

Organic macadamia growing

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Consumers and producers of organic products understand 'organic agriculture' to be the production of food and fibre without the use of synthetic chemicals. However, there is more to organic farming than just doing away with artificial inputs. Organic farmers aim to achieve a totally integrated production system where increased biodiversity and a balanced soil ecosystem encourage plant and animal health. This has beneficial environmental and catchment management outcomes.

Organic farming aims to minimise inputs, to create an agricultural system that is as near as possible to a self-perpetuating or closed system of production. However, some nutrients are removed when the crop is harvested, so some inputs (in the form of composted animal manures, composts and green manure crops) are added to replace these nutrients. Other natural substances, such as lime and other mineral-bearing rock dusts, may also be added, to stimulate biological activity in the soil.

Organic farmers aim to feed the soil – not the plant – to create a soil that is balanced in nutrients, and has good structure, high biological activity and high levels of organic matter. Organic growers understand that a plant grown under these conditions is healthier, and therefore may be less susceptible to attack by pests and diseases. The benefits and limiting factors of organic production can be found in the NSW DPI publication *Organic farming: huge potential for producers*.

What sort of a farm do I need?

As with conventional macadamia growing, organic production requires a farm that has suitable soil, aspect, slope, and climate. In addition to these factors there are also farm requirements that are specific to growing macadamias organically. For information regarding the sort of farm you need, refer to Primefact 5 *Macadamia culture in NSW*. The information given here is specific to organic production.

For organic macadamia growing, it is beneficial to have a farm that will allow mowing to be undertaken down and across the rows, especially when trees are young. This is due to strong and vigorous grass growth, which requires mowing in both directions for control. Out-front mowers (especially zero-turn types) are capable of mowing up to the tree and, in conjunction with mulch, allow for good young tree development.

Herbicide use is a major cause of soil erosion in conventional orchards, especially when trees are young. Organic growers refuse to allow this to happen, and therefore use these methods.

Growing macadamias organically involves the use of specialised machinery, such as belt spreaders for compost application. If not purchased by a farm, this machinery is available through contractors. The orchard needs to be designed to accommodate this specialised machinery (such as manoeuvrable mowers, shown below).



Which cultivars should I plant?

When looking at growing macadamias organically, you should plant those cultivars that are less susceptible to insect and disease attack. For example, it has been found that husk hardness affects damage levels from macadamia nutborer.



You also need to consider cultivars that have low stick-tight incidence. In research work conducted on husk spot disease, it was found that the largest source of inoculum for re-infection from season to season was on old husk left hanging in trees. By having cultivars that drop cleanly, you are able to remove this material from the orchard and reduce the chances of infection for the coming season.

Cultivars with thinner shells have been found to suffer higher levels of insect damage than those with thicker shells. There are other tree factors (such as flowering time) that influence the level of insect damage that occurs in macadamias. The complete interaction between varieties and insects is not well understood.

The use of trap crops is also an option when growing macadamias organically. This means you grow a sacrificial or monitoring crop of plants that are more susceptible to insects, and which lures the pests away from the macadamia crop. This approach is being practised in many other crops, but there is no published research work on the use of this technique with macadamias.

Should I go organic if I am planting new trees or should I wait?

Controlling grass growth is a major issue for both organic and conventional macadamia growers when establishing an orchard. If you do not control the grass, and allow it grow around young trees, the growth of the trees will suffer. An orchard established as organic, would need to be set up to allow mowing in both directions. Out-front mowers (especially zero-turn types) are capable of mowing up to the tree and, in conjunction with mulch, allow good young tree growth. Mulching, especially with side discharge mowers, is an easily achievable way of managing young trees.

If possible, it is best to establish smaller blocks of trees sequentially across the farm, as this aids in ensuring satisfactory management of young trees and reduces the labour demands for the farm.

Another option is to plant your trees and manage them for the first couple of years as a conventional crop, using herbicides to control grass growth. This option allows you to control the grass easily and quickly while minimising costs during the development period, when you have little income. The process of organic certification is started at approximately year 6, when nuts are just starting to be produced. This means that as you go through the three-year transition phase to 'certified organic', you have a canopy that shades some of the orchard floor, reducing grass growth down tree rows. Mowing is then used to maintain the orchard floor.

What level of losses can I expect?

As with conventional production systems, the main variability in macadamia production is due to climatic conditions, which can create very large fluctuations in yield. The overall loss from any farm depends on a range of variables, such as orchard age, site, management practices and varieties.

The main variation in losses between organic and conventional production systems is due to pest and disease problems. Both organic and conventional orchards can suffer large losses if pest and disease damage occurs. Conventional orchards have a larger number of control options available than organic orchards; organic orchards need to use preventative techniques, or rely on a relatively limited range of control options. As a result, organic macadamia growers see the need to maintain a price premium of at least 20% as important to continued profitability, should pest or disease damage occur. A survey of organic growers found that they estimated their yield reduction to be 10–50% relative to expected yields from comparable conventional orchards, due to pest and/or disease damage.

Consumers of organic produce support the avoidance of chemical use by paying a premium for growers' environmental management and the guarantee of chemical residue free food.

Pest and disease management

Organic farmers rely on natural methods of pest and disease control. A high level of understanding of the life cycles and interactions of crops, livestock, weeds, pests and diseases is needed. Problems that may arise need to be pre-empted (rather than reacted to). This requires a high level of management, achieved through a variety of techniques, including:

- the use of a comprehensive orchard monitoring program. You must be familiar with all the possible key pests and diseases, their life cycles and the optimum times in each life cycle to practice preventative management
- creating an environment that encourages beneficial species to keep pest populations in check. There are a range of beneficial insects commercially available, such as trichogramma wasps. These are released into an orchard prior to the pest species' emergence, building up beneficial populations. See 'further reading' for information on the beneficial insects available for use in macadamias
- selecting crop varieties that discourage or are resistant to pests and diseases
- using management tools such as crop rotations and companion planting to inhibit or repel pests and diseases.

Some naturally occurring chemicals are permitted for use in organic farming systems when a demonstrated requirement is shown, but their use is restricted and discouraged.

It is important to follow the integrated pest and disease management (IPDM) approach. This system relies upon effective monitoring, a good understanding of the biology of the pests and diseases and their controls (whether cultural, the use of beneficials or chemical), and the use of alternative hosts.

Most organic macadamia growers have chosen a 'live with the damage' approach to pests and diseases, as long as they can maintain a premium price for organic product. The majority of organic growers choose to farm this way because it is environmentally sound and provides consumers with quality food, not because of a perceived price premium; however, this does not mean they have to accept reduced yields. Continual experimentation with new methods of pest control, building soil health and variety trials should be encouraged as solutions can be found. It is also common for organic macadamia farms to have a mixed farming operation, to minimise risk. Monoculture macadamia growers have limited risk management for global price depression.

The two major pests found in macadamias are fruit spotting bug and macadamia nutborer. Rats are also a major pest problem. The major diseases are husk spot, trunk canker and blossom blight. There is excellent information on these diseases in '*Macadamia grower's handbook*' and *Macadamia problem solver and bug identifier* (see further reading).

Macadamia nutborer (*cryptophlebia ombrodelta*) larvae penetrate to the forming kernel of young nuts and develop in the husk after shell hardening, causing premature nut drop and immature kernel. A biological control agent, trichogramma wasp (*trichogrammatoidea cryptophlebia*), is commercially available. These tiny wasps lay their eggs inside macadamia nutborer eggs, destroying the eggs' viability. They need to be re-introduced into the orchard each season and when pest numbers increase; monitoring of egg numbers and pheromone trapping are used to determine levels present.

Fruit spotting bug (*Amblypelta nitida*, *A. lutescens*) feeds by puncturing nuts. Small nuts will shed if damaged, but older nuts do not drop, meaning damage may not be detected until processing. A small number of insects can cause considerable damage. This pest can cause damage levels estimated to be up to 30%. There is currently no biological control agent available for this pest, and the use of trap crops is currently being investigated. Research work has indicated that

varieties with thinner shells are more susceptible to damage than thicker shelled varieties. There are other factors that can impact upon the damage levels observed, such as the availability of alternative hosts and carry over crop (predominately due to out-of-season flowering). Monitoring in macadamias shows that if hot spots can be identified, minimal spraying is possible. The level of loss resulting from this approach on organic farms can be similar to conventional.

A less common but devastating pest is lace bugs (*Ulonemia* sp.). These insects suck sap from flower buds, causing them to desiccate and wither. Most damage occurs on the basal parts of the bud. These insects have been found to attack the same trees each season. They are a relatively minor pest of macadamias, but in the orchards (or sections of orchards) in which they are found, they can cause significant damage. If untreated, these insects can cause total loss of production from infected trees.

Husk spot (*psuedocercospora macadamiae*) is a fungal disease that causes infected nuts to drop prematurely, leading to immature kernel. Research work has found that husk remaining in trees from one season to the next is the greatest source of inoculum. Cultivars that have sticktights are prone to high levels of infection; these should be avoided, to minimise husk spot infection. By selecting cultivars with high levels of sticktights, and with the right environmental conditions, damage levels will be significant.

If husk is being returned to the orchard, it should be properly composted prior to application, to destroy husk spot spores. This is often combined with



Pheromone traps can be used to monitor male macadamia nutborer populations.

animal manures for effective hot composting. Information on composting can be found in Agnote DPI-448 *How to compost on farm*.

Trunk canker is caused by the fungus *Phytophthora cinnamomi*, and can severely damage or kill trees in the nursery as well as weaken and kill trees in the orchard. The fungus usually enters through bark damaged by orchard equipment. For organic production, the best control is to ensure you plant trees that are free of this disease, avoid planting in soils subject to periodic waterlogging or in windy areas, and avoid damaging trunks. Spray drift from herbicides causes bark cracks that predispose the trees to infection. Improving soil health by adding compost or other organic rich material minimises the ability of phytophthora to infect macadamias.

Blossom blight is caused by the fungus *Botrytis cinerea*. It can cause economic damage to flowers during prolonged periods of wet conditions. In general, a high proportion of bud and flower damage can be tolerated without causing yield loss, and so it is not a common problem each season. As this disease is dependent upon weather conditions, there are few preventative measures that can be taken by either organic or conventional growers. The best measures are to avoid overcrowding by careful planning of orchard density, and pruning to improve airflow throughout the orchard.

How do I control rats?

Rats are one of the largest pest problems in macadamia orchards. The main rodent causing losses is the black rat, *Rattus rattus*. Once this pest is established in an orchard, control can be difficult and costly. The best method of control found in research work is to maintain short-grassed headlands and habitat manipulation. It was found that removing rat-friendly habitat (such as lantana) and replacing it with well maintained grasslands or tree canopy, reduced damage levels substantially. Other practices required for organic control are to follow good agricultural practices, such as keeping headlands mowed, and picking up nuts regularly so there is not a source of food for rats. Removing any rat nests that develop in the orchard is also essential.

The development of habitat and structures that encourage animals that prey on rats are also useful options. Erecting owl perches throughout your orchard, as well as developing habitat locations for snakes and other predators is also useful.

Further information on rat control can be found in the final report *A management strategy for the control of rodents in macadamia orchards* (see 'further reading').

How do I formulate a fertiliser program?

It is important to test the soil at your chosen site for pesticide and heavy metal contamination. Excessive levels of either will exclude your product from being certified and sold as 'organic'. This is also critical when converting established orchards, particularly where copper sprays have been used. A soil test will also provide important information about fertility and nutrient levels.

It is best to base any fertiliser program on soil and leaf analysis, combining the results with a crop replacement strategy. This will ensure you are delivering what is required for crop production, and minimise any environmental impacts. The addition of minerals for soil physical and biological fertility as well as crop requirements is also a major part of an organic nutrition program. This ensures the best use of applied materials.

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 losses and deliver what the whole orchard requires.



Compost is good for improving soil health and providing nutrients. Shown are the compost heap (above) and the beneficial hyphae (below) growing in it.



The main form of organic fertiliser used in macadamia growing is broiler litter. This is the major source of nitrogen for trees. It must be composted before use in an organic orchard. Composting will reduce the levels of food pathogens to acceptable levels and destroy antibiotic residues. If using organic manures, it is important to follow the recommendations of COSOP (*Code of Sound Orchard Practices*), which includes precautions to be taken when using manures. Information on how to compost can be found in Agnote DPI-448 *How to compost on farm* (see 'further reading').

Broiler litter also provides potassium and phosphorus for tree and nut growth. Due to the high phosphorus fixing capacity of the red Ferrosol soils (krasnozems), the level of phosphorus provided by chicken litter may need to be supplemented to provide adequate phosphorus. Soil and leaf analysis should be used to determine if this is necessary, as the form of phosphorus applied will also affect its fixation rate. Soft rock phosphate is a slow-release source of phosphorus that is commonly used. Due to its slow release nature, you need to start adding it to your soil early in the life of the orchard. This will allow it to become available when the orchard reaches production.

Table 1 shows the elemental analysis of a synthetic fertiliser compared with that of some organic fertilisers.

Table 1. Nutrient content of organic fertilisers compared with inorganic fertilisers.

Fertiliser	N (%)	P (%)	K (%)
Inorganic fertiliser			
North Coast Macadamia Mix®	14	4	11
Crop King 88®	15	4	11
Organic fertiliser			
Dynamic Lifter Pellets®	3.5	2.4	1.5
Broiler litter*	2.6	1	0.8

*The nutrient content of broiler litter is highly variable, and these are average figures. They are reported on a dry matter percentage, with the average dry matter content of broiler litter being 75%.

Table 2 shows the application rates of these fertilisers required, under a crop replacement strategy, to deliver the nitrogen requirements. The phosphorus and other nutrient requirements are not outlined here. Due to the large variability in nutrient content of manure-based fertilisers, a nutrient analysis of the manure is beneficial.

It is best to consult expert nutrition consultants to develop a nutrition program, because of the complexity of soil chemistry, biology and nutrition. Added to these factors is the problem that many fertilisers do not have the exact blend to meet your crop's requirements, requiring a mixed approach.

Table 2. Typical crop replacement rates for nitrogen using organic fertilisers. An inorganic fertiliser is included for comparison purposes.

Crop yield (t/ha)	Inorganic fertiliser* (kg)	Dynamic lifter pellets® (kg)	Broiler litter# (kg)
2	192	772	1385
4	390	1571	2820
6	582	2343	4205

*These rates are based on a nitrogen content of 14%.

#These figures are based on 75% of material applied being dry matter and have been calculated as actual application volumes to allow for this factor.

Is there an organic processor?

Currently, there is a limited market for organically produced nut in shell. The main way that organic macadamia growers sell their product is to have the nut in shell contract cracked by a processor. There is currently only one certified organic processor in Australia. Processing is done in 13 tonne lots, whereby a fixed rate is charged for this process and the kernel is packed and stored by the processing company. The ownership of this kernel is retained by the grower. The grower then sells the kernel through their own means into the markets. This creates an increased workload for those growers, but results in higher prices returned.

Will going organic increase my workload?

For some operations going organic will increase the workload, and in other areas there is a decrease in the amount of labour required.

There are increased workloads associated with grass and weed control, primarily in mowing, hand weeding and heavy mulching for young trees. In older orchards there is little difference, due to the shaded orchard floor; and the use of zero-turn mowers has increased the ability to mow quickly.

If organic macadamia growers adopt a 'live with the damage' approach to insect pests (especially fruit spotting bug) there are increased sorting labour requirements to remove this damage but there is a decreased workload for insecticide application due to the minimal spraying carried out.

Extra labour hours are required for crop nutrition. The main increase is in application time, due to the large amount of material to be applied. Specialised

machinery (such as a belt spreader) is required for this operation, or contractors can be used.



Spreading compost requires specialised equipment, such as a belt spreader and front end loader, for moving the material.

What should my first step be?

If you are contemplating going organic, a good first step is to start to build your knowledge base on organic farming and, in particular, organic macadamia production. TAFE NSW runs courses in organic production, and these have been tailored to different crops to meet the needs of the industry.

Bibliography and further reading

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Useful websites

Bugs for Bugs- www.bugsforbugs.com.au

Bioresources - www.bioresources.com.au

Organic farming: huge potential for producers
Agnote DPI-190 *Organic fruit production*
Organic Farming: soils, crops, fruit and vegetables
Organic farming
www.dpi.nsw.gov.au/agriculture/farm/organic

TAFE NSW – www.tafensw.edu.au

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