Working with nature for a sustainable future

Innovative thinking and a collaborative spirit continue to drive the Australian macadamia industry's pursuit of consistent high-quality yields and long-term sustainability.

With the call for sustainable production growing louder every year, the responsibility to produce the world's best macadamias as eco-sensitively as possible is felt and shared by everyone from the largest operators in the processing sector right through to new growers navigating their first season.

A deep commitment to sustainable farming

Australia is recognised internationally as a clean, green and reliable food producer. Australian macadamia growers are deeply committed to sustainable production and believe the actions they take on-farm today must benefit the environment and people in the future.

Feeling a true affinity for the land on which they farm, Australian macadamia growers take great care to develop and implement ecologically sensitive techniques to protect the natural environment. Our industry invests millions of dollars in research every year to ensure our practices are the world's best and that the natural resources on which our industry relies to grow this delicious wholefood are managed as efficiently as possible.

More Australian growers than ever are now actively monitoring and measuring their operation's sustainability practices, delivering the data and transparency that today's market demands.

Working with nature from the ground up

As growing and orchard management practices become more advanced, so too does understanding of the environment and how it is changing. Macadamia growers remain committed to conserving the natural resources on which their product relies, and now more than ever, are prioritising the protection of the water, soil, air, native vegetation and wildlife.

While growers have been challenged by a year of variable weather, they have continued to focus on working with nature to consolidate orchard fundamentals.

- **Soil health:** By increasing soil carbon, mulch and living ground cover to replicate a rainforest floor environment, growers are nurturing soils that take up and conserve water and creating a more resilient orchard floor that can stop evaporation and mediate soil temperature.
- **Biodiversity:** Macadamia orchards are living ecosystems. The trees themselves provide habitat and food sources for countless species, supporting biodiversity in ways few other crops can. Growers are planting diverse ground covers and native vegetation between tree rows and around orchards to build biological resilience, create refuges for beneficial insects and pollinators, and encourage natural predators that help keep pests in check.
- **Canopy management:** Sunlight and airflow are natural enablers of a healthy crop and help to maintain a balanced orchard ecosystem. Open, solarised trees through proactive management help suppress disease, support healthy groundcover and underpin efficient nut production.
- **Waterways and marine estates protection:** Growers continue to invest in diverse vegetation within and surrounding orchards, along riparian zones. By adopting natural orchard management practices they are protecting water quality, mitigating runoff and using inputs efficiently. Macadamias are also leading the way in Reef Certified farming in macadamia Reef catchments. This reflects the industry's strong stewardship of land and water in regions that border the Great Barrier Reef.

Macadamia trees are largely grown in the locations where they naturally evolved more than 60 million years ago, meaning it is a crop that has naturally adapted to its environment. This natural advantage and inherent resilience coupled with the ongoing improvements growers are making will ensure the industry can continue to produce a high quality, consistent crop.

Answering the call for sustainable ingredients

The era of meeting demand at any cost is well and truly gone as businesses, governments and consumers across the globe grapple with the environmental impacts of their choices large and small.

Once considered a secondary focus, sustainability is now central to ingredient innovation. As Mintel notes in *The Future of Ingredients 2025*, the food and drink industry is entering a period of "bold transformation" driven by climate change, resource scarcity and shifting consumer expectations.

Advances in regenerative agriculture, circular production models and biotechnologies are reshaping how ingredients are sourced, produced and consumed. This shift reflects rising consumer demand for transparency and accountability, alongside a long-term commitment to planetary health. These drivers are "redefining industry standards, paving the way for a future where food nourishes both people and the planet in harmony"[1].

Manufacturers already understand the taste, texture, health, luxury and plant-based cues macadamias can add to products. Macadamias grown in Australia deliver powerful, research-backed sustainability credentials too, from water use efficiency and carbon sequestration to minimisation of carbon outputs, recycling of by-products and world's best biological control.

1. Mintel, *The Future of Ingredients 2025*, February 2025.

A framework for the future

In the globalised supply chain, consumers are increasingly seeking transparency about where their food comes from and how products are produced. Similarly, supply chain companies and their shareholders, markets and investors are seeking evidence of high standards of product safety, workplace ethics and environmental care.

Hort Innovation has developed the Australian-grown Horticulture Sustainability Framework, a guide for understanding and measuring the many elements of sustainability of Australian-grown horticultural production and setting goals for the future. The Australian macadamia industry has started using this to develop its own industry approach.

The Australian-grown horticulture sustainability framework provides a logical process to measure how Australian horticulture is tracking on key sustainability issues. With this information, Australian horticulture, its industries and businesses can:

- Measure and track the sustainability of their production systems
- Work towards safe, ethical and environmentally sustainable production practices
- Find simplified ways to gather or model data on the sustainability metrics of production systems to meet supply chain needs and reduce burden on individual growers
- Work together on common challenges across the sector
- Target research
- Tell their story of sustainable production
- Protect and grow access to investment and finance
- Strengthen relationships and transparency with stakeholders.

Precision agriculture and mapping – tools for the future

Modern mapping and precision agriculture technologies are helping growers monitor orchards in real time, understand variability and make better resource decisions.

While large-scale industry mapping once focused on locating trees and assessing storm or flood damage, it's now used as a future-readiness tool that supports biosecurity response, efficient irrigation, and sustainability benchmarking.

The mapping of wild macadamias has also been critical for identifying and protecting this rare genetic heritage.

Using R&D to drive ongoing improvement

Australia's macadamia industry leads the world in terms of on-farm research and development. More than three decades of commitment to R&D has laid the foundation for growers to develop practical solutions that ensure consistent supply of premium quality macadamias.

The industry invests over $5 million in R&D annually through levy and other industry and research agency investments. Recent years have seen a surge in grower-led innovation as well, with many growers investing in their own trials and implementing innovative new practices on farm as a result. Adoption of new technology, enviro-monitoring and more efficient, targeted and precise irrigation scheduling are paving the way for continued long-term growth in Australian macadamia production.

These important investments will help to improve productivity while aligning with environmental stewardship and sustainable practices.

Following completion of the Hort Frontiers Funded Tree Intensification initiative, the industry has reinvested in a new program, "Maximising Macadamia Yield", which focuses on understanding tree physiology and resource-use efficiency to improve productivity under variable climatic conditions.

Advances in pollination brought about by improved understanding of its importance and of which insects pollinate most effectively has resulted in cross-pollination becoming a significant consideration when planting new orchards. The Hort Frontiers Pollination Fund covers multiple crops including macadamias, and this has seen many growers adopting pollination services and redesigning their orchard landscapes to create a safe harbour for natural pollinators. Pollination contributes to greater yields and better kernel recovery, again proving that working with nature is often the best strategy.

2025 saw ongoing R&D investment in the following areas:

- Integrated pest management*
- Integrated disease management*
- Industry benchmarking which includes a sustainability pilot*
- Pollination practices, pollinator health studies and gap analysis*
- Multiple water quality projects including reef certifications and marine estuary health
- Macadamia physiology to understand how climatic signals influence the inner workings of the tree in response to climate variability*
- Macadamia orchard mapping

**These research projects have been funded by Hort Innovation, using the macadamia research and development levy and contributions from the Australian Government. Hort Innovation is the grower owned, not-for-profit research and development corporation for Australian horticulture.*

Serious about food safety and quality

Food safety is a top priority for Australia's macadamia industry. Its approach is underpinned by sophisticated production processes, generations of knowledge about quality on farm and in factory, a commitment to biological pest control, and Australia's reputation as a clean and green environment.

The Australian macadamia industry has rigorous food safety & quality standards, and testing protocols. Good agricultural practice (GAP) on farm underpins a quality and food safety focus that extends throughout the supply chain.

All processors are HACCP certified and most have additional quality management systems, to ensure compliance from orchard to end customer.

Advanced traceability systems across the supply chain ensure confidence in Australian macadamias delivering to customer expectations.

Australia's standing as the producer of premium quality macadamias is validated by the results of the Australian Government's National Residue Survey, a program that screens Australian crops for a range of chemical pesticides and environmental contaminants. Australia's macadamia industry has achieved strong compliance in the NRS, maintaining a superior record every year since the Survey's inception in 1996.

At a glance: the Australian macadamia industry's sustainability and productivity initiatives

Precision agriculture

Precision agriculture is helping the industry stay productive, resilient and climate-ready. Growers are embracing digital tools like mapping, soil monitoring probes, weather stations and remote sensing to make precise, evidence-based decisions. These technologies help fine-tune irrigation, fertiliser use and pest monitoring, cutting waste and improving resource efficiency. By tracking soil and climate variability in real time, growers can adjust quickly to seasonal changes, protect soil and water, and maintain consistent yields.

Integrated orchard management

Integrated management of canopy, orchard floor and drainage.

- **CANOPY**
  Light and ventilation in the orchard improves productivity but also supports biodiversity - the beneficial insects and birds that keep pests at bay thrive in these conditions. Sunlight also acts as a natural solariser, helping control disease, maintain healthy groundcover and drive production.
- **ORCHARD FLOOR**
  The orchard floor is the engine room for production – rich in organic matter, covered with diverse plants, holding adequate moisture and teeming with soil life that supports both biodiversity and yield.
- **DRAINAGE**
  Effective drainage keeps precious soil where it's meant to be and helps orchards withstand extreme weather, making macadamia systems more climate resilient.

Integrated pest and disease management

Combining a range of strategies including biological controls and cultural farm practices, IPDM continues to be a significant investment for the industry. By creating a pest suppressive landscape and monitoring and understanding pest lifecycles, growers can better discern when intervention is needed.

Improved soil erosion management

Significant work has been undertaken to better mitigate soil erosion using whole farm planning and re-contouring that helps balance nutrients, prevent run-off, and monitor and manage water quality. The use of cover crops plays an important role in this area, encouraging beneficial insects while retaining soil and moisture levels.

Biological control and diversity

Collaborative research examining biological control is currently being undertaken by multiple research agencies. This will build on the industry's use of naturally occurring organisms to control pests and disease. Orchards are now boasting more diversity than ever, with many growers establishing inter-rows in their orchards to create habitats for beneficial insects, native bees and other pollinators such as flies and beetles. This is delivering production benefits as well as a more sustainable way of growing. Programs that support barn owl perches and hollows in orchards are strengthening ecosystem balance and reducing synthetic inputs.

Revegetation and restoration of riparian zones

Riparian zones are extremely sensitive to any activity occurring in and around them, with careful management required to ensure there is no adverse impact on the waterways. The industry is restoring these precious zones and planting more native vegetation to encourage biodiversity and natural resilience, control erosion and create a naturally pest-suppressive landscape.

Increase in use of European and native bees

Insect pollination by both managed and naturally occurring bees and other insects are beneficial to the crop.

Nothing wasted

The macadamia industry is making inroads to developing a circular economy. 100% of the harvested nut is used, with nothing going to waste. The husk is used as mulch and compost and the shell is used for co-generation of electricity in macadamia processing plants. Some macadamia processors are now repurposing their nutshell waste into biochar, which is the result of burning macadamia shells at a high temperature in a special, low oxygen environment. Used as a soil enhancer, biochar makes soils more fertile and stores carbon in the soil so it's not released as a greenhouse gas. Biochar production creates bio-oil and gas by-products that can be used as fuel for renewable energy plants.

Breeding programs

Macadamias are part of some long term breeding programs that capitalise on the selection of natural favourable characteristics, not genetic modification. The MCT1 macadamia cultivar was produced following a long breeding history and testing in multiple regions. It has gone on to become one of the most sought-after varieties in the industry. The levy-funded breeding program has produced four elite varieties which are starting to be planted more widely. It is anticipated these could be game-changing for productivity.

Wild Macadamia Conservation

To secure the industry's future, it's important to preserve the past. It's a little-known fact that macadamias are native to Australia.

They originated in the rainforests of the east coast 60 million years ago and Australia is the only country in the world where macadamias grow wild. From South Africa to Hawaii, China to Kenya, every single macadamia tree in the world can be traced back to the wild macadamia trees that still grow in the Australian rainforest.

Over millions of years macadamias retreated to favourable niches in the rainforests along the east coast from Gladstone in Queensland to northern New South Wales. But since European settlement, up to 90% of wild macadamias have been lost due to land clearing, with wildfires, grazing, weeds and climate change posing ongoing threats to their survival. There are four wild macadamia species, all of which are now classified as either vulnerable or critically endangered by the Australian government.

Conserving the genetic diversity found among all four endangered wild species plays an important role in securing the future of the macadamia industry. Wild macadamias offer a wealth of genetic diversity and many of the commercially grown macadamia cultivars the industry relies on today are from a very narrow genetic base. The DNA of wild macadamias holds significant untapped potential for development of the macadamia industry world-wide. It could hold the key to breeding commercial macadamia cultivars that are not only more productive, but better adapted to changing weather patterns, and emerging pests and diseases.

As the only home of wild macadamia trees, Australia is the guardian of this diversity. The Australian Macadamia Society (AMS) established the Macadamia Conservation Trust (MCT) in 2007 to work with community groups and government to conserve wild macadamia trees. This year, the Trust evolved into an independent environmental charity, Wild Macadamia Conservation, dedicated to supporting and conserving Australian wild macadamia trees and their native habitat.

Community planting includes Macadamia ternifolia in habitat restoration (Image courtesy of Hinterland Bush Links)

The challenging terrain in which M. jansenii grows (Image courtesy of Keith Sarnadsky)

Precious potential for survival of critically endangered M. jansenii (Image courtesy of Keith Sarnadsky)

Australia now has a National Recovery Plan to guide protection of wild macadamias.

The first Recovery Plan for macadamias, adopted in 2012, was commissioned by Horticulture Australia Limited and the AMS in recognition of the value of wild macadamias as genetic reservoirs for macadamia farmers both in Australia and internationally. The AMS is the only industry body in Australia to initiate a recovery plan for conservation of the wild species on which its industry is based.

2023 delivered a significant milestone in the form of a National Recovery Plan made jointly by the Federal and Queensland State Governments to guide the protection of Australia's precious but endangered wild macadamias. Just as we rely on other countries to safeguard genetic resources for most of the food we eat, Australia has an obligation to look after the genetic resources of our native nut. Protecting wild macadamias and their habitat will conserve high value forests including endangered and critically endangered ecological communities.

Wild M. integrifolia at Mount Cotton about to flower (Image courtesy of Liz Gould)

M. integrifolia grows tall in the wild (Image courtesy of Liz Gould)

Wild Macadamia Conservation, an organisation dedicated to protecting Australia's wild macadamias and their habitat, would not have been possible without the support of the AMS. The two organisations will continue to work together to protect the genetic heritage of this remarkable nut.

In 2025 Wild Macadamia Conservation supported on-ground conservation efforts at Mount Cotton in Queensland's Redland Shire, along the Blackall Range on the Sunshine Coast and in Bulburin National Park near Bundaberg. A new version of the Wild Macadamia App was launched, allowing people to see if they live near wild macadamias, and identify which species they should be planting to maintain integrity of the original populations.

The organisation is also investing in research that will inform conservation strategies and expand industry understanding of this species and its requirements. Two new projects supported by Wild Macadamia Conservation focus on identifying and protecting genetic resources. Dr Alice Hayward leads a project to develop techniques for banking genetic resources that cannot be stored using conventional methods, with the Critically Endangered *Macadamia jansenii* one of the test species. Associate Professor Craig Hardner leads another project to develop a rapid, low-cost method for genotyping by sequencing, making it easier to check the genetic identity of individual macadamias and enabling targeted conservation efforts.

A new project funded by the Ian and Janet McConachie Macadamia Conservation Grant will pioneer the use of computer learning to locate additional wild macadamia trees in the Northern Rivers - the region most affected by historical clearing. Wild populations will then be monitored to identify which insects (both pests and beneficials) and pollinators visit the trees in their original habitat.

The Macadamia – Australia's Gift to the World, a book by Ian McConachie AM released in 2024 continues to raise funds for Wild Macadamia Conservation and build awareness of Australia's unique nut.