrents and scare tactics are time consuming and need people on the ground, so that’s expensive.”

Fortunately, the turnaround in seasonal conditions is providing some relief, with population numbers estimated at 3,500 cockatoos at the height of the drought two to three years ago to between 150 and 200 per day this season.



*Cockatoos chewing off small branches leaves a mess on the orchard floor and can cause problems at harvest, jamming the finger wheels and augers.*

Daryl attributes this to the availability of more attractive food sources in the mountains and elsewhere.

“With harvest in full swing, we are in the orchard every day, so that also deters the cockatoos,” he said.

“We are also tree shaking, as it means there’s less food left behind on the orchard floor.”

Like other growers, Daryl finds that cockatoos not only destroy the macadamia nuts, but they damage the trees and irrigation lines, and add to harvesting costs.

“In our experience, white cockatoos can’t crack the shells of mature nuts, but they come in earlier in the season to strip bunches of immature nuts and try to eat them,” he said.

“Meanwhile, black cockatoos make light work of mature nuts, cracking the shells and eating the kernels.

“Cockatoos also damage the irrigation lines, partly looking for water and partly for fun, so it helps to provide them with a separate water source.

“As they chew off small branches, these can jam the finger wheels and augers of the harvester, so this means we need someone following the harvester full-time to clear the blockages.

“Cockatoos are certainly adding to our costs and eating our profits.”



Daryl Wake finds cockatoos damage the irrigation lines, partly looking for water and partly for fun.



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## Multi-pronged approach works best

James and Aimee Thomas have found that taking a multi-pronged approach is the best way to manage cockatoos at their property, 'Falkirk Farm', in the lower Wonga Valley north-west of Gympie.

"Lots of things work really well but only for a short time, but we have learnt it's wise to be vigilant and use a range of techniques to move them on as quickly as possible," says James.

Currently, he is using everything from scare guns, cracker shot, phantom drones and chasing the cockatoos to scare them off.

"Clay pigeon shot is cheap and noisy – about \$100 for 250 shots – and I can drive by a flock, let off a few cracks and that's enough to keep deterring them," James said.

"Scare gas guns are also useful, working on a computerised cycle to fire at random intervals with a fixed start and finish time. The scare gun is mounted on a rotating pivot so it fires in different directions each time, and it's also useful to shift it to different parts of the orchard every two or three days.

"We also chase the cockatoos which they don't like at all.

"The key is to make the cockatoos as nervous as possible to be in the orchard and change their feeding habits."

James has also tried hanging kite eagles from flag poles around the orchard, and while they work on windy days, they don't fly in calm weather.

Sulphur crested white cockatoos and red-tailed black cockatoos are prevalent at different times throughout the year and they come and go, depending on how hard he works at deterring them.

"The big flocks come and go, but it's what I call the resident white cockatoos that live in the orchard that are the most destructive," James said.

"They eat the nuts and destroy the irrigation, snipping the lines in half, chewing the nozzles, chasing the water or just playing in it.



*This is typical of the damage caused by red tailed black cockatoos where they break off branchlets and eat the nuts.*

"And after a while of eating macadamias, the residents get sick and can no longer fly, losing their feathers and dying from such a rich diet, so it's in their interests that we move them on."

Earlier in the season from around November, James finds the black cockatoos more prevalent and they tend to favour more open varieties like the A16s, where they chew off branches and feed from the ground.

"They eat the crop and make a huge mess, but I also find them easier to move on than the white cockatoos," he said.

"While they seem to favour certain varieties or parts of the orchard, there's a lot of work involved in deterring them."

Emphasising the need for taking a multi-pronged approach to managing the pests, James is exploring other options such as drones, growing trap crops and setting up feeding stations on towers to encourage birds of prey such as wedgetail eagles and sea eagles.

He also plans to apply for a damage mitigation permit to cull the birds as a last resort.

A former cotton grower and grain grower from St George, James is considering trialling a summer crop of sunflower as an alternative food source for the cockatoos.

"Trap crops are commonly used in broadacre farming to attract pests away from commercial crops, so I am thinking of planting a sacrificial crop of sunflower in January to see whether this helps," he said.

"I have also heard that multi-coloured netting may be a deterrent, so this is in the pipeline as well."



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## Tips and advice from Hogarth Range

Mark Duncan is a consulting agronomist for a company managing 60 hectares of macadamia at Hogarth Range, west of Casino. He says different measures have been employed to control cockatoos with varying degrees of success. Cockatoo numbers have increased at Hogarth Range over the past four years and bird numbers have been particularly high in the last two years of drought. Mark shares his experience and advice.



Mark Duncan.

### In what ways do cockatoos damage the crop?

- They knock the nuts off to the ground, and crack the nut in husk/shell, from the nutlet stage until the nuts are harvested. This is mainly for the cockatoos to keep their beaks worn down.
- They also roost in the trees, breaking off thin limbs.
- All varieties are susceptible, but the thin shelled varieties of 816, A16 and 849 are most affected. Other thicker shelled varieties such as A203, A268, A38 and 246 are also targeted during the shell hardening period.
- There also seems to be a mutualistic relationship with the crows, which provide a danger alert for the cockatoos. The crows need the cockatoos to break shells.
- They damage soft irrigation lines.
- Approximate loss per season over the past three years is around 20-40% (around 40 to 60 tonnes per season), and that is after implementing all the current control methods. High cockatoo pressure and peak nut loss generally occurs from shell development to shell hardening.



Disco balls are worth a try.

### What steps have you taken to control cockatoos? Which measures work and which don't?

- Drone: \$10,000 was spent on a drone, but it had mechanical issues, battery limitations and could not fly in strong winds, rain and fog. However, it did have some effect. Another downside was that it could not be insured under the farm insurance policy.
- Utes, motorbikes and quadbikes: two quads and a motorbike along with farm utes are used every day to move them away from the block, mainly at post dawn and pre dusk. This is the main method of control at present, taking 6-8 hours per day.
- Gas guns: two gas guns, costing \$600 each, are used at dawn and dusk, but they have limitations and may create issues with neighbours.
- Kites: fake eagles have been used in the past with minimal impact if any, as the cockatoos get used to them.
- Chilli spray: \$30,000 was spent on a small trial, with good effect for 10-14 days, but it was not a cost-effective option.
- Disco balls and scarecrows are worth a try.
- Shooting: a licence to shoot has been granted and a number of birds have been shot at irregular periods. Shooting has obvious issues around safety and community relations.
- We are planning a trial with bird scaring laser technology.



All varieties are susceptible to cockatoo damage, but Mark Duncan finds that thin shelled varieties such as 816, A16 and 849 are most affected.



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## Brice's top tips

Brice Kaddatz from Macadamia & Horticultural Services at Gympie knows how tough it is to manage cockatoos.

After nearly two decades working among macadamia and other horticultural growers in Queensland, he has shared some thoughts.

- Be ready to operate a gas gun or fire 12g cracker shells in the orchard when the first scout arrives from sunrise. Keep this up for a week to 10 days and it has been observed to deter the cockatoos for some time. Cracker shell cartridges are not cheap, but they are non-lethal and explode in the air, closer to the birds. The persistent early rises required are painful.
- Where irrigation infrastructure damage is an issue, consider hard drip tube on the orchard floor, rather than using micro-sprinklers and soft tubing, hung between the trees. This is a technique Brice first witnessed at an orchard at Emerald and it appeared to avert any bird damage. He says the cockatoos find the hard tubing more difficult to puncture while the irrigation water goes straight into the soil and is less attractive to the birds.
- A fish-based product mixed with liquid nitrogen through fertigation was used with some success in Rockhampton as a deterrent, several years ago. Brice is aware of a few growers who tried this approach with limited outcomes.
- Kites are a successful deterrent to cockatoos, but they are fragile, high maintenance and need to be shifted around the orchard regularly. Kites work well in windy conditions but must be taken down when there is no wind. Black cockatoos have been known to attack and shred them once they learn they are not real.
- A moving scarecrow worked well until the birds learnt it was not real.
- Drone technology with noise producing apparatus may have some potential but that has yet to be developed.
- It is also possible to secure a permit to eliminate a small number of birds. This is generally not a favoured option.



*Kites deter cockatoos, but they are fragile, high maintenance and need to be shifted often around the orchard.*

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# New trade PR campaign promotes importance of Australian macadamia origin

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



Findings from the Australian macadamia industry's latest consumer insights research have revealed just how important ingredient origin is to consumers around the world, forming the foundation for a new international trade PR campaign.

Executed in Australia, Japan, China, Taiwan and South Korea, the campaign told the story of Australian provenance, achieving more than 100 pieces of coverage and reaching a potential audience of 1.2 billion.

## Powerful research findings

When it comes to food, trust in the source, food safety and stable supply is growing in importance for consumers and manufacturers. Consumers are increasingly demanding to know the story behind the products they are buying and expect transparency from food producers and manufacturers.

Consumer research commissioned by Australian Macadamias has revealed 82% of consumers say origin is important to them when purchasing macadamia nuts. In China and Taiwan, this was even higher at 89% and 95% respectively.

Ninety per cent of Australian consumers and more than 50% of consumers surveyed across Asia and the US ranked Australia as one of their most appealing origins of macadamias.

## From seed to snack

Our trade PR campaign told the Australian provenance story by sharing the journey of the macadamia nut

from its on-farm origins on the Australian east coast, to becoming the hero ingredient in a host of popular food and beverage products.

It described how macadamias originated in the ancient rainforests of Australia's east coast over 60 million years ago, with our country growing a thriving industry that has enabled macadamias to become Australia's fourth largest horticultural export.

## Other key messages included:

- Australian growers' appetite for innovation, adoption of on-farm technology and commitment to best-practice orchard management and biodiversity
- the rigorous quality standards and testing protocols of Australia's macadamia processing sector
- the robust and long-standing relationships Australian processors have with customers around the world, built on quality, impeccable food safety standards and great customer service
- our 23-year unbroken record of 100% compliance achieved in the NRS
- our industry's commitment to offering a variety of product formats to help manufacturers innovate with macadamias across a host of categories and applications.



Macadamias' versatility and proven ability to elevate a wide variety of products in the minds of consumers make them the perfect production partner for major brands, such as *milkadamia* plant-based milks and creamers (USA), Thank You Nuts snack products (Taiwan), Kikkoman Macadamia Milk (Japan), and Nutworks branded macadamia snack, chocolate and confectionery retail products (Australia). These brands participated in the campaign, providing valuable insights into what Australian grown macadamias bring to their products.



"We take premium Australian macadamia kernel and grind it into a paste that forms the basis of our milks and creamers," says *milkadamia* CEO Jim Richards.

"Australian origin is preferred by our business and the *milkadamia* brand is built on our team's passion for supporting Australian growers who are farming regeneratively – something consumers see real value in."

In Taiwan, Thank You Nuts owner Mr Hsieh said, "We choose only Australian grown macadamias as they deliver exceptional quality and delicious taste. Consumers in Taiwan attach great importance to the origin of ingredients, and that's why we promote the Australian origin of our macadamias. There is no doubt that the most delicious macadamias in the world come from Australia."



### The coverage

This PR campaign delivered impressive coverage in publications across Australia, Taiwan, South Korea, China and Japan. Interest was particularly strong among trade media in China and Korea where a combined total of 70 articles were published, including several 'tier 1' major publications.

This exposure will help ensure the Australian origin message is seen by key decision makers in international food and beverage manufacturers, and in turn influence preference for Australian grown macadamias.

*\*In late 2020, Australian Macadamias commissioned research based on 6,014 individual surveys with consumers in Australia, China, South Korea, Japan, Taiwan and the USA. Conducted by the Singapore regional office of independent research agency Kantar, the research was carried out between August and October 2020 and the findings were delivered in December 2020.*





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# Meiji launches high-cacao macadamia chocolate for increasingly health-conscious consumers

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

**Iconic Japanese food company Meiji recently announced a new macadamia variant of their much-loved high cacao chocolate 'Chocolate Koka' range. Launched in February, Chocolate Koka Cacao 72% Rich Macadamia – a boxed chocolate with nine pieces per pack – matches dark chocolate with the flavour and sweetness of roasted macadamias and is designed to appeal to consumers who have grown more health conscious.**



## Elevating the health benefits of Chocolate Koka

Meiji has led a strong education campaign around cacao as a superfood, featuring the high proportion of beneficial cacao polyphenols in their Chocolate Koka range.

"In recent years, customers have become more aware of the health benefits of nuts and consumers now regard them as a healthy snack," a spokesperson for Meiji says.

"The beneficial polyphenols from cacao are a central part of the Chocolate Koka story, and macadamias contain oleic acid, palmitoleic acid and dietary fibre, so we can promote this as a healthy product that combines the benefits of both high-cacao chocolate and macadamias."

It's not just the health benefits of macadamias that are appealing. The taste and texture of the nuts are particularly complimentary to the bitterness of the high-polyphenol dark chocolate.

"The natural flavour and richness of macadamia nuts make the bitter taste of high-cacao chocolate much milder, so the taste appeals to consumers who find the regular Chocolate Koka too bitter," says the company representative.

## Consumers focus on health and small pleasures

Meiji is carefully monitoring the rise of health-conscious consumption following the spread of the coronavirus, and a recent survey run by the company revealed a notable increase in health concern among consumers.

"Our survey showed that 60% of people are now more concerned and conscious about their health, compared

to pre-COVID. This will drive demand for healthier between-meal snacks, so we're focused on products that not only taste great but have health credentials as well," says Meiji's spokesperson.

Meiji has been leading the discussion of their chocolate as a healthy option among health-conscious Japanese consumers for some time.

"We found that 80% of Japanese chocolate consumers are concerned about excessive sugar intake, with 70% limiting their chocolate consumption as a result. However, cacao – one of chocolate's main ingredients – is a superfood which contains lots of cacao polyphenol and dietary fibre," says the spokesperson.

Meiji recommends that consumers treat Chocolate Koka Cacao 72% Rich Macadamia as a 'small pleasure' to make the most of the product's health benefits.

"The cacao polyphenols are metabolically active and not held in the body, so we recommend people eat a little bit at a time to keep up the effect throughout the day. It's a small pleasure to look forward to."

It's a consumption approach that's very much on trend, with recent Australian Macadamias consumer insights research<sup>1</sup> revealing that almost half of consumers globally value these smaller moments in everyday life over occasional big experiences and milestones to keep them happy.

## Innovating with an established brand

While companies are often reluctant to tamper with established brands that are already crowd favourites, Meiji has reason to believe the combined benefits of high cacao dark chocolate and macadamias will be a success.

The company first launched Chocolate Koka in 1998 and persisted with formula improvements to improve the taste until it was a favourite with consumers.

"It took about 15 years for this product to take root in the market. We worked hard to improve the quality. Through repeated trial and error, we have been able to blend the beans and thoroughly improve our processing to create a delicious high cacao chocolate that is rich in cacao polyphenols, has a gorgeous cacao aroma and a moderate bitterness. It's a process that is ongoing and we will continue to refine our products," says Meiji's representative.

So far customers are enthusiastic about the new Chocolate Koka range, with the company saying the combination of the "just-right bitterness of the chocolate and roasted aroma of the macadamias" is garnering positive feedback.

It's exciting to see macadamias playing a role in catering to health-focused consumption trends that have emerged around the world.

<sup>1</sup> Discover Macadamias Research 2020: conducted by independent research agency Kantar Singapore, commissioned by Australian Macadamias



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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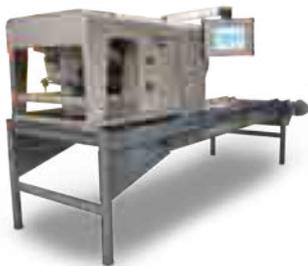


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This pre-cleaning assembly incorporates a Pre-vac, Stick Remover, Sizer/Cleaning Reel, and a Trash Conveyor. It is available in three different size configurations.



The Stick Remover uses a rotating sizing chain to remove sticks from the harvested nuts. It is available in 36", 48" & 60" widths.

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## New data adds to nutrient knowledge

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Research into the nutrient composition of eight macadamia varieties is helping to build a more comprehensive picture of the nutrients removed each year at harvest. New data was gathered last year as part of the Clean Coastal Catchment (CCC) project funded by the Marine Estate Management Strategy (MEMS). The aim of the research was to update the limited information available and compare individual varieties, Australian A versus Hawaiian varieties, varieties with different kernel recovery sizes, potentially different farming regimes (25 years ago compared with now) and new and old varieties. The outcome of this project will ultimately be more efficient fertiliser management, through a better understanding of the nutrient requirements of macadamia crops.

This project investigated the quantities of nutrients removed at macadamia harvest to determine whether the nutrition being applied was sufficient, too little or perhaps too much.

As a basis for understanding nutrient requirements, the industry generally relies on visual assessment of the trees, crop yields and backing this, soil and leaf analysis. Nutrient removal is another key piece of information in the nutrient puzzle.

Estimates of nutrient removal from macadamia orchards through Nut in Husk (NIH) harvested, incorporating husk, shell and kernel, is based on limited data in Australia. Previous work by Trochoulas (1993), Batten and James (1994), and Vimpany and Bryen (1997) reported crop replacement figures extrapolated from averaging three varieties (Hawaiian 246, 344 and H2) for nutrient removal values.

Rather than rely on old data averaged across varieties, this project aimed to accurately define the nutrient removal values for specific varieties grown under modern soil and nutrient management systems.

The project also allowed a comparison between Hawaiian varieties and Australian A varieties. Anecdotal reports suggest that Australian A varieties require more nutrition.

Previous research by Vimpany (2016) also shows different varieties have different carbohydrate requirements. For example, the Australian A varieties have approximately half the total non-structural carbohydrate levels of the Hawaiian varieties. If this is the case, we could hypothesise that there may also be differences in the nutrient composition of the nuts.

It is worth noting that the nutrient removal figures are only part of the nutrition equation. Additional losses occur, for example from leaching or run off, or when nuts are eaten by pests, and these should also be considered when planning nutrition programs.

There are also soil management considerations. For example, soils that have a low pH or are not in balance may not allow certain cations to be available for the

nuts. This would affect the crop removal values. Perhaps, with a good soil balance, the crop removal values would be higher for certain cations. This is why it is important to conduct soil and leaf analyses every year.

### What we did

Samples of green non-split mature husks (2 kg of NIH) were collected by Scott Hill from Healthy Hills Horticulture from eight sites. The samples were collected from between 40 and 150 trees evenly spread over the block depending on the availability of nuts with green non-split husks.

Ideally, we would have preferred one site with multiple varieties so that management systems and other variables were similar. However, we had eight sites that were all on par with the industry average and had reasonable soil nutrition (O'Hare et al 2004) and leaf nutrition (Huett and Vimpany 2007). All sites were non irrigated.



Scott Hill from Healthy Hills Horticulture collected green non-split mature husk, nut samples as part of the study.

The varieties selected were:

- Hawaiian varieties: 816, 741 and 246
- Australian varieties: A38, A203, A16, A4 and G.

The orchards were mostly located on typical NSW Northern Rivers plateau Ferrosol soils, except for G which was sourced from the coastal floodplains and was on predominantly Vertosol soil.

Nutrient levels were collected separately for accompanying husk, which may or may not be removed from the field, and for nut in shell (NIS) at 10% moisture, which is removed from the field. The nutrient levels reported here are the nut in husk levels.

Samples were collected over three harvests in early May, mid-June and mid-July. Previous work by Baten (1994) details a similar methodology in determining crop removal values. However, the sample size was considerably less in Baten’s study which sampled 20 nuts across three varieties – H2, 344 and 246. The nutrient levels were then averaged across the three varieties. Bryen and Vimpany (1997) repeated the study a few years later with 2 kg samples of nut in husk across two varieties – 344 and 246. These were then averaged and values were assigned. See Table 1.

	N	P	K	S	Ca	Mg
<b>Husk</b>	4.03	0.37	7.33	0.65	0.22	0.25
<b>Shell</b>	1.93	0.06	0.72	0.24	0.12	0.12
<b>Kernel</b>	4.54	0.8	1.1	0.49	0.12	0.37
<b>Total</b>	10.5	1.23	9.15	1.38	0.46	0.74

**Table 1:** A guide to nutrients removed with husk, shell and kernel (kg of nutrients per tonne of crop)  
Source: Bryen and Vimpany (1997), AMS News Bulletin: Technical papers (September 1997)

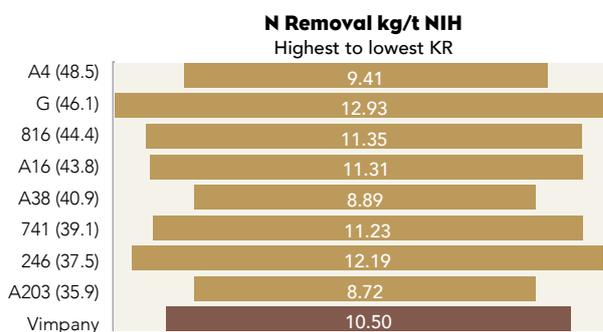
### What we found

The nutrient removal values for nitrogen, phosphorus, potassium, sulphur, calcium and magnesium are shown in Table 2 and the following graphs, with the varieties ordered from largest to smallest kernel recovery.

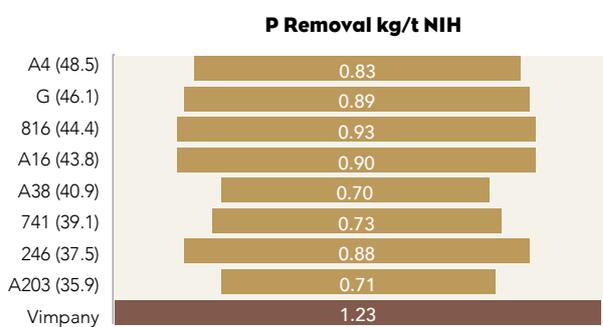
These can be compared with the average crop removal figures reported by Bryen and Vimpany in Table 1.

Note that these findings are based on one year of testing and that last year was not a typical year, with the

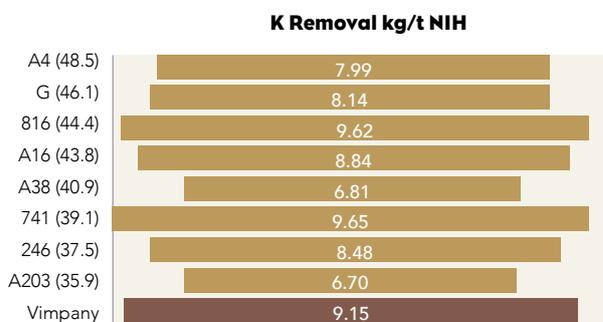
harvest following one of the worst droughts the industry has ever experienced. We also do not know the soil nutrient analysis from the Vimpany research. The soil status at the time could have been an important factor in the results they recorded.



**Figure 1:** Test results for nitrogen removal by variety (kg N/t NIH).  
Source: J Bright (2020) NSW DPI



**Figure 2:** Test results for phosphorus removal by variety (kg P/t NIH).  
Source: J Bright (2020) NSW DPI



**Figure 3:** Test results for potassium removal by variety (kg K/t NIH).  
Source: J Bright (2020) NSW DPI

	Kernel recovery	N	P	K	S	Ca	Mg
<b>A4</b>	48.5%	9.41	0.83	7.99	1.08	0.69	0.78
<b>G</b>	46.1%	12.93	0.89	8.14	1.30	0.81	0.78
<b>816</b>	44.4%	11.35	0.93	9.62	1.27	0.77	0.79
<b>A16</b>	43.8%	11.31	0.90	8.84	1.44	1.11	0.94
<b>A38</b>	40.9%	8.89	0.70	6.81	1.21	0.53	0.74
<b>741</b>	39.1%	11.23	0.73	9.65	1.37	0.63	0.74
<b>246</b>	37.5%	12.19	0.88	8.48	1.38	0.54	0.78
<b>A203</b>	35.9%	8.72	0.71	6.70	1.23	0.68	0.62

**Table 2:** Nutrient removed by variety with husk, shell and kernel (kg of nutrients per tonne of crop)  
Source: J Bright (2020) NSW DPI

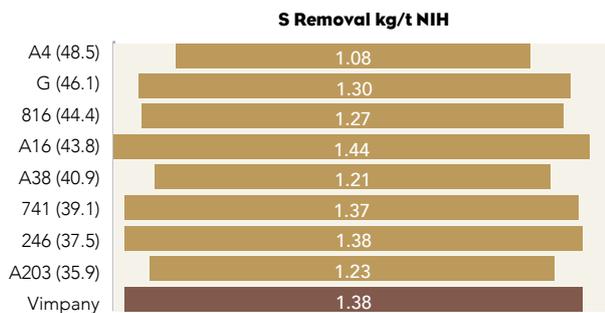


Figure 4: Test results for sulphur removal by variety (kg S/t NIH).  
Source: J Bright (2020) NSW DPI

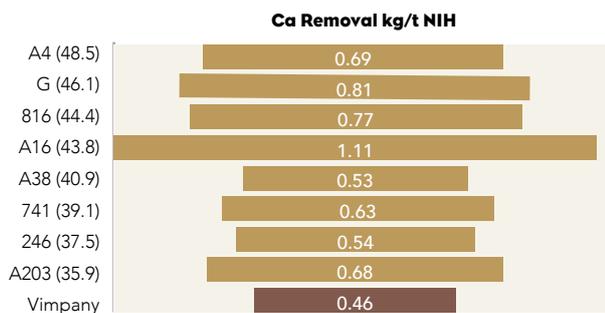


Figure 5: Test results for calcium removal by variety (kg Ca/t NIH).  
Source: J Bright (2020) NSW DPI

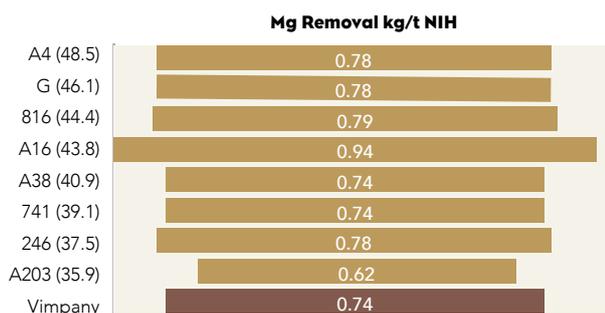


Figure 6: Test results for magnesium removal by variety (kg Mg/t NIH).  
Source: J Bright (2020) NSW DPI

## Were there differences between Australian A and Hawaiian varieties?

In some instances, the A varieties removed similar nutrient levels to the Hawaiian varieties. For example, A16 removed just as much nitrogen as 816 in these tests.

Generally, the Hawaiian varieties removed higher quantities of nitrogen, phosphorus and potassium, while Australian varieties removed higher quantities of calcium and magnesium. The calcium and magnesium removal of A16 was particularly high.

## Were there differences in nutrient composition between varieties?

The difference between varieties was minimal, at most there was a 4.21 kg N/t NIH difference between G (highest nitrogen removal) and A203 (lowest nitrogen removal). Looking at this another way, G removed 1.5 times more nitrogen per tonne of NIH than A203. A16 showed a higher removal of calcium, magnesium and sulphur than other varieties. The Hawaiian varieties 816 and 741 showed a higher removal of potassium than other varieties.



Nut in husk samples from Australian and Hawaiian varieties from eight different sites were analysed for their nutrient composition.

## Did kernel recovery size influence nutrient removal?

A larger kernel did not necessarily mean higher nutrient removal.

## Did the new varieties remove more nutrients than the older varieties?

The new variety, G, removed more nitrogen per kilogram than all of the other varieties, including A4. Based on these figures, it looks like G will require some extra nitrogen to sustain it.

## Other findings of note

The "normal" nutrition program was compromised by the drought and this is likely to be reflected in the nutrient removal data. For example, any nutrition added to the soil in a dry land situation would not have been taken up by the plant. Post drought rainfall in January may mean that nitrogen availability increases markedly, as residual nitrogen from previous applications becomes available with mineralisation of nitrogen (conversion from organic to plant-available forms). (Jenkins et al 2020)

The new testing showed lower levels of phosphorus removal than the previous data across all varieties. Similarly, calcium removal tended to be higher in 2020 than in the 1997 tests. This may be due to changed soil and nutrient management practices.

The more we look into nutrient removal values, the more it appears to be replicating a typical leaf analysis. It is about what cations are made available to the NIH, not just what the NIH takes out of the orchard. This emphasises the point that all growers should ensure they have an adequate soil nutrition program.

## Next steps

It is more complex than is suggested here. We can speculate a lot, but if industry is keen, there is scope to further investigate nutrition removal values by variety.

We could also learn more about the nutrient values removed over a longer period.

Testing will be repeated this season from a farm located at Newrybar, NSW with all eight varieties. Importantly, this will mean that all varieties are managed under the same system, as opposed to the previous trial which had eight different farms involved. Building data over several seasons will help to build a better base line understanding of the nutrient requirements of modern macadamia crops and refine soil and nutrient management systems.

Growers are encouraged to arrange plant tests of their own nut samples to provide accurate data relating to their own trees. The information can be used with leaf test results to accurately quantify nutrient uptake by the trees.

### Take home messages

Nutrient removal data shows what is available in the soil for the plant to take up, similar to leaf testing.

To understand variety nutrient removal, NIH samples need to be taken from trees growing where there is an adequate soil nutrient balance, pH and cation exchangeability.

Different varieties can remove different amounts of nutrients from the field.

A varieties don't necessarily remove more nutrients than Hawaiian varieties.

G may require more nitrogen than other varieties.

Should we consider managing our varieties differently based on these results? Ensuring good soil and leaf nutrition levels will probably mean we do not need to.

All in the industry should conduct annual soil and leaf analysis.

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## Mapping the growth of macadamia orchards

**Craig Shephard**, Senior Researcher, and **Joel McKechnie**, Researcher, Applied Agricultural Remote Sensing Centre, University of New England, Armidale, NSW **E:** cshepha2@une.edu.au **P:** 0405 297 850

The mapping of Australia's horticulture tree crops provides industries with an accurate understanding of the extent (distribution and area) of production as well as annual growth. This information is now serving as an essential 'base layer' to inform traceability, forward selling, improve resilience to biosecurity threats and for post-natural disaster response and recovery.

### Key findings

- The latest Australian Tree Crop Map includes 99% of all commercial macadamia orchards in Australia.
- The map shows macadamias are grown on 31,878 hectares.
- Bundaberg has seen the biggest growth in new orchards, adding 4,582 hectares of macadamias since 2017.
- The Northern Rivers region of NSW has also grown rapidly, with 2,905 hectares of new orchards established over the same period.
- Growers can assist by reviewing the map. Is something missing or incorrectly mapped, or are you planting a new orchard? Add your feedback via the Industry Engagement Web App.



Figure 1: The ATCM Dashboard is a great tool to see where Australia's tree crops are grown.

Understanding the spatial distribution and area of commercial macadamia crops supports more accurate yield forecasting at national, regional and farm levels. It also provides essential information to manage and inform transport, market and labour logistics, and as applied recently in the industry response to the Paradise Dam issue, water security.

Knowing where crops are located is also vital for an improved response to biosecurity incursions, such as establishing exclusion zones and coordinating on-ground surveillance, as well as quantifying

the area of crops affected following a natural disaster.

Recent developments across a number of tree crop industries have set a clear benchmark of how high resolution spatial (location) and temporal (timing of mapping currency and updates) information can benefit an industry, even more so when industry bodies drive the needs and applications from the data.

This map was developed through collaboration with the Australian Macadamia Society and other industry bodies, the Australian

Mango Industry Association, Citrus Australia, Australian Olive Association, Australian Banana Growers Council and Avocados Australia. Growers also assisted in collecting on-ground calibration and validation information to inform the map, using purpose-built location-based tools, 'Land Use Survey' and 'Industry Engagement Web App'. To access these applications, visit [www.une.edu.au/webapps](http://www.une.edu.au/webapps)

The contribution of stakeholders is extremely valuable, especially for mapping new crops which are not visible in satellite imagery.

To date, 625 surveys and 386 comments relating to macadamias have been received, with each submission interpreted and actioned in the map. Figure 2 illustrates a survey of a newly planted orchard that would otherwise be missed if we relied on image interpretation alone.

The mapping adheres to national standards for commodity level land use mapping, supported by the Australian Collaborative Land Use and Management Program (ACLUMP), which promotes nationally consistent methods for building and sharing land use information. Privacy concerns are acknowledged and respected as the information sources used to compile the map include remotely sensed data (imagery), state and national ancillary datasets, field observation and expert knowledge.

No personal or confidential information is collected as part of the mapping process or contained within the map. The map simply presents a polygon feature that denotes the tree crop, but there is no property information (block, variety, yield, etc) or personal information (grower, enterprise, owner) included.

**What's changed and where?**

The AARSC has derived change metrics based on the differences between the initial mapping phase in 2017 and the new map, updated in 2020. These metrics are essential for the macadamia industry to understand future supply and demand, manage logistics including labour, processing and transport, as well as resource inputs such as water, root stock production and land availability. The Australian Tree Crop Map provides this essential information.

Analysing the change since 2017 shows that 4,582 ha of new macadamia orchards were established in Bundaberg and 2,905 ha in the Northern Rivers of NSW. The maps highlight where new orchards have been established (Figures 3 and 4).



Figure 2: Land use survey of a new macadamia crop. Without this survey, this orchard would not yet be in the map.

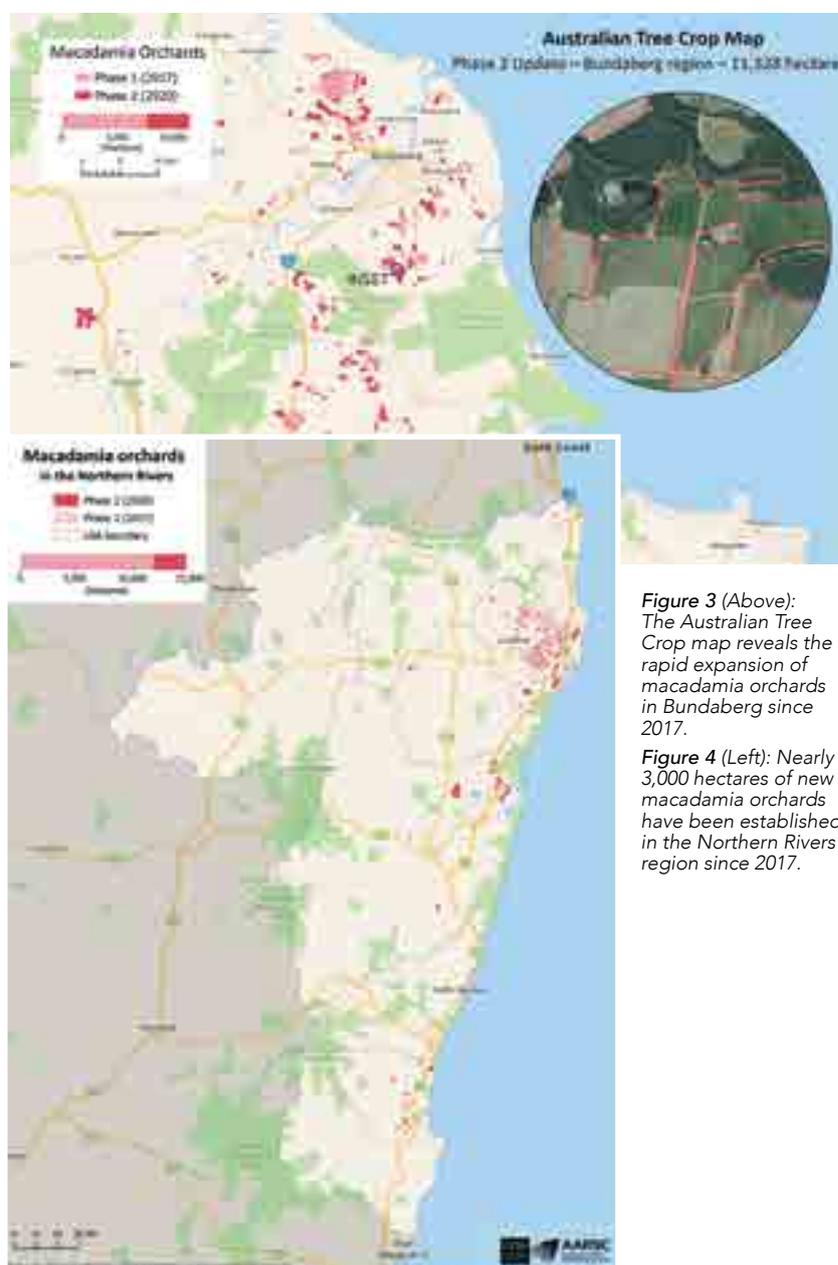


Figure 3 (Above): The Australian Tree Crop map reveals the rapid expansion of macadamia orchards in Bundaberg since 2017.

Figure 4 (Left): Nearly 3,000 hectares of new macadamia orchards have been established in the Northern Rivers region since 2017.

## Help maintain the map

The phenomenal growth in new orchards highlights the ongoing challenge to maintain and update the map. Mapping new crops which are not visible in satellite imagery is best informed with the engagement of industry and growers using location-based tools built by the AARSC.

Growers can review the map in the 'Industry Engagement Web App' (best on desktop). If anything is missing or incorrectly mapped, or a new orchard is being planted – add a comment to bring it to the attention of the research team at AARSC. All feedback is interpreted and a reply to each comment is posted before the updated mapping is published across the range of web applications.

The success of the mapping showcases the value of science and innovation across the horticulture industry in Australia. This is a result of collaboration that combines industry and government data interpreted with imagery and



Figure 5: Growers can help maintain the accuracy of the map by giving their feedback through the Industry Engagement Web App.

ancillary information including field validation to map and classify the location and extent of tree crops.

The AARSC is now working with the AMS to host the map of macadamias on the AMS website. The functionality to capture stakeholder feedback as comments, to maintain the map will be included on that map. Until that update is released and integrated

with the AMS website, the range of theme-based applications can be accessed from the AARSC web app gallery at [www.une.edu.au/webapps](http://www.une.edu.au/webapps)

### Acknowledgement

The Multi-scale monitoring tools for managing Australian tree crops initiative is led by the University of New England, and supported by Hort Innovation under the Australian Government's Rural Research and Development for Profit program.

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### New Severe Weather App

The AARSC has developed the Australian Tree Crop Map: Severe Weather App to give the tree crop industry and its growers a tool to prepare for and respond to extreme weather events.

The app overlays live and historical weather information from the Bureau of Meteorology with the location of commercial tree crops in Australia. It will assist growers and their industries to respond to severe weather events, including

tropical cyclones, thunderstorms, hazardous winds and hail.

Users can view active (near-real time) weather layers. For recorded events such as tropical cyclones and detected severe thunderstorm cells, summary statistics are published within pop-ups showing the area of potential impact to tree crops.

It's a practical example of how the AARSC, in collaboration with

industry, is using satellite imagery, industry engagement and field validation to support Australia's multibillion dollar tree crop industries.

"With many of our most lucrative tree crops concentrated in small geographical regions, the impact of a single severe weather event can be significant," says AARSC founder and Director, Professor Andrew Robson.

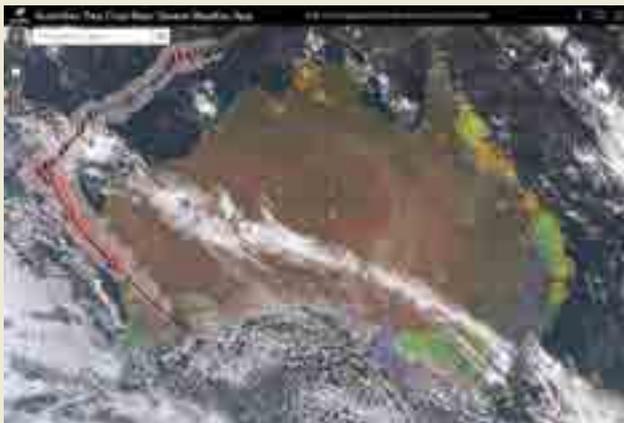


Figure 6: The Severe Weather App showed Tropical Cyclone Seroja on April 14, 2021.

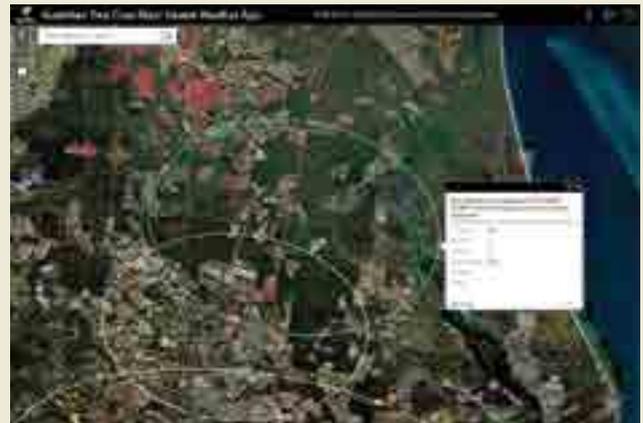


Figure 7: The Severe Weather App showed a thunderstorm cell detected on March 21, 2021 at 7.34 pm and its potential impact on 242 ha of macadamia orchards.



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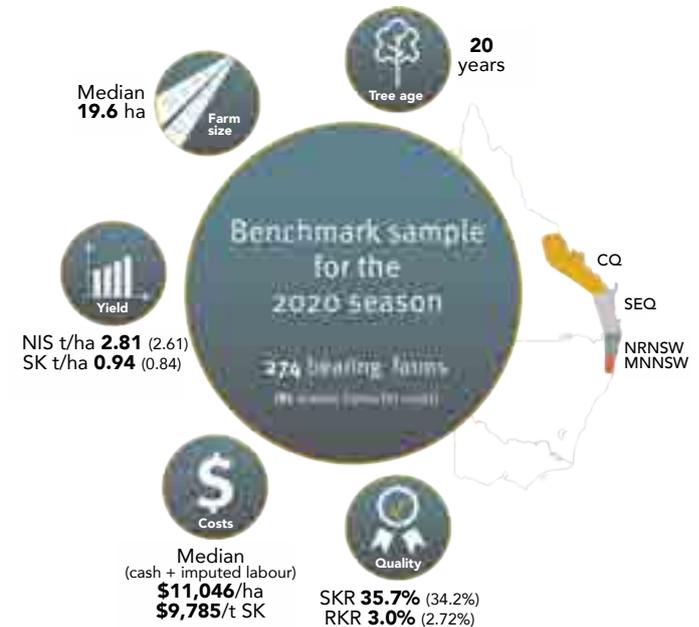
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# Benchmarking 2020 season wrap-up

MC18002 benchmarking team – **Shane Mulo, Grant Bignell** and **Ingrid Jenkins**, DAF Queensland, **Jeremy Bright**, NSW DPI and **Geoff Slaughter**, University of Southern Queensland  
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The macadamia benchmarking team has finalised data collection and reporting to participating growers for the 2020 season. Benchmark Group meetings have also been held in all major production regions, including the first ever meeting in the emerging coastal flats region of Northern NSW. The next step is to generate the industry report which will summarise long term trends in production, quality and costs.



## Key findings

The 2020 benchmark sample consisted of 274 bearing farms, 11,808 hectares and 29,367 tonnes of nut-in-shell (NIS) which equates to approximately 58% of industry production. Figure 1 shows trends in the weighted average nut-in-shell (NIS) and saleable kernel (SK) yield per bearing hectare for mature farms (10 years old or more) in the sample from 2009–2020. Average saleable kernel recovery (SKR) for mature farms is also shown, weighted by NIS production.

In 2020, weighted average productivity for mature farms in the benchmark sample was 2.94 t/ha of NIS and 0.95 t/ha of SK. These values are higher than both the 2019 season (2.75 / 0.87 t/ha) and the long-term average (2.78 / 0.88 t/ha). SKR averaged 34.7% for mature farms in 2020. The 2020 average was higher than both the 2019 season and the long-term average.

Figure 2 shows regional weighted average NIS productivity for mature farms. Productivity increased in 2020 in both Mid North New South Wales (MNNSW) and Central Queensland (CQ) compared with 2019, while South East Queensland (SEQ) farms saw a decrease in

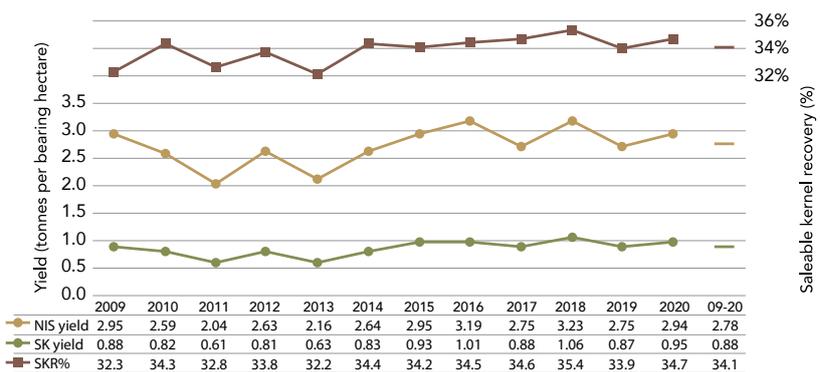


Figure 1: Yield and saleable kernel recovery trends for 2009 to 2020.

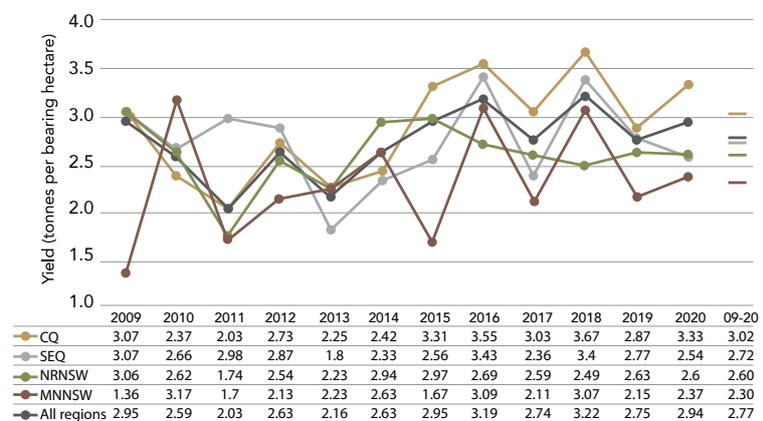


Figure 2: Regional NIS yield trends for 2009 to 2020.

2020 compared with the previous season. Average productivity in the Northern Rivers region of NSW (NRNSW) has been relatively stable for the last five seasons.

Figure 3 shows unweighted average saleable kernel recovery trends for each region in the benchmark sample from 2009 to 2020. In 2020, average SKR

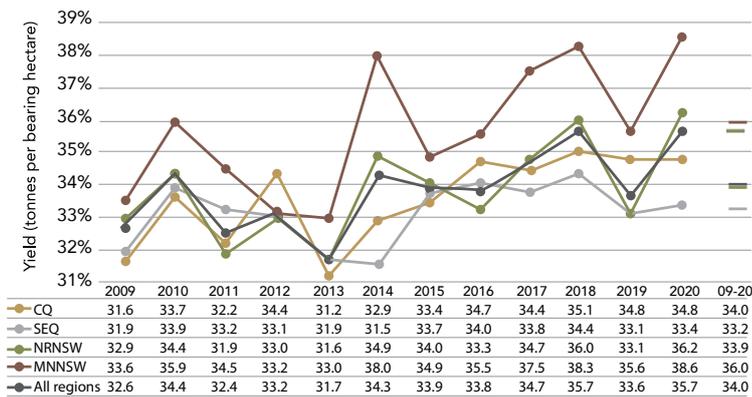


Figure 3: Regional saleable kernel recovery trends for 2009 to 2020.

increased in all regions except CQ when compared with 2019. The largest increase was evident in New South Wales where SKR was approximately 3% higher than in 2019 and substantially higher than the long-term average.

Benchmark participants were asked to identify up to three limiting factors affecting their production in the 2020 season (Figure 4). Hot or dry weather was by far the most reported factor affecting production across all regions in 2020, which was also the case in 2019. Soil or tree health, pests and tree or limb removal were the next most reported factors, although only 7% of farms in the CQ region reported pests as a limiting factor in the 2020 season. Storms and hail were reported by over 20% of participating farms in the SEQ region.

Fruit spotting bug was the most significant pest reported across the benchmark sample in 2020 (30%) followed by rats (15%), macadamia seed weevil (14%) and macadamia nut borer (10%).

The most significant diseases reported in 2020 included Phytophthora (33%) followed by branch or tree dieback (23%). These disease rankings were consistent across all major production regions. Approximately 15% of farms reported no significant disease limitations.

### Next steps

The upcoming industry benchmark report will provide a more comprehensive analysis of both the 2020 season and long-term trends in productivity, quality and costs. All benchmarking participants will

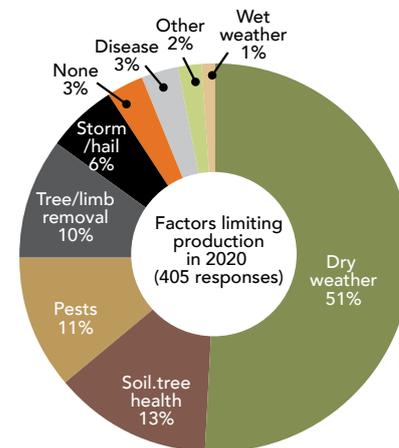


Figure 4: Major factors limiting production in 2020.

receive a hard copy of the industry report in the mail. The report will also subsequently be available for download from the Queensland Government Publications portal. Collection of 2021 season data will commence around September.

Benchmarking is a free service available to Australian macadamia growers. It allows businesses to compare yield, quality and optionally costs with other farms with a similar locality, tree age, farm size and management structure. For more information about the benchmarking service please contact the team by emailing [macman@daf.qld.gov.au](mailto:macman@daf.qld.gov.au) or phoning (07) 5381 1300.



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# Australian macadamia minor use and emergency permits

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<b>Minor use permits</b>					
<b>Abamectin</b>	PER87510	Thrips and flat or broad mites	<ul style="list-style-type: none"> <li>Product containing 18 g/L abamectin: 750 mL/ha plus 5 L summer spray oil/ha</li> <li>Product containing 36 g/L abamectin: 375 mL/ha plus 5 L summer spray oil/ha</li> </ul>	28	All states and territories except VIC
<b>Chlorpyrifos &amp; maldison</b>	PER13642	Australian plague locust	<ul style="list-style-type: none"> <li>Product containing 500 g/L chlorpyrifos: 350 mL/ha</li> <li>Product containing 440 g/L maldison: 1.4 or 1.9 L/ha</li> <li>Product containing 500 g/L maldison: 1.2 or 1.7 L/ha</li> <li>Product containing 1000 g/L maldison: 600 or 850 mL/ha</li> <li>Product containing 1150 g/L maldison: 520 or 750 mL/ha</li> <li>Ground application</li> </ul>	Chlorpyrifos: 30 Maldison: Not required when used as directed	All states and territories except VIC
<b>Diazinon</b>	PER14276	Macadamia lace bug	<ul style="list-style-type: none"> <li>Product containing 800 g/L diazinon: 120 mL product/100 L</li> </ul>	14	NSW, QLD & WA only
<b>Ethephon</b>	PER11462	Promote nut fall after maturity reached	<ul style="list-style-type: none"> <li>Product containing 480 g/L ethephon: 65–250 mL/100 L water</li> <li>Product containing 720 g/L ethephon: 55–165 mL/100 L water</li> <li>Product containing 900 g/L ethephon: 44–132 mL/100 L water</li> <li>Do not spray stressed trees</li> <li>Refer to critical comments for varietal rate adjustments</li> </ul>	7	NSW, QLD, WA & NT only
<b>Indoxacarb</b>	PER86827	Macadamia seed weevil	<ul style="list-style-type: none"> <li>Product containing 150 g/L indoxacarb: 50 mL product/100 L</li> <li>Product containing 300 g/kg indoxacarb: 25 g product/100 L</li> </ul>	42	NSW & QLD only
<b>Methomyl</b>	PER90592	Banana fruit caterpillar	<ul style="list-style-type: none"> <li>Product containing 225 g/L methomyl: 1.5–2 L/ha</li> <li>Spraying ground mulch/soil surface up to treelines only</li> </ul>	Not required when used as directed	QLD only
<b>Petroleum oil</b>	PER11635	Macadamia felted coccid	<ul style="list-style-type: none"> <li>Product containing between 763 and 861 g/L petroleum oil: 1 L/100 L water</li> </ul>	Not required when used as directed	NSW & QLD only
<b>Trichlorfon</b>	PER13689	Macadamia lace bug, fruit spotting bug, banana spotting bug and green vegetable bug	<ul style="list-style-type: none"> <li>Product containing 500 g/L trichlorfon: 200 mL/100 L</li> </ul>	2	NSW & QLD only
<b>Emergency permits</b>					
<b>Chlorantraniliprole</b>	PER89353	Fall armyworm	<ul style="list-style-type: none"> <li>Product containing 350 g/kg chlorantraniliprole: 18 g product/100 L + 15 g active/100 L non-ionic surfactant/wetting agent</li> <li>Product containing 200 g/L chlorantraniliprole: 30 ml product/100 L + 5 g active/100 L non-ionic surfactant/wetting agent</li> </ul>	10	All states and territories except VIC
<b>Indoxacarb</b>	PER89278	Fall armyworm	<ul style="list-style-type: none"> <li>Product containing 300 g/kg indoxacarb: 25 g/100L</li> </ul>	42	All states and territories except VIC
<b>Methomyl</b>	PER89293	Fall armyworm	<ul style="list-style-type: none"> <li>Product containing 225 g/L methomyl: 1.5–2 L/ha</li> <li>Product containing 400 g/kg methomyl: 0.84–1.13 kg/ha</li> <li>Spray ground mulch/soil surface only</li> </ul>	Not required when used as directed	All states and territories
<b>Spinetoram</b>	PER89241	Fall armyworm	<ul style="list-style-type: none"> <li>Product containing 120 g/L spinetoram: 40 mL product/100 L</li> </ul>	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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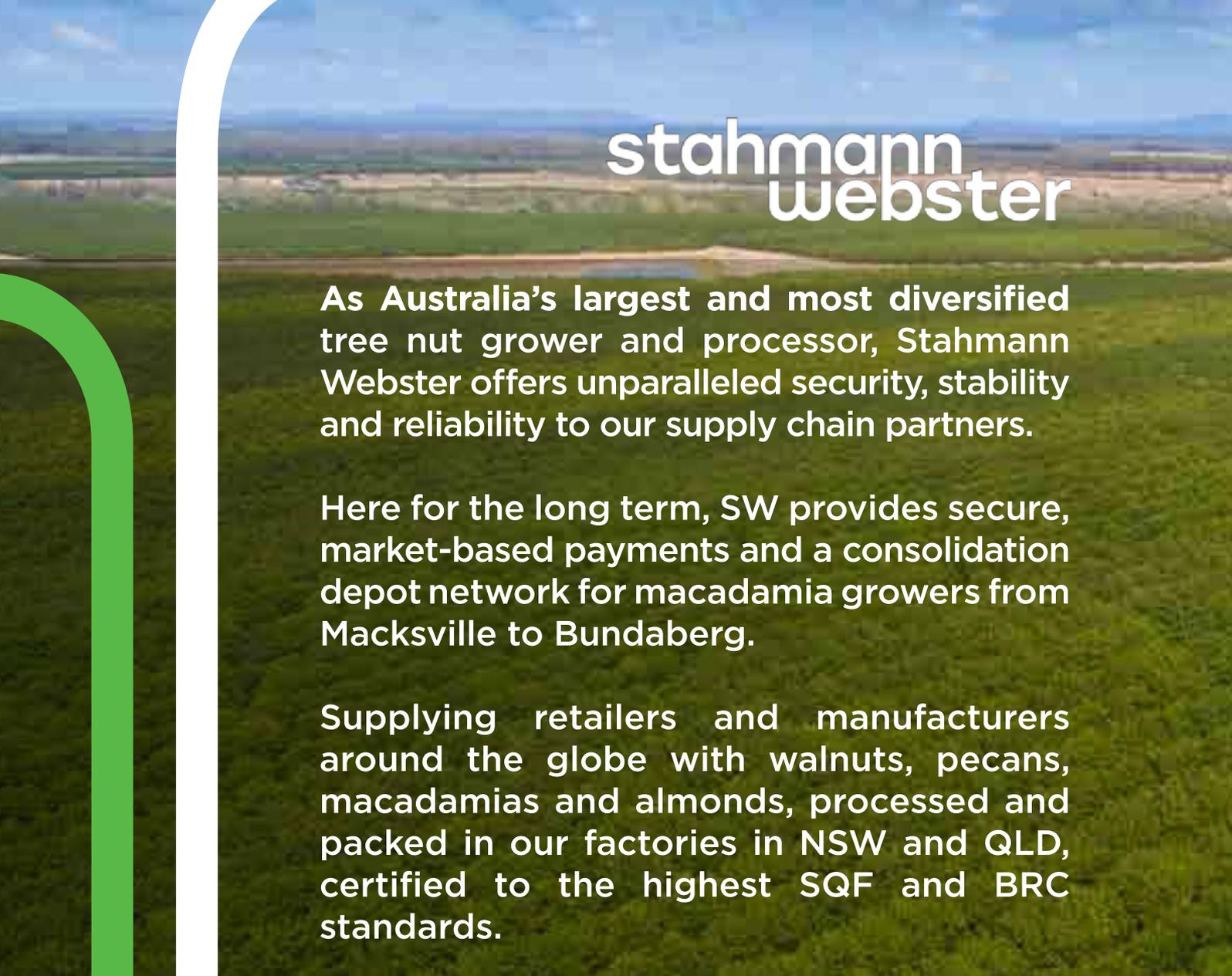
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