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RURAL Landholder Initiative

BOOK.
03

Macadamias and other orchards

CONTENTS

This booklet has been produced by Lismore City Council in partnership with Southern Cross University and Richmond River County Council with assistance from the NSW Environmental Trust.

PART A: FARM HEALTH ASSESSMENT TOOL

Introduction to Book 3: Macadamias and other orchards

Book 3: Macadamias and other orchards is the third in a four-book series for the Rural Landholder Initiative. This initiative aims to help rural landholders achieve a number of social, environmental and economic benefits by **conserving and improving biodiversity** on farms and rural lifestyle properties.

Book 1: Healthy Landscapes and Waterways provides information relevant to **all** rural landholders across the Lismore Local Government Area (LGA), while Books 2, 3 and 4 are specific to the main agricultural industries in our region:

Book 2: *Beef grazing and dairying*

Book 3: *Macadamias and other orchards*

Book 4: *Floodplain cropping*

The book is in three parts:

Part A - Farm Health Assessment Tool

Part B - Summary of threats to biodiversity and orchard health

Part C - Management practices you can implement on your property to conserve and improve biodiversity.

Farm Health Assessment Tool

In each book there is a 'Farm Health Assessment Tool' that was developed by Southern Cross University in partnership with Council. The Tool is based on the 'ABCD management framework' first used by the Queensland sugarcane industry. Each book describes 5–10 land management practices that can benefit biodiversity. Each land management practice is scored as either:

A = Aspirational **B** = Best Practice **C** = Common **D** = Dated

The Farm Health Assessment Tool, which starts on page 7, highlights how you as a landholder can progressively adapt your land management practices to conserve and improve biodiversity and 'ecosystem services'. The importance of biodiversity and the current threats to biodiversity in our region are explained in more detail in Book 1: Healthy landscapes and waterways.

Table 1 below introduces the Farm Health Assessment Tool A, B, C and D classes. It includes a general description of practices; and a description of the property and regional scale effects that these practices have on native vegetation, wildlife and ecosystem services.

Table 1: Management classes and definitions for the Farm Health Assessment Tool

Class[1]	Description of practices	On-property effect of practices on biodiversity and ecosystem services	Regional effect on biodiversity and ecosystem services where practices are widely adopted
Aspirational	• New and innovative practices that go beyond best practice • Balance biodiversity and agricultural outcomes • Integrated farm management plans in place	• Self-sustaining, resilient and diverse native vegetation communities requiring minimal maintenance • Ecosystem services are strengthened and become more resilient to change	• Medium- to long-term benefits • Ecosystem services are improved at a landscape scale
Best practice	• Current 'best practice' • Manage for biodiversity with agricultural production benefits • Farm management plans incorporate biodiversity outcomes	• Diverse native vegetation communities requiring minimal intervention • Ecosystem services are enhanced	• Short- to medium-term benefits
Common	• Common practices meet only basic environmental expectations in the community • Farm management plans are focused more on agricultural outcomes	• Existing native vegetation communities are maintained • Unlikely to substantially improve biodiversity and ecosystem services	• Unlikely to achieve short-term benefits
Dated	• Superseded or unacceptable practices that do not meet current environmental expectations and community standards • No farm management plan in place	• Existing native vegetation communities are maintained or degraded • The condition of biodiversity and ecosystem services continues to degrade	• Likely to degrade the condition of biodiversity and ecosystem services

[1] Note: Over time, changes in knowledge, technology, costs and market conditions may result in an 'A' class practice becoming more widespread and accepted as a 'B' class practice.

What are benefits for landholders?

Each management practice in the Farm Health Assessment Tool states what the benefits of implementing A and B practices are to landholders and agriculture. Looking after ecosystem services means reducing costs of property management. For example, providing habitat for insect-eating birds will reduce costs for pesticides and increase numbers of insect pollinators.

What are the benefits for biodiversity?

The Farm Health Assessment Tool aims to improve biodiversity in the Lismore LGA, however, it is relevant across the entire Northern Rivers Region. Each management practice has a corresponding green leaf symbol which indicates the level of benefit that a particular management practice provides to biodiversity (see Table 2). The more symbols the larger the benefit for biodiversity.

Table 2: Biodiversity benefits scoring

Biodiversity benefit score	Benefit to biodiversity
	These management actions are the most beneficial to biodiversity as they improve habitat and native vegetation connectivity across the landscape, and increase resilience to change.
	These management actions have moderate benefit to biodiversity.
	These management actions have a small beneficial impact on biodiversity.

Land management practices for macadamias and other orchards

There are six land management practices that relate to improving and conserving biodiversity across Macadamia and other orchards. These practices can help address the types of threats described in Part B of the book and can increase agricultural productivity at the same time. They are:

Practice 1: *Maintaining groundcover and controlling soil erosion*

Practice 2: *Applying compost and fertiliser for soil health*

Practice 3: *Capturing runoff within the orchard*

Practice 4: *Monitoring and planning surface drains*

Practice 5: *Monitoring populations of pests and beneficial insects to determine spray schedule*

Practice 6: *Minimising the impact of pesticide applications on beneficial insects and wildlife*

You may already be doing some or all of these practices on your property to varying degrees. The Farm Health Assessment Tool will give you an indication of which class your current management practices across the whole property fall into: Aspirational, Best Practice, Common or Dated.

Later in the book we provide you with an outline of the types of techniques you can build into your farm management activities over time to help you transition from one class to a higher class. There are also many more detailed resources and guides available to help you that are included in the Resources section, or you can talk to Council or other agencies (see Contacts list).

How to use the Farm Health Assessment Tool

When using the Tool consider three things:

- your vision and knowledge of your property
- your whole property – although not every management practice in the Tool will apply to all land uses and physical characteristics
- any project sites or individual actions you wish to highlight.

To use the Tool we suggest you do the following:

1. Read the numbered Management Practice in the left hand column and the way the practice can benefit agricultural production. Think about how the practice can improve productivity by improving and conserving biodiversity on your property.
2. Think about how and if these benefits are currently being achieved on your property. Are they relevant to you?
3. Look across the coloured columns and decide which of the property descriptions or types of practices apply to your property. There may be a few in each column that are relevant to your property. Place a tick in all the boxes that are relevant to your property.
4. Some sections may not apply to your property. You can make a note of this in the 'Your self-assessment notes' section of the table.
5. Make notes if there is a particular site to which a practice applies, or any conditions that influence your decision.

If you don't know enough to make a decision, make a note in the 'Your self-assessment notes' section of the table.

Certain terms in the Tool have certain meanings as follows:

Term	Meaning
Cultural control methods	Management practices to control pests or weeds that reduce pest establishment, reproduction, dispersal, and survival e.g. pruning branches to allow sunlight onto the orchard floor and sweeping up and mulching fallen fruit or nuts.
Species diversity	Diversity between different species and the diversity of ecosystems
Low groundcover species diversity	Only 1 or 2 groundcover species under the orchard
Moderate groundcover species diversity	A mix of 3 to 5 groundcover species under the orchard
High groundcover species diversity	6 or more groundcover species under the orchard
Soil chemical tests	Chemical tests to determine nutrient levels for P, K, Ca, Mg etc.

Farm health assessment tool: ABCD for Macadamias and other orchards

Land management practice	Dated	Common	Best	Aspirational
1/ Maintaining groundcover and controlling soil erosion **Production benefits of A&B practices:** • Reduces runoff containing sediments, nutrients and chemicals entering waterways • Provides habitat for beneficial insects • Retains soil and nutrients • Can be nitrogen fixing	☐ Orchard has very little groundcover (<60%) with bare soil and surface roots exposed under trees and very low groundcover diversity ☐ No mulch or tree residues (e.g. leaves, husks etc.) used under the tree canopy ☐ Hill slopes have visible erosion and erosion is left untreated	☐ Orchard has moderate groundcover and mulch (60–80%) year round with some surface roots exposed and moderate groundcover diversity ☐ Hill slopes have visible erosion and some attempt at remediation occurs (e.g. maintaining groundcover to prevent problem from worsening)	☐ Orchard has high groundcover and mulch (80–90%) all year round, little to no root exposure and high groundcover diversity ☐ Degraded areas have groundcover maintained and are revegetated using native tree species	☐ Orchard has exceptionally high groundcover and mulch (>90%) all year round, no root exposure and very high groundcover diversity ☐ Active canopy management to allow sufficient light onto the orchard floor ☐ Degraded areas as well as all vulnerable slopes are revegetated using diverse native tree species to actively prevent erosion
Your self-assessment notes				

Farm health assessment tool: ABCD for Macadamias and other orchards

Land management practice	Dated	Common	Best	Aspirational
2/ Applying compost and fertiliser for soil health **Production benefits of A&B practices:** • Improves crop productivity • Retains groundcover year round	☐ No soil, leaf or microbe testing is undertaken, and a set rate of fertiliser is used for entire property based on historical application rates ☐ Soil Health Card not implemented	☐ Soil, leaf or microbe tests seldom carried out (every 5–8 years), and fertiliser rates are determined using old results or historical application rates for entire property ☐ Synthetic fertilisers regularly applied with occasional use of chicken litter or compost ☐ Soil Health Card implemented occasionally and actions for improvement are rarely implemented	☐ Soil, leaf or microbe tests carried out on a regular basis (every 2–3 years) for individual blocks, and fertiliser rates for individual blocks are calculated using recent test results ☐ Chicken litter and compost used as the main fertiliser and soil improvers with occasional use of synthetic fertilisers ☐ Soil Health Card implemented yearly and actions for improvement are implemented	☐ Comprehensive soil, leaf or microbe tests are carried out yearly for individual blocks, and organic fertiliser rates are calculated using recent soil test results ☐ Chicken litter and compost applied regularly with no application of synthetic fertilisers ☐ Soil Health Card implemented yearly for individual blocks and actions for improvement are implemented
Your self-assessment notes				

Land management practice	Dated	Common	Best	Aspirational
3/ Capturing runoff within the orchard **Production benefits of A&B practices:** • Improves water quality by filtering runoff • Slows down runoff and therefore reduces soil erosion before water enters waterways • Improves water infiltration	☐ There are no surface drains or banks in the orchard ☐ Water runoff capture devices are not installed	☐ Surface drains and banks in orchards are not designed to handle large rainfall events (i.e. 1 in 20 year event) ☐ Surface drains and banks have established groundcover for the majority of time ☐ Limited number of drains discharge into runoff capture devices (e.g. dams, constructed wetlands, sediment traps, grassed filter strips)	☐ Surface drains in orchards include grassed swales in inter-rows and cross-slope banks that are designed to handle large rainfall events (i.e. 1 in 20 year event) and encourage water infiltration ☐ Surface drains have well established groundcover ☐ All drains feed into a runoff capture device or constructed wetland before water enters waterway ☐ Quality of runoff is monitored during significant rainfall events	☐ Extensive interconnecting network of grassed swale drains throughout orchard designed to handle extreme rainfall events (1 in 50 year event) and encourage water infiltration ☐ Surface drains have well established groundcover at all times and include native shrub or grass species to encourage beneficial insects and birds ☐ All drains discharge into a series of runoff capture devices or constructed wetlands before water enters waterways ☐ Quality of runoff is monitored during significant rainfall events and appropriate actions carried out as required
Your self-assessment notes				

Farm health assessment tool: ABCD for Macadamias and other orchards

Land management practice	Dated	Common	Best	Aspirational
4/ Monitoring and planning surface drains **Production benefits of A&B practices:** • Improves water quality • Improves soil water retention	☐ Established or new orchards are not redesigned to accommodate grassed swales and no water capture devices installed ☐ Opportunistic inspection of drains ☐ No remedial works implemented if erosion occurs within drains	☐ Established or new orchards are not retrofitted or designed to accommodate surface drains and water capture devices ☐ Semi-regular inspection of drains and water capture devices ☐ Reactive erosion remediation works undertaken when needed	☐ Established and new orchards are retrofitted or designed with surface drains and water capture devices for the majority of blocks ☐ Regular monitoring of drains, water capture devices and remediation works ☐ Proactive works undertaken to prevent erosion in drains	☐ Erosion and drainage management plans for established and new orchards are developed and followed with water capture devices for all blocks ☐ Regular monitoring of drains, water capture devices and remediation works ☐ Proactive works undertaken to prevent erosion and stabilise vulnerable areas in the long term
Your self-assessment notes				

Land management practice	Dated	Common	Best	Aspirational
5/ Monitoring populations of pests and beneficial insects to determine spray schedule **Production benefits of A&B practices:** • Reduces pest burden and impacts • Reduces cost of chemicals and labour	☐ No to very little knowledge of local pest and beneficial insect species ☐ No counting or recording of pest and beneficial insects in a sample area of orchard	☐ Little knowledge of local pests and beneficial insects ☐ Ad hoc counting of pests and beneficial insects in a sample area of orchard block ☐ Basic and inconsistent records of monitoring activities ☐ Records occasionally used to determine level of pest control needed	☐ Good knowledge of local pest and beneficial insects and their life cycles ☐ Regular counting of pests and beneficial insects in a number of sample areas across several orchard blocks by grower or pest scout ☐ Consistent well timed counting in line with pest and beneficial insect life cycles applied and records of monitoring activities kept ☐ Monitoring records used to determine the type and level of pest control needed	☐ Exceptional knowledge of local pest and beneficial insect life cycles and timely release of biological controls (e.g. wasps for nutborer) ☐ Systematic counting of pests and beneficial insects in a number of sample areas across several blocks (particularly hot spots) and coordinated with neighbouring growers ☐ Consistent counting techniques applied and detailed records of monitoring activities kept ☐ Monitoring records directly inform the implementation of a long-term pest management regime
Your self-assessment notes				

Farm health assessment tool: ABCD for Macadamias and other orchards

Land management practice	Dated	Common	Best	Aspirational
6/ Minimising the impact of pesticide applications on beneficial insects and wildlife **Production benefits of A&B practices:** • Reduces impact of spraying on beneficial insects and pollinating species • Reduces cost of chemicals and labour	☐ Pesticides are applied irrespective of level of pest damage and using application rates that are the same across the whole orchard ☐ Spraying broad-spectrum pesticides with little consideration of impact on beneficial insects	☐ Pesticides are applied when pest damage causes crop loss and using a variable strategy between orchard blocks ☐ Substituting broad-spectrum with selective or alterative environmentally lower risk pesticides	☐ Avoiding the use of pesticides and opting for a long-term strategy to reduce pests using beneficial species (e.g. insects, birds and bats) ☐ Applying pesticides only when pest damage causes economic loss ☐ Biological control agents trialled in combination with selective pesticides as part of an integrated pest management program	☐ Integrated pest management program in place including the creation of habitat for beneficial bird and insect species (e.g. barn owl nest boxes and perch trees for rodent control) ☐ Applying organic pesticides (e.g. lime sulphur) only when pest damage causes economic loss and using variable application strategies between tree rows ☐ Established biological controls for specific pests
Your self-assessment notes				

PART B: THREATS TO BIODIVERSITY AND ORCHARD HEALTH

Impacts of Macadamia and other orchards on biodiversity and catchment health

The Macadamia industry was founded around 1880 at Rous Mill, near Lismore, using seed from local wild stock. Today it is a major agricultural industry in the region. The Northern Rivers has Australia's largest production area with nearly 500 growers and an estimated 50% of national production. Other orchard crops grown in Lismore include bananas, pecans, avocados, custard apples, blueberries and citrus. Combined, fruit and nut orchards occupy a large portion of the rural landscape across the Lismore Local Government Area.

*Book 1: Healthy landscapes and waterway*s outlines the common threats to biodiversity and catchment health associated with all agricultural industries across the Lismore LGA. To recap, these threats include:

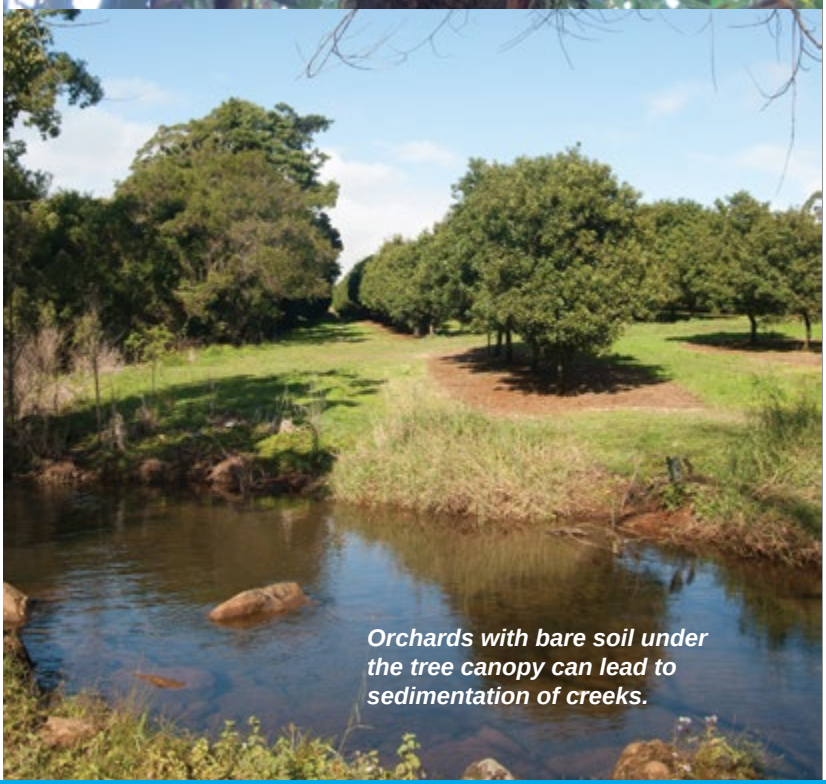
- very high levels of nutrients washed into waterways from adjacent lands
- soil erosion from cultivated and grazed land
- native vegetation being smothered by exotic vines
- Coral trees, Camphor, Lantana and Privet inhibiting native vegetation
- grassed or bare river and creek banks
- low dissolved oxygen
- bank erosion.

Orchard management practices can degrade native vegetation, soil and water so that productive land and ecosystem services are diminished. Windbreaks, patches of native vegetation and riparian buffers provide habitat for diverse native wildlife, beneficial insect pollinators and pest predators such as owls. Native vegetation also filters and treats runoff from orchards, provides a barrier for dust and spray drift, reduces soil loss, increases moisture retention and reduces weed invasion by minimising open space. All of these benefits improve production and environmental standards while improving the scenic and other values of your property.

Unnecessary or excessive clearing of windbreaks, which form habitat corridors across agricultural land, can isolate wildlife such as Koalas and put them at greater risk of stress, disease, road fatality and dog attacks. The Australian Macadamia Society produced a factsheet in collaboration with Council, Friends of the Koala Inc. and the Northern Rivers Catchment Management Authority (now North Coast Local Land Services) to assist farmers in their decision-making around clearing (see Resources section).

Orchards with bare soil under the tree canopy can lead to soil loss and sedimentation. Runoff, soil erosion and pesticide use can impact waterways and damage ecosystems. Most orchards are located on the fertile clay soils of the midland hills of Lismore (see Figure 2: Landscapes of Lismore, Book 1 p. 19) which are highly susceptible to erosion.

A koala using a macadamia tree during the heat of the day. Photo by Friends of the Koala Inc.



Orchards with bare soil under the tree canopy can lead to sedimentation of creeks.

Soil lost from under the orchard canopy may be deposited in downslope areas, including the drainage lines that feed into creeks. Fine clay particles in soil that enters waterways as a result of erosion may remain in suspension indefinitely, leading to a muddy appearance in waterways and favouring pest species including Carp. Soil nutrients (e.g. phosphorus and nitrogen) bind to clay particles and impact on aquatic biodiversity by favouring weeds and algae.

Soil and orchard health

At the property level, poorly managed orchards will mean lower crop quality and yield. The Australian Macadamia Society estimates that poor drainage, exposed roots and dark unproductive orchards cost growers $1000 in lost production per hectare each year (approximately 300kg of Nut In Shell/hectare). Keeping the soil bare under trees in orchards results in:

- loss of topsoil and the humus layer (organic component of soil), resulting in exposed feeder roots and poor soil health
- increased damage to trees by harvesters and other machinery
- poor tree health as a result of exposed roots and low organic matter
- increased water runoff and reduced infiltration, potentially stressing trees in dry times
- greater susceptibility to pests and diseases such as phytophthora, increasing reliance on pesticides and compounding poor soil health.

PART C: MANAGEMENT PRACTICES FOR MACADAMIAS AND OTHER ORCHARDS

If the majority of your land management practices fall in the Dated or Common classes, there are ways you can improve management practices over time to transition into the Best practice or Aspirational classes. The types of techniques that can help you improve practices are outlined in this section of the book. More detailed resources are listed in the Resources section and are available from Council or other agencies. Many of them are available online as a downloadable document.

The following six land management practices from the Farm Health Assessment Tool are relevant across Macadamia and other orchard land uses. Note that you also need Book 1 for all the general land management practices.

1. Maintaining groundcover and controlling soil erosion

Good soil management is essential for sustainable production in orchards because soil loss leads to stress, lower yields and higher susceptibility to pest damage and disease. Ultimately, this will mean additional costs and less profitable production.

Three principles apply to reducing soil erosion: provide maximum soil surface protection, minimise bare soil areas and control runoff. Soil loss not only removes the living basis of all orchards, it takes away the mineral components essential to tree health.

Having cover crops or groundcovers including nitrogen fixing species, or mulch between rows and underneath trees will help maximise soil surface protection thereby reducing erosion. Additional benefits include:

- increase organic matter in soil
- suppress weeds
- increase water infiltration
- reduce the loss of applied fertiliser
- can be nitrogen fixing (e.g. pinto peanut)
- provide habitat for beneficial insects.

There is a direct correlation between levels of groundcover and the level of erosion, with the likelihood of erosion increasing dramatically as groundcover falls below 50%. Ideally you should aim for an orchard with very high levels of groundcover and mulch (>90%) all year round, with no root exposure and diverse groundcover species. Some practices that help achieve very high levels of groundcover include:

- mowing rather than spraying herbicide in the root zone of trees
- active canopy management to allow sufficient light onto the orchard floor
- using organic matter (e.g. mulch or compost) under trees
- planting shade-tolerant grasses and other groundcovers
- covering exposed roots using soil profiling equipment or a grader in extreme cases.

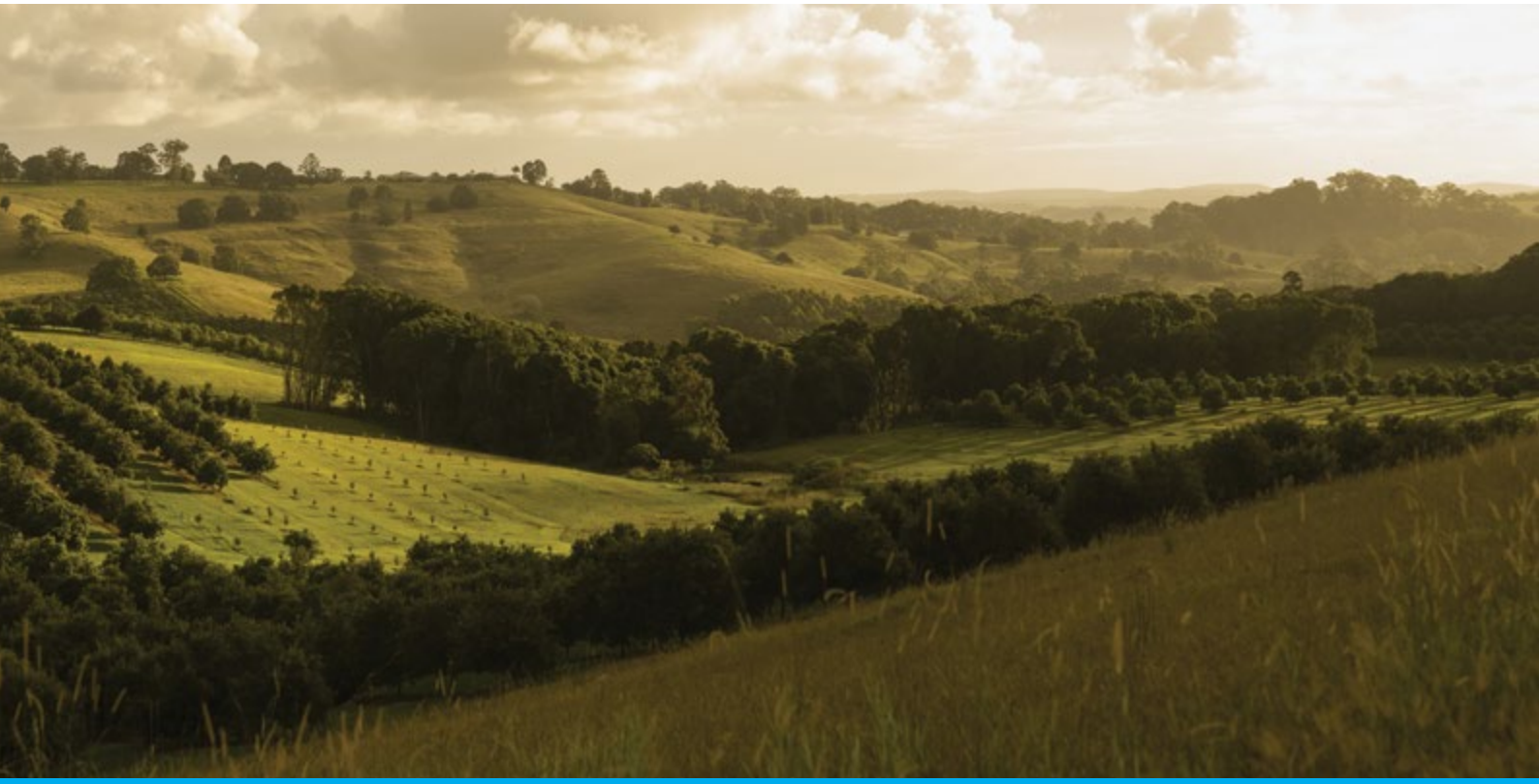
Outside of the orchard zone, monitoring other land uses such as grazing is recommended, as cattle can initiate erosion through pads and overgrazing pasture. Revegetate or mulch bare areas created by harvesting, vehicle traffic or other reasons. Degraded areas, as well as all vulnerable slopes, are best revegetated using diverse native tree, shrub and groundcover species to actively prevent erosion.

2. Applying compost and fertiliser for soil health

The main purpose of adding composts and fertilisers to an orchard is to maximise yields and provide higher returns. Ideally this is done without compromising the health of the trees or the broader environment.

A basic soil audit and leaf analysis will provide important information about fertility and nutrient levels and inform your crop replacement strategy. This will ensure you are giving the crop what it needs for production and not spending money unnecessarily, while minimising any environmental impacts from over use of fertiliser or other applications. The addition of trace elements and minerals for soil physical and biological fertility is also a major part of an organic nutrition program.

A crop replacement strategy bases nutrient application rates on the amount of nutrient removed by the crop and an allowance for expected losses through processes such as leaching and soil fixation. The aim is to minimise the nutrient losses and deliver what the whole orchard needs.



The *Northern Rivers Soil Health Card* aims to help Macadamia farmers assess the biological and physical properties of their soils. It goes beyond standard tests for nutrients (e.g. P, K, Na etc.) by recognising that soil health is created by microorganisms and the soil's physical properties.

Compost is a good soil conditioner and increases soil carbon. It can improve nutrition provided to the trees if it is made from suitable materials. Not all composts are equal, so if compost is used as part of a crop nutrition program then the nutrient content of the material should be measured and amended as necessary to provide optimal nutrition over time.

Good quality compost incorporated into the soil or used as mulch on the surface will provide a number of benefits:

- increase soil microbe activity and nutrient-holding capacity
- assist in weed suppression
- reduce disease
- protect against erosion
- reduce soil temperature variations
- improve soil water-holding capacity and plant available water by increasing infiltration.

If you would prefer to purchase rather than make your own compost, Northern Rivers Waste (Lismore City Council's Commercial Waste service section) sells bulk compost made from domestic green waste. Product for sale includes certified organic screened 10mm compost (BFA Registered Product 11538AI). For more information and prices visit www.northernriverswaste.com.au or phone 1300 87 83 87.

3. Capturing runoff within the orchard

Runoff management and erosion control becomes increasingly important on steeper land, however, even on relatively flat country traditional methods of growing trees can cause erosion problems. Water runs down the tree trunk and along the tree row, removing soil and exposing tree roots. As soil is removed, the tree row acts more and more as a drainage channel, increasing the rate of erosion.

A well-executed drainage management plan will help deliver more effective water capture for irrigation and other purposes and is based on two main principles, slowing down the runoff and directing it along desired pathways. By slowing down runoff water is able to infiltrate the soil more effectively and minimise sediment movement with less silt entering dams and waterways, benefitting irrigation water quality.

Contour or diversion banks are unsuitable in high rainfall areas because they can be breached by heavy rain. They can also pond water, which is not desirable and can make routine mechanical harvesting across the slope difficult and dangerous.

The runoff control system that is easiest to build, and works most efficiently, is to run mounded tree rows and associated drains directly downhill. It is essential that good groundcover is maintained in the inter-rows and drains as this will act to slow the water and prevent soil erosion. Runoff capture devices or constructed wetlands can be installed before water runoff from the orchard enters waterways.

Constructing wetlands requires engineering advice and highly skilled earth moving, however, if you have a mid-slope dam or low-lying wet area that is already acting to capture runoff water, there may be potential to modify it to be a functional wetland. Native wetland plant species can be introduced to assist nutrient uptake and improve habitat (refer to aquatic plants list in Book 1 p. 27).

4. Monitoring and planning surface drains

In combination with other activities, monitoring and managing drains will assist in overall farm productivity and sustainability by managing water through the orchard, minimising soil erosion and enabling access and safe operation of machinery.

As production in older orchards declines, some owners are selectively removing some trees, for example removing every second row of trees for better light, drain management and groundcover, or replanting the entire orchard. This presents an opportunity to plan and modify existing drainage and to rectify soil erosion and profiling problems. Earth moving equipment such as a grader may be required where root exposure is prevalent while profiling equipment can be used where erosion is less severe. The NSW DPI *Macadamia: Integrated orchard management guide 2015* provides detail on canopy, orchard floor and drainage management (see Resources).

Ideally, a plan should detail an extensive interconnecting network of grassed swale drains throughout the orchard designed to handle extreme rainfall events and encourage water infiltration, provide runoff capture devices and consider the endpoint health of creeks and rivers.

In summary, the practices that lead to better runoff control include:

- mounded tree rows
- interconnected surface drains with full and diverse groundcover
- runoff capture devices (e.g. constructed wetlands)
- working on drainage in September–October after harvest, when kikuyu or other preferred species are about to resume growth, and the risk of heavy, erosive rainfall is lower
- monitoring water quality in drains during significant rainfall events.

5. Monitoring populations of pests and beneficial insects to determine spray schedule

In the Macadamia industry, the economic impact of just one pest (Fruit-spotting Bug) is estimated at $8.9 million per annum. While the cost to individual farmers varies greatly, understanding and monitoring both pest and beneficial insects (and other types of animals) across your farm will help save money through reducing the need for chemicals.

Green Lacewing (photo Richard Llewellyn)

In all orchard types, knowledge about local pests and beneficial insects and their life cycles will help you implement preventative measures. For example, lacewings are aggressive general predators that feed on a range of pest insects and mites. Larvae of the Green Lacewing are wide-ranging predators that will attack and eat almost any small insect or egg, including aphids, moth eggs and small larvae, scales and whiteflies. Having a permanent 'bank' of native flowering plants around the orchard will help to maintain populations throughout the year and provide habitat for lacewing hibernation during colder months.

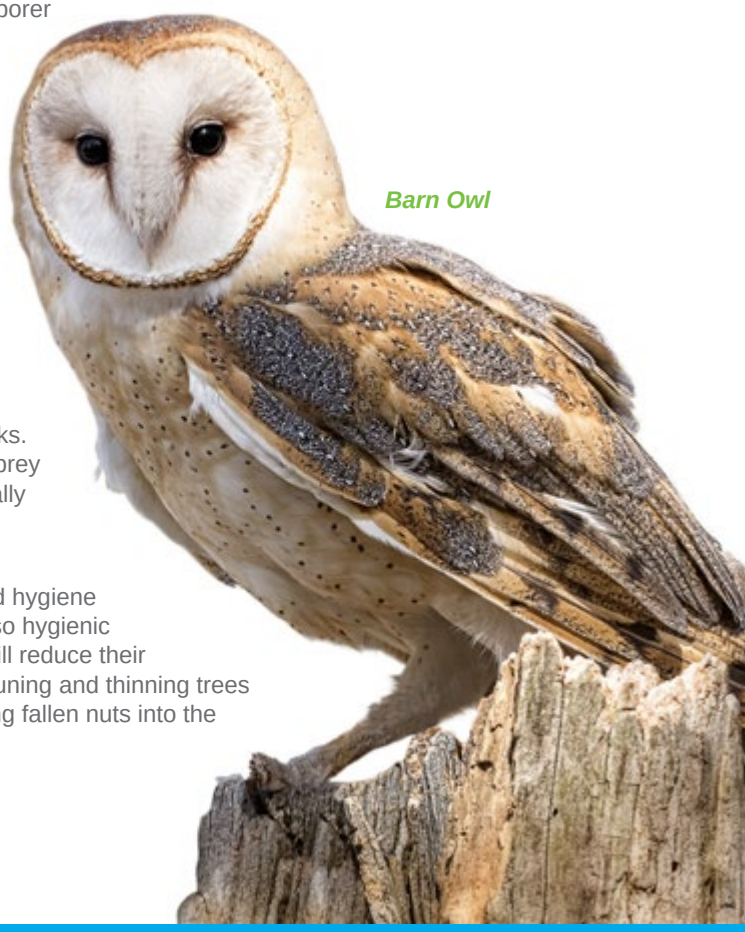
Monitoring procedures for a range of pests are described in the *Macadamia Grower's Handbook and Macadamia Problem Solver & Bug Identifier*, both published by Queensland Department of Primary Industries.

The best defence against pests and diseases, including phytophthora (root rot fungus), is to implement sound biosecurity practices on your farm. Quick and simple measures designed to protect your property from the entry and spread of pests, diseases and weeds can be built into everyday practice and will help protect your orchard and your production. A farm biosecurity plan provides explicit guidance to everyone involved in the farm how to avoid pest incursions and how to respond if a biosecurity breach occurs. For more assistance with developing a biosecurity plan tailored to your farm and risk factors, visit the farm biosecurity website (see Contacts section).

6. Minimising the impact of pesticide applications on beneficial insects and wildlife

For organic growers, it is important to follow the integrated pest and disease management approach. This system relies on effective monitoring, a good understanding of the biology of pests and diseases and their controls.

The Australian Macadamia Society actively encourages growers to implement biological controls and consider organic and alternative solutions in the management of their orchards, including the use of integrated pest management to control pests and reduce the use of pesticides. An example is the introduction of the 'MacTrix' wasp, now widely used by growers, which has helped contain losses to nutborer and led to a dramatic reduction in the use of chemical sprays. The wasps lay their eggs in the egg of the nutborer where they develop into fully formed wasps. Two or three wasps emerge about 10 days later from each egg. They are a very effective parasite able to hunt through dense foliage and into the tops of trees.



Barn Owl

Macadamia growers are increasingly encouraging native barn owls by providing nest boxes and perch trees so they can prey on rodents and reduce crop losses. Rats are one of the few pests that are able to chew through the Macadamia nut's tough outer shell and are a significant problem in Macadamia orchards. WetlandCare Australia, in partnership with the Australian Macadamia Society and Southern Cross University, has commenced a field trial on the effect owls may have on reducing Macadamia nut crop losses from rats. A single barn owl can catch 6–10 rats a night when feeding young chicks. Owls need perches with a clear vantage point for them to sight their prey and Macadamia trees are too dense for them to do this, so strategically planting suitable native perch trees within or around orchards and installing temporary perches is required.

For some pests there are no specific registered chemicals so orchard hygiene is critical. The Sigastus Weevil develops on fallen Macadamia nuts, so hygienic practices such as destroying fallen nuts during the harvest season will reduce their numbers. Sunlight will kill the larvae, so cultural practices such as pruning and thinning trees so that sunlight reaches the orchard floor, and sweeping and mulching fallen nuts into the centre of the row can help.

RESOURCES

Industry guidelines:

- Australian Macadamia Society Fact Sheets www.australian-macadamias.org/industry/site/industry/industry-page/for-growers/faqs-fact-sheets/faqs-and-fact-sheets?lang=en
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CONTACTS

Department of Environment and Heritage, at: www.environment.nsw.gov.au/

Office of Water, Department of Primary Industries: Phone 02 6676 7380; Fax 02 6676 7388; Street address 135 Main Street Murwillumbah www.water.nsw.gov.au/about-us/contact-us

North Coast Local Land Services, at http://northcoast.lls.nsw.gov.au/ Phone 02 6623 3900; Street address 79 Conway Street Lismore

SoilCare Inc. http://www.soilcare.org/ PO Box 525, Alstonville, NSW 2477

Richmond Landcare Inc., at www.richmondlandcare.org Phone 02 6619 0115

Lismore City Council Resource Recycling Centre compost sales www.northernriverswaste.com.au

Farm Biosecurity at www.farmbiosecurity.com.au/

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