

organic

mangoes

a production guide

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acknowledgement

For their kind and generous contribution and assistance, with thanks:

Jill and Quentin Parker, Parker Poynt Plantations, Kununurra, WA
Peter Johnson, Department of Agriculture and Food, Western Australia, Kununurra, WA

Introduction

Mangoes have been identified as a prospective crop for conversion to organic production, particularly at Kununurra in the Ord River Irrigation Area. The comparative advantages that favour organic mango production in that region are as follows:

- low nitrogen requirement;
- relatively few pests and diseases;
- early production season;
- established conventional mango industry and infrastructure;
- export market opportunities alongside conventional mango exports;
- existing conventional growers who are progressive and innovative with some interest in an organic or biological approach.

Mangoes can also perform well under organic systems in other regions of WA, however variations in pest and disease pressures may require additional attention to these problems.

Establishing a well-functioning organic system takes time. The wide range of biological processes involved must be initiated, nurtured and maintained at optimal levels in an integrated fashion to achieve the desired results. This integrated biological management must replace the routine reliance on conventional substances including

synthetic chemical fertilisers, herbicides, pesticides and growth regulators.

There are now very good examples of successful commercial organic mango orchards in many parts of Australia, including WA. The organic production systems developed by these dedicated growers are showing that yields and quality can be comparable to conventional systems.

Modern organic systems are largely the result of many years of on farm trial, error and improvement – typically undertaken without the routine support and scientific research effort afforded conventional growers. However, in recent years the emergence of new equipment, substances and techniques suitable for organic systems suggests the future development and refinement of organic systems will accelerate as will the provision of professional supporting services. For new entrants into organic production this means the path to success may be less arduous. However, establishing an organic system typically requires a fundamental change in approach – toward a biological basis for production management. Motivation and commitment to this biological approach is seen as an essential requirement if the development of a reliably profitable and robust sustainable organic system is the business objective.



Organic mango orchard at Kununurra, WA.

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Market outlook for organic mangoes

World mango industry

Conventional mango production occurs in over 280 countries with total production estimated at 26.5 million tonnes in 2004 according to FAO data. The top 10 mango producing countries by volume are shown in Table 1. Australian production in 2003 was reported at around 60,000 tonnes, representing a tiny proportion of world production.

Table 1. Top 10 mango producing countries

Mango production (tonnes)	Year 2004	%
India	10,800,000	41
China	3,582,000	13
Thailand	1,700,000	6
Mexico	1,503,010	6
Pakistan	1,089,000	4
Indonesia	1,006,006	4
Philippines	967,535	4
Brazil	850,000	3
Nigeria	730,000	3
Egypt	327,000	1
WORLD TOTAL	26,572,579	100

(Source: FAO 2004.)

Australia	60,000	0.24
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(Source: Mango Industry Strategic Plan 2004.)

Australian mango industry

Australian mango production has seen dramatic growth over the past 10 years. Total production in 2003 was around 60,000 t and growing at around 8 per cent per year. Production is likely to double within eight years. About 75 per cent of mangoes are sold fresh on the domestic Australian market the remainder sold for processing with less than 10 per cent being exported (Table 2).

Mangoes are now at the stage where they are one of the major horticultural crops in Australia. Queensland is currently the State which produces the majority of mangoes, having an estimated value of \$70 million in 2002-03 financial year. However significantly increasing volume is now coming from the Northern Territory and a dramatic rise in production is occurring in Western Australia.

The seasonal availability of mangoes spreads from September through to March (Table 3). The earliest fruit comes from Kununurra and Katherine. This fruit can command high prices on the domestic market while supply is limited.

Mangoes from WA have freedom from the mango pest mango seed weevil and fruit from Kununurra has fruit fly freedom status – allowing this fruit to be sold into various southern states without the need for post-harvest pest treatments.

Table 2. Mango production in Australian regions 2002-03

Australia	2002-03	Region	2002-03	Region	2002-03
Total	tonnes		tonnes		tonnes
Fresh production	48,781	Queensland	32,937	Western Australia	3,094
Processing	13,544	Burdekin/Townsville	14,813	Carnarvon	1,330
		Bowen	na	Kununurra	1,309
		Mareeba	15,577	Other	455
Total production	62,325	Rockhampton	1,555		
Export (ex Qld)	2,793	Bundaberg	1,392		
		SE Queensland	na		
Export (Total)	4,714	Northern Territory	12,600	New South Wales	150
		Darwin	8,750		
		Katherine	3,850		

(Source: Australian Mango Industry Association.)

Table 3. Seasonal supply of Australian mangoes

Mango production	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Kununurra, WA							
Katherine, NT							
Darwin, NT							
Burdekin, Qld							
Mareeba, Qld							
Carnarvon, WA							
Bundaberg, Qld							
Northern NSW							
Gingin, WA							

Domestic demand for organic mangoes

The WA market for organic mangoes is essentially a captive market for WA producers. WA quarantine regulations impose import barriers relating to fruit fly and mango seed weevil. Imported mangoes must be treated for these pests. While some treatments are acceptable for organic fruit, the quality of treated fruit is often adversely affected

The domestic market in Perth for organic produce is relatively small and immature, although growing rapidly.

Organic mango industry

World trade in all organic agriculture products is estimated to be valued at US\$31 billion in 2005 and growing at 10-30 per cent per year. Major markets are the affluent nations of North America, Europe and Japan. Domestic and export markets are expanding for organic products across all agriculture sectors and mangoes add to the range of exotic tropical fruits on offer.

No figures are available for world production of organic mangoes, however a number of the major mango producing countries do have active organic programs and it can be expected that mango production is involved. Certainly both Brazil and South Africa produce organic mangoes and may be considered as potential competitors on export markets.

In Australia, organic mangoes are grown in most mango producing regions, with over 45 growers certified for organic mango production. Many are small mixed orchards, however some larger orchards are now involved.

Western Australia has about 11 producers certified organic for mangoes. A number of growers are located at Carnarvon, with others at Kununurra, Broome and as far south as Serpentine.

The present growth in domestic WA organic sales has been achieved at relatively high price premium and without any coordinated marketing strategy. As yet little promotion and advertising of organic mangoes has taken place, indicating that demand continues to be driven by ‘consumer pull’ rather than ‘retail push’. This suggests a well designed and implemented market development plan, combined with a carefully planned pricing strategy, would stimulate significantly greater consumer demand than current levels.



Premium organic markets demand high quality fruit.

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Organic wholesalers in WA report that the market for organic fresh produce including mangoes has doubled in the past two years. This growth is largely driven by the emergence of mainstream retail traders into the organic sector.

A number of leading specialist fresh produce retailers (greengrocer/growers markets) and independent supermarkets are active in building and promoting their organic range. Wholesale traders report that these shops have become more active in the organic market as they use organics to create a point of difference from their competitors.

The two major supermarkets have national policies to range organic products and are embarking on the development of 'own brand' organic lines. However, where supply volumes, continuity, quality and price are perceived as erratic, significant investment in promoting organic products remains unlikely. Select wholesalers in most States have been engaged by the major supermarkets to investigate the supply of organic produce and consolidate volumes to suit their needs.

The emergence of supermarket interest in organic products, combined with improved supply continuity may lead to some mainstream promotional activity related to organic. A number of independent supermarkets are actively developing their organic range and developing organic sections within categories. Some of these stores are now beginning to promote and advertise their range of organic products. It is envisaged this increase in promotional effort will increase demand for organic products among more mainstream consumers.

Eastern States markets for early season fruit from Kununurra offers good prospects. The volume of sales for organic produce in these markets is in the order of 10 times the volumes sold in Perth. A number of new organic retail and food service outlets have opened in Sydney and Melbourne and have reported difficulty in sourcing adequate supply of fresh produce. Tasmania and South Australia have quarantine restriction for mangoes subject to fruit fly. WA fruit from regions with fruit fly freedom have direct access to these markets without the need for post-harvest pest treatment.

Export prospects for organic mangoes

Small quantities of organic mangoes are sent air freight in mix consignments to Singapore and Hong Kong. A few growers have sent small quantities to Germany and Holland and report that buyers were looking for more volume.

Potential exists to offer organic mangoes on the back of existing conventional mango export trade. Destinations that have strong organic market growth such as the United Kingdom and Europe have potential. Conventional mango exporters indicate markets are very interested especially France, Germany and the UK. However these prospects are subject to competitive pressures from other southern hemisphere mango producing countries. The extent and profitability of these markets requires further investigation and confirmation. A number of issues including quarantine risk, price, quality and supply need to be carefully considered before attempting to establish export markets. At present WA has insufficient supply capacity to seriously consider exploring these export market opportunities other than small volume air freight into premium markets.

Processed and value-adding

Mango is a versatile fruit that lends itself to a wide range of processed products. The flesh can be used for canning, juicing, drying, freezing and as fresh slices for the pre-prepared fruit salad market.

Several companies produce dried organic mango products in Australia. The emergence of an organic dairy industry in Australia and overseas suggests an opportunity for mango puree and slices as ingredients in various dairy based organic products.

General principles of organic mango production

This section outlines the general principles that underlie organic mango production systems. Aspects of organic standards specific to mango production are highlighted.

A whole system approach

Many farms involve a mix of crops that may include mangoes, banana, citrus or other fruits and possibly some seasonal vegetable crops. Production of mangoes must be considered as only one component of an integrated whole farm system. The inclusion of other crops from unrelated botanical families, as well as soil regenerating pasture or green manure phases and the use of other plant species, can have implications for management of pest, disease or weed control. The whole system is designed and managed to optimise benefits and minimise problems across all crops arising from treatments to any one crop. The layout of cropped areas may change towards more mixed cropping as a way of breaking up large areas of a single crop, thereby increasing biodiversity and assisting pest or disease management.

Enterprises aim to become closed systems

Organic farms aim to operate as closed systems wherever possible – using renewable resources, maximise recycling, minimise waste, and reduced reliance on outside (off-farm) inputs as far as practical. Management strategies based on an understanding of biological cycles and other interactions are the main tools that replace reliance on synthetic chemical and non-renewable inputs. Organic farms can be managerially more complex, but should be less dependent on the use of external inputs.

Plant health stems from soil health

The underlying principle of organic crop production is that: 'healthy plants grow from healthy soil'. Well balanced, biologically enhanced soil – measured by adequate organic matter, humus level, crumb structure and feeder root development – forms the basis of organic production. Plants are nourished through a soil ecosystem built over time, and not primarily through fast-acting, soluble fertilisers added to the soil.

Synthetic fertilisers and chemical pesticides and herbicides are not permitted and can be detrimental to biologically active healthy soil.

Conservation and recycling of nutrients is a major feature of any organic farming system. Organic and mineral fertilisers should be used as a supplement to recycling, not as a replacement.

Land degradation problems such as organic matter depletion, soil structure decline, compaction, erosion, and nutrient leaching must be avoided. In general terms, well managed soils with adequate organic matter, biological activity and humus formation tend to be more resilient against most forms of land degradation.

Biological processes are important

Organic systems are primarily biological systems, both above and below the ground. Pest, disease, and weed control must, in the first instance, encourage and maintain natural biological processes so as to balance disease and pest problems. Enhancement and manipulation of these biological processes forms the basis of organic management. Other control measures can include:

- choice of crop species and varieties for resistance;
- orchard layout and tree structure and canopy management;
- orchard hygiene;
- orchard floor species mix;
- mulching and mowing regimes;
- biological control and maintenance of beneficial predator habitats;
- mechanical controls such as traps, barriers, light, sound and pheromones.

Where available, the grower should use organically grown nursery plants, not treated with synthetic chemicals.

Part certification of a property can aid conversion

Growers may initially convert part of a property to organic methods while continuing to use conventional methods on the remainder. Sometimes referred to as parallel production, this typically involves selecting a location with low risk of spray drift or contamination from adjacent land. Buffer zones may be required to ensure adequate separation from conventional cropping.

Where the same variety is grown both as organic and conventional on the same property, the grower must demonstrate that very tight management protocols for

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product separation and record keeping are in place to allow complete verification of production volumes and trace-back through the operation.

Sufficient area must be allocated to develop a proper functioning organic system. Some organic certifiers may also require a development plan that aims to convert the whole property to an organic system within a defined period. Moving into and out of organic certification is generally unacceptable.

Minimum qualifying period

The transition from a conventional system to a balanced, biologically active organic system is a gradual process. For organic mango production the land must be managed in accordance with organic standards for a minimum of three years. However, growers can obtain certification as 'in conversion' to organic after completion of one year (pre-certification) of compliance with organic standards. Markets for 'in conversion' status fruit may require careful assessment as premiums can be lower than for full 'organic' certification. Product in the first year of conversion (pre-certification) can not be sold labelled as organic.

Avoid contamination and spray drift

Potential sources of contamination from spray drift, water sources or other means, can require careful consideration. Buffer zones are likely to be required between organic crops and conventional crops. Neighbours must be informed of contamination risk and cooperation sought. Soil tests may be required to check for chemical residues in soil from previous land use.

Old orchard sites can potentially have residual soil contamination from past use of synthetic chemicals such as DDT or Dieldrin. Generally soil chemical residues should be less than 10 per cent of the MRL (maximum residue limit). In cases where soil residue is above this level, special orchard management and tissue testing conditions can apply.

Genetic engineering is banned

The use of genetically engineered (GE) organisms and their products are prohibited in any form or at any stage in organic production, processing or handling. Crops and land must be free of GE contamination. Land must have at least five years freedom from previous GE crops.

Co-existence with, and protection of the environment

Maintaining biological diversity on and around the farm is an important feature of organic systems. Avoiding monocultures by encouraging biological diversity tends to allow ecological balance or equilibrium to establish, resulting in a more stable system with less dramatic biological fluctuations – both on the farm and in the surrounding natural environment.

Areas of remnant vegetation should be protected. Shelterbelts and areas of remnant vegetation can be important habitat for natural predators of insect pests, which when kept naturally in check reduce harm to crops and reduce the need for control measures.

Organic farms should also ensure that pollution and other forms of degradation resulting from agricultural practices are avoided. The use of non-renewable resources should also be minimised to help extend future availability of these finite resources.

Irrigation management

Irrigation methods must be adequately managed, scheduled and monitored to reduce problems related to watertable, leaching of nutrients and salinity inducement. Irrigation management must minimise disturbance to the environment and natural ecosystems, including wetlands, river flow regimes and wildlife habitat.

Post-harvest, storage and processed products

To prevent contamination of mangoes on farm, organic product must be kept in a dedicated storage area separate from conventional product. Post-harvest treatments and packaging materials must comply with organic standards.

Where growers intend to value add or process mangoes, compliance with organic processing standards is required if the final product is to be labelled as certified 'organic'.

Making the change to organic

Setting up an organic system for mango production will take time. Organic standards require a minimum of three years, and this reflects the significant changes that must take place for an organic system to begin to function properly. This period will require serious commitment to understanding the different approach involved, especially in relation to the way plants are fed and how to manipulate biological processes – both above and below the ground.

Developing a system of organic mango production that suits your situation may not be simple. Expect some disappointments, be prepared to make mistakes and don't expect an organic crop to perform the same as a conventional crop. Sometimes a crop you are familiar with will perform quite differently under an organic system, for example different growth patterns or different impact of pest or disease pressure.

Many growers start with a small area that is unlikely to have a significant impact on profit. By starting with a small trial area dedicated to organic methods, growers can gain experience, knowledge and confidence about what works and where problems may occur.

One useful strategy can be to move towards a more biological approach for several years prior to considering organic production. Interest in developing a more integrated and biological approach can result in a reduced need for many of the conventional fertilisers and sprays normally used. This can mean that the transition into a fully organic certified system is unlikely to require dramatic changes to management practices and that crop quality and yields should remain relatively stable.

Growers who already use integrated pest and integrated weed management techniques may find the transition to organic less dramatic than otherwise.

Working in conjunction with a few other growers can speed up the learning period and provide more scope for testing ideas and finding better solutions.

The transition toward an organic system can lead to some problems in the first few years. Some growers report that tree vigour may look a bit poor, but as the system establishes, tree health recovers and improves to better than previous conventional condition and good yields return. Also in the first few years some pest or disease problems can get worse while others improve. However, over time those transitional problems diminish as changes in the biological dynamics progress toward a different equilibrium.

Existing orchard condition

The existing condition of an orchard can have a significant bearing on the likelihood of successful conversion to an organic system.

Listed below are some important considerations:

- **Tree health** – the existing condition of trees needs to be healthy. Successful conversion to organic management can be difficult to achieve with diseased trees or trees in poor condition.
- **Weed status** – existing serious problems with invasive perennial weeds can present a major difficulty and cost to control under organic systems. The usual course of action is to minimise these problem weeds before establishing an organic system. On-going vigilance is needed to ensure timely control of subsequent outbreaks.
- **Varieties** – It has yet to be determined which varieties of mangoes are more amenable to organic systems in WA. As yet no specific varieties have been developed for organic production. Obviously, varieties that are less prone to problematic pests or diseases are desirable, as are varieties that typically are not treated with growth hormone to aid flowering. Market preferences and other agronomic traits must also be considered. Majority of mangoes grown in WA are Kensington Pride (also known as Bowen). While this variety does well under organic management, it is known to respond to the growth regulator paclobutrazol.
- **Orchard layout and tree structure** – the best layout and pruning system may vary to suit regional conditions. High density plantings may be subject to less airflow and therefore more susceptible to fungal disease. However this may be off-set with careful layout and pruning to facilitate good air flow. Pruning to an open structure that allows good airflow and adequate internal light without burning fruit can be important to minimise disease risk and assist good fruit colouration.

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Selecting a site

Selecting a location isolated from potential sources of pest, disease or weed introductions is obviously desirable but not always possible. Sites that are away from conventional production areas, allows for relative isolation to reduce the risk of contamination from adjacent land use. This means the area needed for buffer zones between organic and conventional crops are minimised. On windy sites windbreaks may be required, not only to control spray drift problems but also to protect crops from wind effect and damage.

Selecting better quality soils is likely to be helpful and require fewer inputs than poorer soils. Loamy soils are likely to require relatively less nutrient inputs and lower water demands than sandy soil types. In addition, the clay content in loamy soils can accommodate organic matter, the development of good soil biological activity and humus formation suitable for organic production. Chemical or heavy metal residue in soil must not exceed limits set by organic standards.

Water requirements for mango production in WA can vary according to location, size of trees and season. Total water requirement can exceed 10 ML per ha per year. Consideration should be given to possible sources of unacceptable contamination or excessive nutrients in irrigation water.

Choosing a small initial block for organic conversion can reduce the commercial risk in the event of crop failure, while providing a commercially realistic scale to gain knowledge and experience. The commercial and technical feasibility for future expansion of the organic system can then be assessed.

Mature mango trees that are considered healthy with no major production problems relating to soil conditions, weeds, or disease are preferred. This can mean establishing an organic system is unlikely to face serious existing problems.

Choosing mature trees is also considered an advantage especially for Kensington Pride (KPs) because older KPs are considered to have less tendency for biennial bearing. The benefit to conventional production of using the growth regular paclobutrazol – commonly used to ‘even out’ biennial cropping patterns – would be less pronounced than may be the case for younger trees, therefore any yield disadvantage would be minimised. Weed management under mature trees is also easier due to greater shading and leaf litter.

Organic mango production strategies and methods

To meet organic certification requirements, conversion from a conventional system to an organic system is likely to involve changes to existing management practices and adoption of some new strategies and techniques. Changes to management go beyond simply not using synthetic chemicals and fertilisers.

This section outlines some of the strategies and methods used by organic mango growers that should be considered when planning conversion of an existing conventional production system. Please note that details provided are general outlines only. Specific techniques and strategies adopted by individual organic growers will vary according to their circumstances, location of the property and type of enterprise.

Good organic managers rely on close observation, anticipation and prevention to develop a robust and productive organic system for each situation.

Overall management strategies need to reflect the following key organic farming principles:

- soil health largely determines plant health;
- organic systems are biological systems;
- organic farms should operate as closed systems as far as possible; and
- a holistic approach ensures good integration.

Many of the best management practices developed for conventional mango production are likely to also be applicable for organic systems. Efficient irrigation management, windbreaks, erosion control, and aspects of integrated pest management or integrated weed management may be adapted to suit an organic production system. In addition, quality control management systems, preferably incorporating a Hazard Analysis and Critical Control Point (HACCP) system are likely to be beneficial.

As with other forms of organic farming, organic mango production requires a whole farm approach. Increased reliance on management rather than substances demands careful planning.

A well designed whole farm plan should devote special attention to the conversion phase – the first three years of transition from conventional to organic management. During this period practical experience is being developed and market price premiums for ‘in conversion’ product may be less certain.

Mapping out the details of the progressive changes intended will help develop a smooth conversion towards a productive, profitable and sustainable organic system. Such a plan can enable financial risk to be managed and adoption of each new operational component of the organic system can be readily integrated with other farm activities to improve management and enterprise effectiveness.

The major changes are likely to relate to the following aspects of a conventional production system:

- Soil fertility and nutrient management.
- Orchard floor management.
- Irrigation layout.
- Weed management.
- Flowering habit.
- Pest and disease management.
- Post-harvest treatments.

Soil fertility and nutrient management – no synthetic fertilisers

Managing nutrients is important because synthetic chemical fertilisers are not permitted. Many conventional growers wrongly believe organic systems use no fertilisers at all. In fact a wide (and increasing) range of nutrient inputs are permitted, making it possible to correct any soil imbalance and provide specific supplements as required.

The main difference from conventional systems is that inputs are used in keeping with a biological approach to managing soil fertility. This means that growing plant cover over the orchard floor and mowing to create mulch that will fuel soil biological activity becomes the engine that generates soil fertility and plant available nutrients. The application of supplementary fertiliser inputs only becomes necessary where an imbalance or deficiency can be demonstrated. The amount of supplementary inputs needed typically diminishes over time to maintenance levels, as the system of biological cycling develops. Growers with well established and managed organic orchards report that relatively small quantities of input nutrients are required each year to sustain tree health and yields that are comparable to conventional systems. They try to use good science to target fertility and assist the natural recycling process rather than use large quantities of product.

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In conjunction with taking a biological approach to managing soil fertility, a number of growers use the 'Albrecht' method of balancing soil chemistry. Dr William Albrecht was an American soil scientist that established a set of ideal ratios for the main soil cations (Ca, Mg, K., Na). One feature of this method is the importance given to Ca to Mg ratio as a key driver of soil health and therefore plant health and performance. Various other alternative soil management approaches are briefly described in Appendix 3.

Like most fruit, mangoes have certain nutritional requirements that must be maintained at optimal levels. Mangoes are generally known to be sensitive to excess nitrogen during the fruit development and ripening stage. This can result in poor quality and green fruit with poor storage characteristics. Calcium and potassium levels are also thought to influence fruit quality and storage. Trace elements like zinc, copper, boron and manganese are important, especially the role of boron in flowering and internal fruit quality.

In general, nutrient supplements can be applied to remedy identified soil deficiency – rather than applying as a routine event. Occasional foliar nutrients are permitted. Soil and tissue tests are important to verify the need to apply the deficient nutrient. The general approach toward correcting any deficiency is via the soil, rather than applying directly to the plant (leaves). Of course in early years of conversion some foliar may be required while soil imbalance is corrected. The grower needs to demonstrate that measures are being taken to correct the soil rather than simply relying on direct (foliar) feed to the plant – so the approach is to 'feed the soil and let the soil feed the plant'. Care must be taken to use materials that will not be detrimental to soil biology, in fact they should be beneficial to soil biological processes – as soil biological health is the foundation of organic soil management.

Compost can be a valuable input to be used in conjunction with an integrated soil fertility management program. However, availability, quality, purpose and cost of compost are important considerations depending on location. Because mango production and quality is sensitive to excess nitrogen, careful consideration must be given to the timing of organic matter decomposition and subsequent nitrogen release to ensure this matches the appropriate stage in the annual growth cycle of mango trees.

A number of acceptable organic input nutrients can cost more than conventional product. Although, the nutrient quantities applied may be less than in a conventional system, overall fertiliser costs can be similar. However, organic growers tend not to 'chase' fertilisers, noting that mulching the orchard floor grass to assist the natural recycling process is better value.

The main nutrients and acceptable organic products are outlined as follows:

- **Nitrogen** – legume plants and mulch, pelletised poultry manure, blood meal, blood and bone, fish emulsion. Compost can provide useful amounts of available N.
- **Phosphorus** – phosphate rock, guano, various pre-digested phosphate rock, compost, blood and bone, Compost can provide useful available phosphorus.
- **Potassium** – as potassium sulphate, langbeinite, seaweed. Compost can provide significant available potassium.
- **Calcium** – as agricultural lime (limestone), dolomite, lime sand, micronised lime.
- **Magnesium** – as dolomite or magnesite. Magnesium sulphate (Epsom salts or kieserite) are also acceptable.
- **Sulphur** – often via the use of gypsum, potassium sulphate or other sulphate nutrients. Elemental sulphur can be used on a restricted basis.
- **Trace elements** – As a general rule, naturally occurring sulphate forms are acceptable, as are oxide forms – though oxides are less available in the short term. Products made from nitrates or chlorides are not permitted. Products must not be chemically treated to promote water solubility. Acceptable examples are; zinc sulphate, iron sulphate, copper sulphate, manganese sulphate, borates or boric acid. A number of other products can also provide useful quantities of trace elements, such as compost, seaweed and fish emulsion. Natural chelates, e.g. ligno sulphonates and citric acid, maleic acid, amino acid and other di or tri acids are permitted. Synthetic chelates, e.g. EDTA and HEDTA are not permitted.

Plant availability of a number of the nutrient sources listed above can differ from highly soluble conventional product. The lead time required from first applying the input until useful quantities are plant available must be carefully considered – especially in the first few transitional years. Over time residual pools of nutrients held in soil biomass can compensate for this time lag.

The impact of growing orchard floor cover and producing mulch must also be considered in calculating a nutrient management program. In some instances too much clover legume growth can lead to excessive nitrogen levels in soil and can have a detrimental effect on fruit quality and storage.

Orchard floor management – orchard floor plants provide functional benefits

The basis of organic orchard floor management is to grow grass to build mulch. Typically a range of preferred species are established that contribute various system functions including:

- generate biomass/organic matter (roots and tops) that feeds soil biological activity as the foundation for sustaining soil conditions, nutrient availability and organic matter cycling;
- build soil structure and improve resilience to soil compaction and erosion;
- protect the soil from extremes of water stress, heat and cold;

- attract and harbour beneficial predators and biodiversity to minimise pest pressure;
- provide competition to suppress problem weeds;
- facilitate rapid decomposition of diseased tissue;
- improve trafficability;
- attract bees and other pollinators.

Establishing floor cover species may include a mix of grass and legume pasture species. Other cover crops may also offer functional benefit or be more suited to local conditions. Careful management to ensure good establishment and persistence of sown cover plants is important, especially the legume component. However, excessive legume dominance can lead to an excess of nitrogen which can affect fruit quality and lead to storage problems.

The aim of building mulch can be achieved by simply bringing in straw. However, experienced growers caution that straw has often been responsible for bringing in too many problems – especially weed problems. An additional issue for mango production relates to avoiding excessive nitrogen release (resulting from the decomposition of the organic material) especially during the fruit ripening period.

Costs associated with orchard floor cover management can relate to equipment and labour time for mowing, and additional irrigation costs to grow cover plants over more of the orchard floor.



Orchard floor cover plants require timely management.

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Irrigation layout – micro sprinklers on raised irrigation laterals

With the aim of growing grass to produce mulch, a number of growers use micro-sprinklers or fan jet sprinklers in place of drippers. This allows a greater area to be irrigated and so the benefits of the cover plants extends over a larger proportion of the orchard floor.

To facilitate periodic mowing under trees and around tree trucks, irrigation lines are typically raised off the ground. A common method used is to install a wire down the tree row above the ground. The irrigation line is then suspended from this wire. This allows mowing machinery to move under the irrigation line and around tree trunks without damaging the irrigation line. Sprinklers can be installed on flexible droppers that hang from the irrigation line above.

Another method used is to pin the sprinkler riser to the trunk of the tree with a stainless steel fastener. With this method access for equipment between the trees is retained.

Weed management – without herbicides

Attempting organic conversion on a site with serious weed problems will be difficult and expensive. Pre-treatment weed control is considered essential for problem weeds.

Starting with a site that is relatively free from serious problem weeds is an important pre-requisite before committing to an organic production system. Vigilant monitoring and timely control of problem weed outbreaks will be important to ensure serious infestations do not get established.

Mowing and mulching

A well established plant cover, of preferred species, over the orchard floor provides the basis for out-competing and controlling weeds. Managing the orchard floor cover requires periodic mowing and mulching, and these events can be designed and timed to optimise the impact on target weeds.

A common machine used is a tractor mounted mower with spring loaded retractable outrigger that moves around trees trunks. The height and timing of cutting can influence the growth and flowering of different orchard floor species.

For new tree plantings, the use of heavy straw mulch down rows during first few establishment years may be useful. The use of barley as an initial cover crop followed by sowing selected orchard floor species can give a solid cover that allows mowing and mulching down the young tree lines. A brush cutter can also be used around young trees and other areas where necessary.

In older mango orchards, weed management under trees is usually less problematic due to shading and leaf litter. Seasonal hand weeding of creepers that climb up the tree trunk may be required in tropical regions.

Flowering habit – without chemical induction

Mango flowers form from terminal buds of the most recent mature shoots. Most mango varieties flower once a year during winter or spring following a dormant period. Flower initiation is usually triggered by cool nights and dry conditions.



Kensington Pride can suffer from inconsistent flowering and irregular bearing.

The most commonly grown mango variety in WA – Kensington Pride – is known to suffer from inconsistent flowering and irregular bearing, especially in climates with a short dormant period. The growth regulating chemical paclobutrazol, used by conventional growers to promote flowering, is not permitted under organic systems.

The following issues relate to flowering and irregular bearing and should be considered in organic production to minimise the cost of inconsistent flowering and irregular bearing.

- Older trees tend to suffer less from irregular bearing than younger trees.
- Flowering can be reduced when tree carbohydrate reserves are diminished as a result of a heavy crop the previous year.
- Early pruning after harvest can improve uniformity of shoot growth and subsequent uniformity of flowering, especially after a heavy crop.
- Mangoes flower from the tips of branches. Pruning to give more terminal branches gives potential for more flowers.
- Heavy pruning to reduce tree size can be detrimental to yield for several years.
- Adequate nutrition is important after harvest to ensure good growth and carbohydrate accumulation prior to flowering.
- Too much nitrogen can give excessive vegetative growth, often at the expense of flowering.
- Trees need a growth check or dormant period to initiate flowering. Cooler weather and low soil moisture encourage dormancy.
- Withholding water from the tree (after the post-harvest flush) for 2-3 months can help ensure trees enter a dormant phase and improve floral induction. Research in the dry tropics of Queensland showed water stress applied to trees, immediately following maturation of the first summer shoot flush, increased the percentage of terminals flowering (88 per cent vs. 56 per cent) and significantly increased fruit yield (235 vs. 195 kg/tree).
- Late pruning can also reduce flowering.
- Tip pruning prior to flowering has been shown to improve flowering in tropical areas. This technique involves lightly pruning trees back to mature wood just prior to flowering.
- Temperatures below 15°C affect pollen viability. Later flowering in cooler climates can be manipulated by removing early flowers.

- Water stress during flowering can upset flower development and reduce fruit set.
- Wind and insects pollinate mangoes. Wasps, bees and large flies are the most efficient pollinators.
- Boron is important for pollination and fruit development and must be readily available from the soil or applied as a foliar spray prior to bud break.
- Any stress after flowering can increase the number of fruit dropped.

Other approaches for promoting flowering and fruit production have been reported. Research conducted by CSIRO has demonstrated that flowering and fruit production of mangoes can be considerably enhanced by cutting a cincture around the tree trunk to induce stress by disrupting sap flow.

Pest and disease management – prevention, resistance and IPM

Mango production in WA has the enviable position of having relatively few pests and disease and freedom from several serious pests that affect other mango growing regions. However, for many conventional growers the first question often asked when considering organic production is how do you manage pests and diseases?

Successful organic production requires an integrated approach to managing pests and diseases. An important part of this approach involves a number of underlying preventative strategies that can contribute to minimising the likelihood and severity of problems.

Conventional growers that have adopted Integrated Pest Management (IPM) techniques into their orchard management practices will find the transition to an organic system less dramatic than those without IPM knowledge and experience.

All of the principles of IPM can be applied to an organic system with the main variation being that some of the substances used for specific pest or disease control may need to be changed. Building biodiversity into an organic system by way of establishing and managing the orchard floor to attract and harbour beneficial predators can increase the effectiveness of IPM techniques.

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A range of preventative measures is important to minimise susceptibility to pest and disease pressures. Some key preventative measures are as follows:

- **Location /regional occurrence** – Understanding the prevalence, timing and severity of specific pests or diseases for a given location is very important and can have a significant impact on production costs and reliability of production. An organic management plan can be developed to minimise identified risks. For example, the hot drier climate of the Ord River Irrigation Area indicates fungal problems may be less severe than in cooler wetter regions. So in the more southern mango growing regions issues of orchard layout, varieties, planting density, tree structure and pruning should be designed with emphasis on avoiding conditions that favour fungal attack. Organic mango production in areas prone to wet weather during fruiting is likely to be difficult.
- **Surrounding land use** – Neglected orchards or poorly managed surrounding properties can be a constant source for new outbreaks of pest or disease (or weeds). Sometimes unhelpful neighbours can make these sources of pests or disease a major problem.
- **Cooperation** – Keeping contact with conventional growers is very useful. A local monitoring group for weather and other risk factors can mean less unnecessary sprays. This is important to reduce resistance issues.
- **Rootstock and variety** – Selection of plant material with resistance characteristic should be used wherever possible. Selecting varieties that are well suited to the local growing conditions will ensure healthy growth and resilience to problems. The Queensland Department of Primary Industries has undertaken research to breed new mango cultivars with Kensington Pride flavour characteristics, improved anthracnose and bacterial black spot tolerance, and improved post-harvest handling features.
- **Tree condition and age** – Successful conversion to organic management can be difficult to achieve with existing trees that are unhealthy and diseased. Older trees may be more easily converted to an organic system than young trees as they may better cope with minor pest and disease pressure. Growth and recovery can be better due to less weed pressure and greater root system to exploit soil reserves for water and nutrients.
- **Healthy trees** – Emphasis on maintaining healthy trees that are naturally able to cope with minor pest or disease problems is important. The foundation for healthy trees stems from healthy soil. This is achieved via biologically active soil with adequate organic matter and nutrient cycling to balance the chemical, biological and physical condition of the soil. A wide (and increasing) range of inputs are permitted, making it possible to correct any soil imbalance and provide specific supplements as required. Research is being conducted by the Queensland Department of Primary Industries and Fisheries (QDPI) into the impact of pre-harvest factors such as nutrition and water stress on defence mechanisms and disease development in mangoes, as well as chemical compounds that induce defence mechanisms in mangoes.
- **Canopy management** – Pruning to an open structure that allows good airflow and adequate internal light without burning fruit can be important to minimise disease risk and assist good fruit colouration.
- **Biodiversity** – Orchard floor management that involves a mix of plant species and timely mowing to encourage and maintain beneficial predators. Windbreaks and shelterbelts can also be designed to encourage biodiversity.
- **Hygiene** – Vigilant and thorough orchard hygiene is very important. Removal of infected wood, fruit and other plant tissue can reduce the severity of subsequent problems.
- **Rapid decomposition** – Infected plant material - as a source of future inoculant - can be reduced by rapid decomposition assisted with mulch from the orchard floor.

Proper identification, regular monitoring and timely intervention are essential for successful pest and disease management.

In the event of an outbreak that requires attention, an increasing range of substances are permitted for controlling pests and disease in organic production. Some substances require close attention to timing and frequency of application in order to optimise effectiveness. Target specific substances should be used in preference to broad spectrum substances, and special attention must be given to any potential impact on beneficial predators.

The main pests and diseases of mangoes with examples of remedies or products used by organic producers are outlined as follows:

Table 4. Pest management options

Pest	Organic management options
<p>Scale insects (pink wax scale, mango scale)</p>	<p>Feed on plant sap from stems or fruit. Prefers shadiest areas within canopy. Best to treat young (crawler) stage. Can cause sooty mould.</p> <ul style="list-style-type: none"> • Oil sprays (white oil). • Mango scale parasite. Host specificity testing of <i>Aphytis sankarani</i> is being tested by QDPI. • Spinosad (Entrust Naturalure®). • Ant control.
<p>Red shouldered beetle</p>	<p>Can build up numbers very rapidly. Causes defoliation and flower death.</p> <ul style="list-style-type: none"> • Tree health. • Cover crop habitat for beneficial. • Pyrethrum is effective, but its broad spectrum action could impact on non-target beneficials. Careful timing to minimise damage to non-target species. • Spinosad (Entrust Naturalure®). • Neem-based repellents.
<p>Fruit spotting bug</p>	<p>Can build up numbers very rapidly.</p> <ul style="list-style-type: none"> • Control as above.
<p>Thrips (flower thrips, red banded thrips)</p>	<p>Causes fruit drop and fruit scaring.</p> <ul style="list-style-type: none"> • Control as above. • Potassium soap sprays.
<p>Green ants</p>	<p>Green ants are efficient predators of a wide range of insect pests and are reported (Northern Territory University) to control some of the main pests of mangoes. Cause discomfort for mango pickers.</p> <ul style="list-style-type: none"> • Colony relocation. • Collars around trunk if needed.
<p>Giant termites</p>	<p>Cause tree death.</p> <ul style="list-style-type: none"> • Trap cropping, i.e. growing plant species that are preferred by termites, to direct them away from mango trees. • Compost, ground cover/mulch and irrigation are thought by some growers to deter termites. • Sound waves can influence ant behaviour and are under investigation at CSIRO.
<p>Fruit fly</p>	<p>Can be a serious problem if not controlled.</p> <ul style="list-style-type: none"> • Spinosad (Entrust Naturalure®) fruit fly bait. Trunk applied with thickener xanthan gum (Keltrol) at 0.5% is reported to increase the efficacy of generic baits by approximately 25% and avoid leaf damage. • Baits can be effective in situations of low Med fly pressure. Other suggested baits are: <ul style="list-style-type: none"> - For males – Dryacide® with Pheromone for male. - For female – Wet yeast bait (brewers yeast 2 g, sugar 150 g, water 500 mL). • Neem oil plus pyrethrum has been reported to provide control. (Note: Neem is not registered for use as a pesticide.)

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Table 5. Disease management options

Disease	Organic management options
Anthraxnose	<p>Potential to be a greater problem in regions with wet cold winters and wet periods during fruiting. Pre and post-harvest control measures may be required.</p> <ul style="list-style-type: none"> • Good canopy management and tree nutritional/soil management. • Close monitoring. • Copper hydroxide (Kocide®). • Potassium bicarbonate (Ecocarb®). • Some biodynamic growers report that a tea made from Casuarina leaves can help reduce the effects of anthracnose and black spot.
Stem end rot	<p>Tends to show as post-harvest disease, but infection levels are related to spore loads present in the orchard.</p> <ul style="list-style-type: none"> • Remove dead wood. Spores reside in dead wood, twigs and bark. • Good canopy management and tree nutritional/soil management. • Applying calcium to soil in the form of gypsum at low rates, 2–4 kg per tree prior to flowering has been shown to significantly reduce the severity of the internal fruit disorder, stem end cavity, in Kensington Pride mango. However, at higher rates, 6–8 kg per tree, there may be a detrimental effect of the additional calcium, possibly due the calcium interfering with the uptake of other minerals involved in fruit development. Other factors such as flushing and fruit load also play a role. • Research by Horticulture Australia Ltd (HAL) into control strategies for mango stem end rot based on the use of defence-promoting compounds that stimulate host defence rather than to directly target the stem end rot pathogens. Control of other fruit diseases such as anthracnose is also a distinct possibility.
Bacterial spot	<p>More significant problem in southern regions.</p> <ul style="list-style-type: none"> • Reduce wind damage to minimise infection site. Shelter belts, windbreaks. • Copper sprays, Copper hydroxide (Kocide®).

Post-harvest treatments

All post-harvest operations must comply with organic standards. The primary objective is to avoid contamination with prohibited chemicals and to ensure separation of organic product from any conventional product.

Producers who convert only a portion of their orchard to organic (known as 'parallel production') are likely to have both conventional and organic product moving through the same pack-house facility. The post-harvest procedure normally adopted is to run organic fruit first after the equipment has had a clean-down. This allows the organic product to be dealt with and packed away in a separate area prior to commencing with the conventional fruit and so avoids the risk of contamination from conventional fruit and related treatments.



Treat organic fruit as a separate operation from conventional fruit.

Hazard Analysis Critical Control Points (HACCP) based quality assurance systems are ideal for establishing protocols and audit systems that meet organic requirements. Operations with existing HACCP based QA systems typically find that only minor changes are required to comply with organic standards.

For post-harvest disease control the best approach involves ensuring good pre-harvest (in-field) disease management and orchard hygiene together with good post-harvest temperature management. Packing shed hygiene that involves regular equipment cleaning and

removal of reject fruit can reduce the transfer of fungal spores onto new fruit. Fruit destined for domestic markets where storage times are short may not require any post-harvest treatments for fungal control. Longer term storage and fruit for export are likely to require some form of treatment to reduce fruit breakdown from the diseases Anthracnose or stem end rot.

The main post-harvest changes for conventional operations may involve some of the following:

Table 6. Post-harvest management

Issue	Organic management options
Equipment washdown and surface sterilants	Substances and procedures used for cleaning equipment prior to handling organic fruit must comply with organic standards. The use of some substances may need to be followed by detergent cleaning and or a clean water rinsing procedures. <ul style="list-style-type: none"> • Commonly used permitted cleaning methods include: steam cleaning, high pressure hot water. • Sanitisers, cleaners, followed by clean water rinsing. • Ozone for cleaning storage bins.
Fruit washing detergents	The use of detergents on fruit is generally prohibited. <ul style="list-style-type: none"> • Mango wash[®] – for the purpose of de-sapping mangoes – provided it is without the addition of QAT. • Hydrated lime. • Detergents and wetting agents must be evaluated on a case by case basis by your organic certifier.
Post-harvest treatments	
Anthracnose	Less of a problem in drier regions. The commonly used post-harvest fungicides prochloraz (Sportak [®]) is prohibited on organic fruit. <ul style="list-style-type: none"> • In field preventative measures are important to reduce spore load on fruit – see disease management options in previous section. • Preliminary tests using potassium bicarbonate (Ecocarb[®]) dip have shown some reduction in fungal breakdown but far less effective than Sportak[®]. • A new class of natural fungicides called strobilurins, for the control of stem end rot and anthracnose post-harvest diseases is being researched by HAL. • CSIRO Division of Tropical Crops and Pastures are looking at various harmless yeasts and bacteria and sodium silicate as fruit coatings that inhibit the disease.
Stem end rot	Can be more of a problem than anthracnose in drier regions. The commonly used post-harvest fungicides carbendazim (Spinflo [®]) is prohibited on organic fruit. <ul style="list-style-type: none"> • In field preventative measures are important to reduce spore load on fruit – see disease management options in previous section. • Avoid water stress during fruit development and maturation.
Fruit fly	Insecticide dips for fruit fly control are not permitted on organic fruit. <ul style="list-style-type: none"> • VHT (vapour heat treatment) or hot water dips for fruit fly control is permitted.
Controlled atmosphere storage (CA)	The use of controlled atmosphere storage is permitted. However, organic product cannot be stored in the same CA room with conventional product. The use of DPA pre-treatments is prohibited as may be other storage chemicals.

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Organic management plan

In a practical sense, one of the first steps in the transition to formal organic certification is to write down an Organic Management Plan (OMP). This plan covers the normal management issues faced by producers, such as management of soil and nutrients, weeds, pests and diseases, water and irrigation, as well as other topics like contamination risk, biodiversity and staff awareness. The real value of writing down these details is as one grower reported “it forces you to really think about each issue and how you plan to deal with it”. Writing the organic management plan also reveals clearly those issues where you don’t have a satisfactory solution – for example in the Kununurra case example presented below control of termites remains unresolved, and doubts remain about in-field and post-harvest treatments for anthracnose (although anthracnose is rarely a major problem in the Ord River Irrigation Area (ORIA)).

The plan may be refined and evolve over time, but essentially it provides a written description of the intended production system and can include details of pest, disease and weed management plans, documented recording systems, key management personnel and future plans.

To obtain formal organic certification an organic management plan (OMP) is usually required.

The following case example organic management plan covers topics and issues typical for mango production in the ORIA at Kununurra. This OMP is taken from an Organic Conversion Demonstration Site at Kununurra, and is adapted from the Organic Management Plan format available from the Australian Certified Organic (ACO) website.

Organic management plan

Case example: Mango production Kununurra

Documents and records

Provide details of how farming practices (composting, cultivation, weed, pest and disease control measures), inputs, harvest and sales are recorded.

- Farm diary records all activity and operations.
- Input materials recorded from purchase receipts and entered into computer accounting system.
- Harvest details collected from field pickers’ dockets and collated each day.
- Grading pack out details recorded in journal.
- Sales volumes and prices recorded from dispatch invoice and sales notice from wholesaler and entered in computer.

Audit trail

Provide details of how produce is traceable from the farm paddock to point of sale, i.e. paddock records, packing records, storage records, delivery docket, etc.

- Field picker dockets record gross yield and orchard location.
- All fruit from same location is batched for washing, grading and packing in trays.
- Trays are date coded to correspond to picking date/location.
- Market consignments carry a delivery docket with details of destination, tray numbers and code.

Parallel production (certified and non-certified area)

How are issues of parallel production addressed within the same production season and production unit?

- The organic mango block will be clearly marked with physical signposts. This block has two sides adjoining non-certified crop. All management and operations on the non-certified block will be similar to the organic block and will involve no prohibited sprays. Therefore the risk of spray drift or other contamination will be nil.
- Staff and pickers will be trained in organic principles and risk management.
- Harvest and pack house recording procedures are date/location coded to ensure accurate traceback to trees.
- The pack house and farm operations have full SQF quality assurance certification.
- The organic mango block is part of a two-year research project where soil, tree, and crop performance will be closely monitored and compared to non-certified crops.
- New picking crates may need to be purchased if acceptable washing is not possible.

Whole farm conversion

Provide details and approximate time frames for whole farm organic certification.

- Based on organic crop performance and market response other areas of the property will be progressively converted over to organic certification over 10-year period.
- Reviews of the whole farm management plans and enterprise performance mix will determine the focus and rate of the conversion program.
- It is envisaged, given satisfactory outcomes from the organic mango block that the adjoining mango block may come under certification in 2006.
- Trial melon production using organic methods is planned for 2003.

Land degradation Issues

List any issues, i.e. erosion, salinity, water quality, etc. and current methods used to manage or address these issues.

- Soil structural compaction – application of compost and mulch and encouragement of beneficial cover-crops. Careful consideration of soil moisture and timing of traffic.

Soil and fertility management

How do you intend to address soil fertility, i.e. compost, green manure crops, foliar sprays, etc.?

- Focus on building humus levels and soil structure through use of compost, surface mulch, humates and cover crop mowing.
- Soils are naturally deficient in Bo and Ca.
- Based on soil tests, annual application of Ca, P, with seasonal application of Bo based on soil and tissue tests.
- Aim is to use compost formulation and timing as basis for building the macro and micro nutrient status of the soil to progressively reduce the need for seasonal foliar applications.
- Boron as boron sulphate, or Borax®.
- Calcium as Gypflow®.
- Phosphorus and calcium as Biophos 3 in 1®.

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Brought-in materials

What measures to ensure that all brought-in materials or contracted equipment are free from potential contaminants?

- Obtain written approval from organic certifier prior to delivery of brought-in materials.
- Compost raw manures prior to use.
- Verify seeds/vegetative materials are GMO free.

Farm water supply

State water source/s and potential risks associated with the use of this water source. How are these risks monitored and/or reduced?

- Ord River Irrigation Scheme – pumped directly from Lake Kununurra supplied from Lake Argyle.
- Three bores draw water from shallow watertable and ensure clean supply free from algal problems.
- Nil risk of contamination – water is untreated taken directly from dam catchment.
- Property is situated at the top of the Ord River Irrigation Area and the water is not affected by discharge from upstream users.
- Water quality is monitored periodically and is acceptable for use as potable water.

Irrigation method

Describe your method of irrigation and how is water use efficiency maintained?

- Pressurised under tree micro sprinklers.
- Irrigation schedule based on industry best practice.
- Soil moisture levels monitored regularly by physical inspection.

Pest management

What are the main pest problems that you anticipate to occur? How do you intend to manage these pests?

- Improve soil conditions and tree health.
- Preventative techniques such as canopy management, tree collars.
- Development and maintenance of habitat for beneficial predators.
- Regular monitoring and seasonal risk evaluation.
- Acceptable substances – preferable target specific, but others as last resort.

Main pests	Specific management
Pink wax scale	White oil, ant control.
Green ants	Collars around trunk if needed, colony relocation.
Termites	Compost, ground cover, irrigation.
Thrips, red shoulder beetle, fruit spotting bug	Tree health, cover crop habitat for beneficials, potassium soap, spinosad, last resort pyrethrum.

Disease management

What are the main disease problems that you anticipate to occur? How do you intend to manage these diseases?

- Soil conditions and tree health.
- Preventative techniques such as canopy management, water management.
- Regular monitoring and seasonal risk evaluation.
- Acceptable substances – preferable target specific, but others as last resort.

Main disease	Specific management
Anthracnose	Good canopy management and tree nutritional/soil management. Close monitoring. Sprays if required copper hydroxide (Kocide [®]), Potassium bicarbonate (Ecocarb [®]). Researching other monitoring and control measures.
Stem end rot	Remove dead wood. Good canopy management and tree nutritional/soil management especially calcium.

Weed management

What are the main weed problems that you anticipate to occur? How do you intend to manage these weeds?

- Improve soil conditions.
- Timely and periodic mowing.
- Compost and mulch under tree.
- Seasonal hand pull creepers.

Main weeds	Specific management
Grasses	Mowing and mulching.
Creepers	Seasonal hand pull.

Biodiversity

What is the estimated percentage of your whole farm area that is under bushland/ native grassland/ buffer zones/ wetlands/ remnant vegetation etc. Outline how you intend to maintain and/or enhance biodiversity on you farm?

- Retain bushland areas and avoid activities that may disrupt natural behaviours and processes.
- Build mixed species cover crops into orchard floor management and maintain flowering periods to benefit biodiversity.
- Retain and manage shelter belts to benefit biodiversity.
- Retention of organic matter and application of compost to enhance soil biodiversity.

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Hazard Analysis Critical Control Points (HACCP)

What are the potential hazards to your production system in terms of maintaining organic certification, i.e. GMO crops and seeds, genetic drift, over-spray risks, brought-in products and livestock, etc.? How do you currently address these risks, or intend to address these risks?

Main hazard	Specific management
Staff awareness and knowledge of organic areas and procedures	Staff training in organic principles and procedure. Clear lines of responsibility.
New input products purported to be suitable for organic	Seek written approval from certifier prior to use.
Neighbours' activities	Notify neighbours in writing and outline risks to be managed and seek cooperation. Buffer zones.
Adjoining non-certified land	Clear warning sign posts defining the certified organic area. Avoid using non-organic inputs on adjoining land. Buffer zones.
Genetically modified organisms (GMOs)	No GMO mangoes in region.
Identifying source of contamination	Traceability system .

Key management issues

The creation of an organic management plan typically reveals a number of areas where changes to existing conventional management will be required. In addition to the normal issues related to tree health, productivity and crop quality, other issues relating to services, markets and staff are likely. Often these can demand considerable management time especially during the first few establishment years.

The following section describes important issues likely to require careful consideration and possibly new understanding, different management or new services – compared to an existing conventional mango operation.

Advisory, support services and inputs suppliers

The routine support and supplier services that contribute to the effective functioning of a conventional operation may be far less useful for an organic operation. Often the usual supply companies do not normally stock various organic input products, and the people involved may not have the knowledge, background and experience (or interest sometimes) with organic systems and products. For example, routine advice regarding rates, timing and effectiveness of some organic fertilisers or sprays may not be readily known by the usual supplier. Often this can mean greater reliance on doing your own investigation and seeking out new people or suppliers that are familiar with the acceptable product or technique. Existing organic growers or growers moving towards a more biological approach can be valuable sources of information and experience.

Target markets and organic supply chains – transport, ripening and wholesalers

The current market for organic produce can be characterised as a specialty niche market. Most major fresh produce wholesale markets in the capital cities across Australia have specialist organic wholesale traders. While the conventional wholesale traders are usually happy to sell organic produce, the specialist organic wholesalers move the majority of organic product. They generally have a good knowledge of organic supply volumes and demand and are well known by organic produce buyers. Establishing good business relations and effective lines of market feedback will be important.

Transport, storage and ripening of organic mangoes are subject to a number of important conditions to ensure no mixing with conventional product and the risk of contamination is minimised. Organic product generally must be held in a clearly identified area separate from conventional product. Ripening mangoes with ethylene is permitted. The use of cleaning or pest control substances must be acceptable under the organic standards. A complete paper trail is required that can trace consignments back through wholesale, ripening, storage, transport chain to farm dispatch. These service providers involved must be informed the product is organic, willing to prevent mixing or contamination, ensure the audit trail remains intact and generally be prepared to ensure the integrity of the organic certification status.

Organic management plan, record keeping, organic certification compliance and audits

Most producers who already have in place some form of recognised hazard based quality assurance (QA) program have little difficulty in complying with the administrative requirements of organic certification. In general existing QA documentation and records may only require minor changes to satisfy organic certification audits. Growers without a formal QA system will need to develop a reasonably comprehensive recording system for all farm inputs, operations and outputs.

Organic certification is based on written evidence and annual physical farm inspections. At present there is no service available that can audit for both QA and organic compliance in the one visit, so additional time is involved in attending to organic certification audits.

The production of an organic management plan (OMP) is usually required as part of organic certification audit process. The OMP is typically used as the guiding document that defines the organic system in place. As such the OMP is often revised and refined to reflect the current circumstances and system development. Details of a case example OMP are provided in a previous section.

The initial timing of application for formal organic certification is critical to ensure that the farm inspection and associated documentation is completed, signed, paid and valid **before** harvesting of fruit.

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Organic site supervision – identity preservation, staff education

Maintaining the integrity of the organic certification on farm can involve informing and educating staff and contactors regarding chemicals and treatments that are acceptable for organic and those that are prohibited. Clear lines of management responsibility for maintaining the integrity of the organic system must be established.

In the case of parallel production, where part of the farm is organic and the remainder is conventional, the organic section must be clearly marked with prominent signs. Staff and contractors must have a clear understanding of the need to treat the organic section with special care to avoid contamination with prohibited inputs. Additional supervision may be required to ensure correct procedures – especially during the establishment years or for new people.

Spray drift and contamination

It is important to always remain mindful of potential sources of contamination to the organic production. One event, accidental or otherwise can negate the organic status of the crop. The reputation of your product can be seriously affected and may take many years to recover if your product is found to be contaminated. Neighbours should be notified of the presence of organic production and their cooperation sought to prevent spray drift.

In the case of parallel production the timing of spray operations on the conventional section may need to be adjusted to prevent drift. Where conventional production adjoins organic, several metres of the adjoining conventional area must be treated as organic, in effect to act as a buffer zone, however this section of crop remains as conventional.

Weed control

Mowing is the usual method of weed control in organic orchards. To facilitate mowing around tree trunks irrigation lines and sprinklers must be suitably positioned to avoid damage.

For effective weed control the timing of mowing operations or hand weeding is the most crucial aspect. Prevention of seed set in problem weeds is an important tactic but requires timely mowing. To minimise the cost of mowing the least number of passes is the aim, however delaying weed control can allow weed seed set and a costly future problem.

Understanding some of the complex interactions between orchard floor cover plants and orchard trees can reveal strategies to manipulate the respective growth patterns for productive advantage. For example, it may be possible to encourage certain beneficial insects by allowing some orchard floor plants to flower. The integration of weed control objectives with cover plant manipulation can require skilful management and careful timing.



Several adjoining conventional rows (left) are managed organically to act as a buffer for the organic mango block (right).

Nutrient inputs – fertiliser types, compost and mulch

A wide range of nutrient inputs are permitted for organic production. For a number of these inputs their performance characteristics in terms of their short, medium and long term impact and value may be quite different from the regular highly soluble fertilisers used in conventional production. For example, forms of phosphorus like reactive rock phosphate (RPR) generally have relatively low immediate P availability. However, over time through the process of microbial action, pools of soil P are transformed into biomass P and subsequently available to plants. Over time the maintenance of adequate soil P levels is achieved through periodic applications, however the initial delay times involved in this indirect biological approach to feeding plants needs to be carefully considered when deciding on rates and timing of application. Similarly the application rates, timing and effectiveness of other input nutrients and trace elements may also differ slightly from conventional practice.

Moving to a biological approach for soil fertility management can involve a new understanding of the role and impact of the orchard floor cover plants, the mulch produced from mowing and the use of compost or other organic mulch materials like hay. Timing the application of nutrient inputs to coincide with mowing/mulching events may facilitate nutrient availability via the flush of biological activity fuelled by the fresh mulch.

The application rates and timing of organic material inputs and subsequent decomposition must be carefully considered to minimise the risk of elevated soil N levels during the fruit growth period. Excessive nitrogen (as a consequence of OM decomposition and N mineralisation) during later fruit growth and especially toward fruit maturity can contribute to poor fruit quality – particularly a number of internal disorders, green fruit, poor ripening and poor storage.

Irrigation management can influence the rate of organic matter decomposition. Ensuring adequate plant cover over the orchard floor without excessive growth and organic matter accumulation/decomposition during the critical fruit growth/ripening stage can be important for fruit quality.

Tree pruning and canopy management

Pruning mango trees is important for tree size control and to improve fruit colour. Essentially, tree pruning and canopy management should be the same for organic or conventional production. Pruning to an open structure that allows good airflow and adequate internal light without burning fruit can be important to minimise disease risk and assist good fruit colouration. Internal pruning to remove dead wood can be very important to help reduce the incidence of the disease stem end rot.

Organic production may place greater reliance on good canopy management and pruning as a preventative strategy for pest and disease management than may be the case where synthetic chemical sprays are used routinely.

Pest/disease contingency plans

While the underlying approach for organic pest and disease management is based on a range of preventative and other management strategies to minimise the incidence of problems, there remains the risk that outbreaks may still occur.

Close monitoring combined with understanding life cycles of both the pest and its predators will allow decisions to be made regarding economic thresholds and the need to intervene. Producers unfamiliar with IPM and biological systems may feel a premature urge to spray. Local experience is most valuable, however the way pests and diseases fluctuate under a conventional system may differ from their patterns under an organic system, and understanding any changes in these patterns can take time and close observation.

Where management strategies are inadequate and spraying is required it will be important to ensure supplies of an acceptable organic substance are readily available, and to be familiar with its use (timing, rates, and application) and effectiveness.

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Harvesting, pack-house operations for organic

Producers often convert part of an operation to organic while running the balance as conventional. Some changes to the sequence of picking and packing will be required to ensure the organic fruit is identified and kept separate from conventional fruit to avoid mixing or contamination. Ensuring staff understand the protocols in place to separate organic fruit from conventional fruit will be important and may require training and monitoring of operations.

On farm pack-house operations are subject to compliance with organic standards. A separate audit and certification is required to ensure the integrity of the fruits' organic certified status. Where fruit of the same variety is grown as both organic and conventional, special stringent conditions apply to verify product separation and allow full audit trail traceback.

Post-harvest treatments

The main post-harvest changes for conventional operations are outlined in a previous section. In general, fruit requiring only short term storage before retail sale are unlikely to suffer from fungal breakdown and post-harvest fungicides may not be necessary.

For longer term storage of mangoes a fungicide treatment is usually required, however an effective organic treatment for post-harvest fungal breakdown has yet to be established.

Careful consideration must be given to consigning untreated fruit to markets where the length of time fruit will be held before sale is uncertain.

The risk of storage breakdown is minimised when fruit is:

- produced from healthy trees in a well managed orchard with good hygiene;
- grown with adequate calcium and other elements;
- not subject to excessive N during fruit development and ripening;
- picked at the correct stage of ripeness;
- not subject to bruising or damage;
- maintained at ideal temperature;
- cleaned, packed, transported and ripened correctly.

New labels, packaging and materials

The production of new labels for trays and fruit will be required. Label design must be approved by the organic certifier prior to use. Distinctively different presentation (from conventional fruit) can be important so the organic fruit is easily identified throughout the supply chain. There are some restrictions on the types of packaging materials permitted for use with organic fruit, although the commonly used mango trays and liners are generally acceptable.

Key conversion impediments for WA growers

Producing a certified organic mango product is no guarantee for a better market response and repeat sales if quality is inferior. Poor quality organic mangoes are unlikely to attract a consumer following, whereas delicious eating qualities and good visual appearance will stimulate consumer interest and repeat sales. So it is important to first build a reputation and brand with customers based on quality before moving into organic. Organic certification can then add value to this relationship by reassuring customers that the product is safe, healthy and produced with care for the environment.

Experience, system knowledge and confidence

There is a common misconception that organic production is not suitable for professional growers. However, there now are good examples of mainstream commercial orchards, managed by full time professionals, who have developed organic systems that work, and have successfully converted to profitable certified organic production.

Motivation for moving towards organic appears to be twofold. Growers want to use environmentally benign and sustainable production methods and they want to make a reasonable living. Taking a biological approach and moving to organic is seen as a way to satisfy both objectives.

One of the biggest problems is the lack of support services that are normally available to conventional growers. The local agricultural suppliers will be knowledgeable about the use of many conventional inputs, but may be unfamiliar with the use of various organic inputs and the biological approach required. Similarly, the advice available from agricultural advisers, consultants and other service providers may be limited. As a consequence many things have to be done by trial and error, so it is important to trial first, and have all the answers before committing. But having all the answers to make an organic system work reliably takes time. Careful application, testing and monitoring of alternative technologies can be required.

Most experienced organic producers report that the longer their organic system operates the less they have to do – the system tends toward its own balance. Each year brings more confidence in the performance of the orchard ecosystem.

Starting with a small trial area to experiment with at first allows time to gain experience, knowledge and confidence. This strategy can reduce the commercial risk before converting more land as market opportunities warrant.

Producers who have implemented integrated pest management (IPM) systems will find the move towards organic less dramatic than those with heavy reliance on synthetic chemical inputs.

Regulation and certification process

Formal organic certification proceeds through a three-year transition period. The first year is known as ‘pre-certification’ and involves compliance with organic standards and implementing an organic management plan. Years two and three are conversion years where a proper functioning organic system is established and product can be sold labelled as ‘in conversion’ to organic. After three years (year four) full organic status is possible and product can be sold labelled as ‘organic’ certified.

Obtaining and complying with organic certification does involve additional administrative time and paperwork. Good records must be maintained to allow a complete traceback of any product from the cool room to the paddock. Direct costs of organic certification vary according to certifier and involve an initial fee for establishment and inspections in the first year. Subsequent years typically attract an ongoing annual charge to cover the cost of subsequent annual reinspections.

Additional management time may also be expected, especially during the early transition years – depending on the extent of changes required to the existing production system. Close observation, attention to detail and careful timing of activities is important when running a biological system. Therefore, organic production can typically be more complex than when using conventional chemicals. This additional management is greatest in the early years and while running a conventional system in parallel. However, experienced organic growers report that a well developed and managed organic system tends to stabilise over time and begins to require less input than their conventional counterparts.

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All reputable markets require product labelled as organic to be certified by a third party body. In Australia, the Australian Government body Australian Quarantine Inspection Service (AQIS) administers the 'Australian National Standards for Organic Produce'. AQIS has accredited a number of independent organisations to conduct the farming system inspections and issue organic production certification.

Not all AQIS accredited certifiers have the same status on some export markets. Some markets have a preference for specific certifiers. For example, some EU supermarkets prefer Australian organic certifiers that are recognised by International Federation Organic Agriculture Movements (IFOAM) – an international organic body. If exporting is envisaged, it is important to ensure the organic certifier chosen is acceptable in prospective target markets. Growers that have in place existing quality assurance (QA) systems typically find relatively few administrative changes are required to comply with the record keeping needs for organic certification. Incorporating organic certification into existing QA systems is currently being developed by some organic certifiers in order to minimise paperwork and costs for growers.

Approved materials

Organic standards restrict the range of products that may be used in an organic system. In general, products that are naturally derived are permitted whereas synthetic pesticides, herbicides and fertilisers are prohibited. Therefore, many growers will have to source alternative products and management techniques when planning an organic management plan. There is an expanding range of acceptable materials available. It is important to check the status of all inputs in advance to ensure compliance with organic standards. Use of prohibited materials can lead to de-certification. Contact your organic certifier for a list of permitted materials. The Department of Food and Agriculture can also provide contact details of suppliers of materials likely to be permitted for use in organic systems.

Where export markets are likely to be involved, it is important to confirm with your organic certifier any special provisions, especially relating to permitted materials, as these may vary slightly from the National Organic Standards for Australia.

Availability, cost, application and effectiveness of approved materials are likely to be different to the more familiar conventional materials. While the range and availability of products is increasing, there is also an increase in exaggerated or unsubstantiated claims for some products. Caution is required to avoid costly mistakes. Checking with other experienced organic growers can be useful to confirm the value of a product.

Reliable production system and management risk

For most producers it usually takes a number of years to gain experience and knowledge in the different management approaches necessary to operate a biologically based organic production system. Starting with a relatively small area to trial different management techniques and the use of organic sprays and fertilisers can minimise the commercial risk of moving toward organic certification.

Key production issues for WA growers and possible solutions are outlined in previous sections. Producers are advised to trial different approaches on small areas over a number of years to confirm solutions to each problem prior to committing large areas over to organic methods.

Issues for organic mango production that could benefit from further research and development relate to flower initiation, in-field and post-harvest disease control especially for anthracnose and stem end rot, organic nutrient management and the streamlining/incorporation of Organic Certification into Quality Assurance or Environmental Management schemes.

Engaging the services of an experienced organic mango orchardist to assist in the establishment of an organic system may be a cost effective way to accelerate the understanding of an organic approach and avoid costly mistakes during the early transitional years.

Organic standards, regulations and certification

A grower who proposes to establish serious commercial production of organic mangoes should seek organic certification to verify that the product is truly organically grown in accordance with reputable organic standards.

This section describes in general terms the requirements and procedure for gaining organic or biodynamic certification within Australia.

Background – organic and biodynamic regulations in Australia

Internationally it is accepted that the veracity of claims on the labels of organic products must be underpinned by product and producer certification. The reputation and recognition of the organic certification system is often of great importance to importing countries.

Australia has a well-regulated system for organic and biodynamic production and processing that has gained a good international reputation. The 'National Standards for Organic and Biodynamic Produce', administered by Australian Quarantine Inspection service (AQIS) form the minimum mandatory requirements for export of products labelled as organic or biodynamic. These standards are implemented by independent AQIS accredited certification organisations, who conduct whole farming system inspections and ensure a comprehensive record keeping system is in place that allows traceback and verification of inputs used, management practices, yield and sales. Organic standards can also apply to processing and distribution, as shown in Figure 1, to ensure integrity of the certified organic product throughout the supply chain.

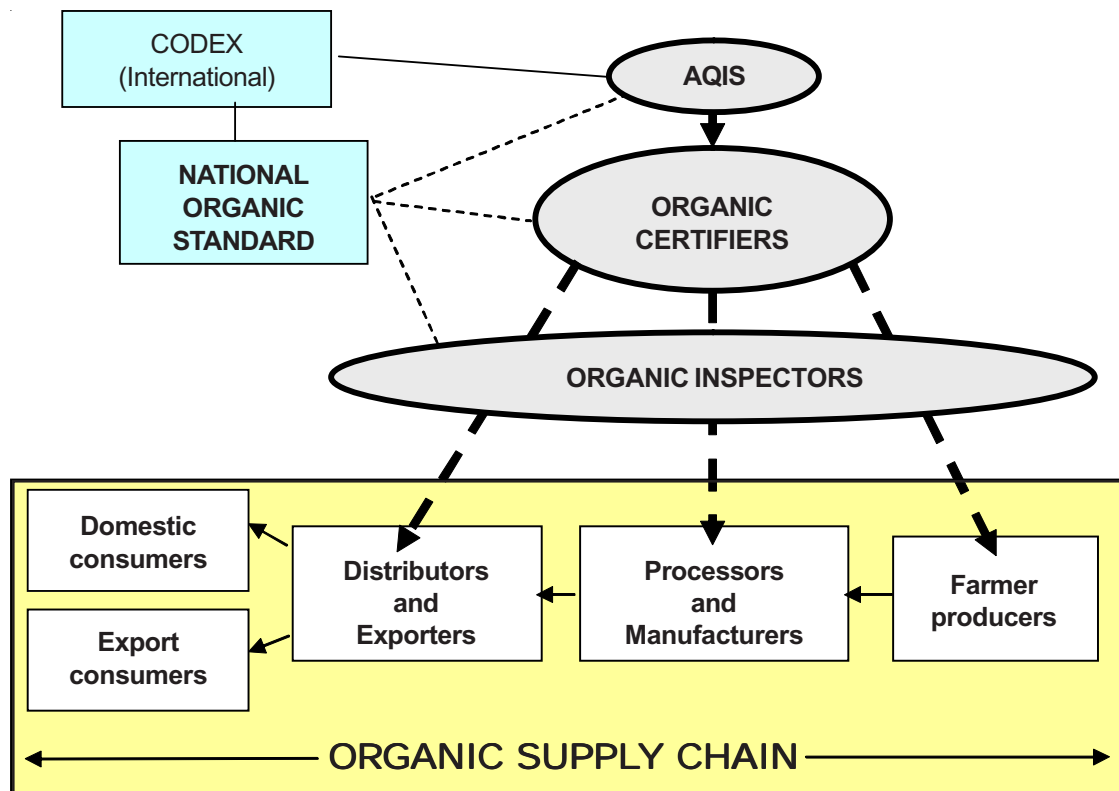


Figure 1. Certification framework of the Australian organic industry.

(Taken from: Comparison of the Australian National Standard for Organic and Biodynamic Produce with Key International Organic Standards and Regulatory Texts. By Mr Rod May and Dr Andrew Monk. Rural Industries Research and Development Corporation.)

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On the Australian domestic market no mandatory requirements currently exist regarding the labelling of products as organically grown – although new regulatory arrangements are proposed. However, there is a trend across all markets for objective proof to support claims relating to product attributes. Most reputable retail outlets require independent organic certification by one of the AQIS accredited certifier organisations for product labelled as organically grown.

Organic production standards aim to:

- protect consumers against deception and fraud in the market place and from unsubstantiated product claims;
- protect producers of organic produce against misrepresentation of other agricultural produce as being organic;
- harmonise national provisions for the production, certification, identification and labelling of organically and bio-dynamically grown produce;
- ensure all stages of production, processing and marketing are subject to inspection and meet minimum requirements; and
- provide a guide to farmers contemplating conversion to organic farming.

Copies of the national standards are available through the certifying organisations, Australian Government Bookshops and the AQIS website (www.aqis.gov.au).

Contact details of the AQIS accredited organic certifiers are listed in Appendix 1.

General requirements for organic certification

The 'National Standards for Organic and Biodynamic Produce' (Organic Industry Export Consultative Committee – OIECC) provide a general definition of organic farming as follows:

Definition

Organic farming means produced in '... soils of enhanced biological activity, determined by the humus level, crumb structure and feeder root development, such that plants are fed through the soil ecosystem and not principally through soluble fertilisers added to the soil. Plants grown in organic systems take up nutrients that are released slowly from humus colloids, at a rate governed by sunlight and warmth. In this

system the metabolism of the plant and its ability to assimilate nutrients is not over stressed by excessive uptake of soluble salts in the soil water (e.g. nitrates).

Organic farming systems rely to the maximum extent feasible upon crop rotations, crop residues, animal manures, legumes, green manures, mechanical cultivation, approved mineral bearing rocks and aspects of biological pest management to maintain soil productivity and tilth, to supply plant nutrients and to control disease, insects, weeds and other pests.'

Aims

The principal objectives of the certified organic operator include:

- the production of food of high nutritional value;
- the enhancement of biological cycles in farming systems;
- maintaining or improving fertility of soils;
- working as far as practicable within a closed system by minimising the use of non-renewable resources;
- the avoidance of pollution resulting from agricultural practices and processing; and
- the coexistence with, and the protection of, the environment.

Features

One essential feature of organic agriculture is the emphasis on biologically healthy, nutritionally balanced soil as the basis for healthy resilient (against pest and disease) plants.

Production avoids the use of synthetic fertilisers, pesticides, growth regulators and other chemical substances detrimental to nature. Genetically modified organisms are prohibited.

In practice, organic certification takes into consideration the whole farming system and typically requires a farm management plan, farm map and record keeping system. The grower must demonstrate and verify that a system is in place and operating in compliance with organic standards. This typically includes a sustainable crop rotation, and strategies to maintain soil fertility, control weeds, pests and disease, as well as water management and buffer zones.

High levels of chemical residues in soil from previous land use can disqualify land from organic certification, as can excessive contamination in plant or animal tissues. Buffer zones and windbreaks can be required to protect

certified areas from contamination by adjacent properties. Organic growers should seek cooperation from neighbours who use chemicals on adjacent properties.

Where growers intend to value-add or process raw product, compliance with organic processing standards is required in order to retain organic certification over the final processed product.

Certification of all production, processing, handling, transport, storage, and sale of organic products is contingent on accurate up-to-date records of the enterprise concerned – to allow scrutiny of the products and processes. Records required typically relate to:

- rotations, soil cultivations and other treatments;
- inputs – type, source, application and timing;
- outputs – production and sales details.

Conversion period

Provision can exist for part certification (sometimes known as parallel production) where part of a property is converted to an organic system while the remainder is farmed using existing conventional methods. Development plans for converting the entire farm to an organic system within a defined period may be required by some certifiers.

The usual progress towards full organic certification is as follows:

- Year 0-1 = 'pre-certification' (no certification status).
- Year 1-2 = 'in conversion' to organic certified.
- Year 2-3 = 'in conversion' to organic certified.
- After 3 years = full 'organic' certified.

During the first year of compliance no organic certification is granted. In the second year of compliance, certification as organic 'in conversion' may be granted. A system certified as organic 'in conversion' typically should progress to full 'organic' after a minimum of three years verified compliance with standards.

Penalties may be imposed for failure to comply with organic standards or breach of rules of certification. This may involve cancellation of certification or reversion to an earlier stage in progress towards full organic certification.

How to gain organic certification

Once you have decided that organic or biodynamic production has potential for your enterprise, follow these steps to become a fully certified producer:

- choose an organic or biodynamic certification organisation;
- read the organic standards;
- write an organic management plan;
- begin farm conversion;
- apply for certification;
- have the farm inspected;
- inspection report submitted; and
- receive organic certification contract.

Choose an organic or biodynamic certification organisation

Contact several organic or biodynamic certification organisations (see Appendix 1) about becoming a certified producer and choose one based on the verbal and written information gathered, on your enterprise needs and goals, fees involved and market requirements. To find out if there is a preferred or highly recommended certifier, set of standards and requirements (as these can differ – especially between organic and biodynamic), it may be helpful to contact existing certified producers, organic manufacturers and/or specialist organic retailers or major retailers selling organic products.

Read the organic standards

Read the organic farming or processing standards, which your farm must comply with. Producers must demonstrate a good understanding of organic farming principles and knowledge of practices and inputs permitted as well as those prohibited according to the certifier's organic standards. If there is little or no extension help offered before implementing and establishing changes to your production system, find out if there are any workshops or field days being run, or experienced organic producers willing to show you around their enterprise. Qualified farm consultants may also be available. Have soil samples taken and analysed prior too, during and following conversion to aid farm planning and soil management.

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Write an organic management plan

Most organic certifiers require a formal organic management plan that outlines the details of how you intend to operate an organic system. Typical topics covered in an organic management plan include:

- Documents, records and audit trail.
- Part (of property) certification details.
- Land degradation issues.
- Soil management.
- Water management.
- Pest, disease and weed management.
- Biodiversity.
- Contamination hazards and buffer zones.

The organic management plan is often revised and refined over time. It can be the key document that describes the farming system and is used by some certifiers as a statutory declaration of compliance with the organic standards.

Begin farm conversion

Changes to the existing production system must be made – either all at once to convert the entire property, or in planned stages. In the first year (pre-certification) initial changes to satisfy the standards are made. Over the following years the producer must demonstrate that an appropriate system is in place and that it successfully operates in compliance with the organic standards.

Apply for certification

When changes to the farming system have begun, application for organic certification can be submitted. Upon receipt of an application, the organic certifier will issue a farm questionnaire seeking all relevant details describing the farming system. Information to be provided includes land use history, rotations, inputs used, details of farming practices and a map of the property and surrounding land use. The questionnaire forms a Statutory Declaration relating to farm practices and inputs used.

Have the farm inspected

A site inspection by an experienced organic farm inspector will follow soon after the questionnaire has been returned to the certifier. The purpose of this inspection is to verify details of the farming system as described in the questionnaire, and to ensure the producer has a good understanding of the principles and methods of organic

farming. As well as discussing the farming system, the inspector will view paddocks, crops, livestock, equipment, sheds and storage areas. The producer must also provide evidence of a complete documented audit trail covering all inputs used, output produced and sales details for all organic products. Soil samples or tissue samples may also be taken for testing.

Inspection report submitted

Following the inspection, the inspector compiles a report confirming details of the farming system established. This report, together with other relevant documents, is considered by the certifier to determine the appropriate level of organic certification. Specific conditions may be imposed where certain practices or circumstances require attention.

Receive organic certification contract

The certifier offers the producer a contract stating which land and crops the certification applies to, and any conditions that must be met. Acceptance of the contract and payment of fees allows the producer to market and label relevant product as certified 'in conversion' or 'organic', and use the logo of the certifier on packaging and promotional material.

Organic certification contracts are generally subject to annual inspection of the site and a viewing of farm records. The producer is required to complete a statutory declaration confirming compliance with standards and detailing yields and sales figures on an annual basis.

Producers may be subject to random, unannounced onsite inspections as part of obligations certifiers must fulfil to satisfy Australian Quarantine Inspection Service (AQIS) accreditation. Some properties may also be subject to inspection by AQIS representatives as part of the regulation of the certifying bodies.

Further reading

Mango information kit. 2000 Agrilink, Queensland Department of Primary Industries.

Mango growing in Western Australia. Department of Agriculture Western Australia, Bulletin 4348.

Mango pests and disorders. Queensland Department of Primary Industries.

Mango picking guide. Queensland Department of Primary Industries.

Organic horticulture: strategic opportunities for Western Australia. Department of Agriculture Western Australia, Bulletin 4622.

Organic food and farming – Introduction. Department Agriculture and Food WA, Farmnote No. 199.

Export market potential for clean and organic agricultural products. Rural Industries Research and Development Corporation, Publication No. 00/76.

Export potential for organics. Rural Industries Research and Development Corporation, Publication No. 06/061.

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APPENDIX 1

Organic industry certification organisations accredited by AQIS as of May 2007



Bio-Dynamic Research
Institute (BDRI)

Bio-Dynamic Research Institute
Powelltown VIC 3797

Phone: (03) 5966 7370
Fax: (03) 5966 7339
www.demeter.org.au



Organic Growers of
Australia (OGA)

The Organic Growers of Australia
PO Box 6171
South Lismore NSW 2480

Phone: (02) 6622 0100
Fax: (02) 6622 0900
E-mail: oga@nrg.com.au
www.organicgrowers.org.au



National Association for
Sustainable Agriculture
(NASAA)

National Association for Sustainable Agriculture
PO Box 768
Stirling SA 5152

Phone: (08) 8370 8455
Fax: (08) 8370 8381
E-mail: enquiries@nasaa.com.au
www.nasaa.com.au



The Tasmanian Organic
Producers (TOP)

The Tasmanian Organic Producers
PO Box 434
Mobray Heights TAS 7054

Phone: (03) 6383 4039
Fax: (03) 6383 4895
E-mail: gretschmann@bigpond.com



Australian Certified
Organic (ACO)

Australian Certified Organic
PO Box 530
Chermside QLD 4032

ACO Head Office: (07) 3350 5706
Fax: (07) 3350 5996
E-mail: info@australianorganic.com.au
www.australianorganic.com.au



The Organic Food Chain
(OFC)

The Organic Food Chain
PO Box 2390
Toowoomba QLD 4350

Phone: (07) 4637 2600
Fax: (07) 4696 7689
E-mail: ofc@organicfoodchain.com.au
www.organicfoodchain.com.au



Safe Food Queensland
(SFQ)

Safe Food Queensland
PO Box 400
Spring Hill QLD 4004

Phone: 1800 300 815
E-mail: info@safefood.qld.gov.au



Australian Quarantine
Inspection Services –
AQIS

Australian Quarantine Inspection Services
GPO Box 858
Canberra ACT 2601

Freecall: 1800 020 504
Phone: (02) 6272 3933
E-mail: organics@aqis.gov.au
Web: www.affa.gov.au

For more information on the production and marketing of Australian organic produce, contact the organic industry organisations at the addresses below:



Organic Growers
Association WA Inc.

Organic Growers Association WA Inc.
Box 7043 Cloisters Square
Perth WA 6850

Phone: (08) 9498 1555
E-mail: enquiries@ogawa.org.au
Web: www.ogawa.org.au

Organic Federation of Australia
Inc. – OFA

Organic Federation of Australia Inc.
PO Box 369
Bellingen NSW 2454

Phone: 1300 657 435
Chairman (07) 4098 7610
E-mail: info@ofa.org.au
Web: www.ofa.org.au

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APPENDIX 2

Input products for use in organic production

(Taken from: *National Standards for Organic and Biodynamic Produce. Edition 3.2. Australian Quarantine Inspection Service. Canberra, 2005.*)

Permitted materials for soil fertilising and conditioning

Substances	Specific conditions/restrictions
Animal manures	Application must be composted or followed by at least two green manure crops in cropping system.
Blood and bone, fish-meal, hoof and horn meal, or other waste products from livestock processing	Following application, uptake of such products by livestock does not form part of the animal's diet.
Compost	Should be produced in accordance with Australian Standard 4454-1999 or recognised equivalent system.
Minerals and trace elements from natural sources, including: <ul style="list-style-type: none"> - calcium (dolomite, gypsum, lime); - clay (bentonite, Kaolin, Attapulgite); - magnesium; - phosphate (rock phosphate, phosphatic guano); - potash (rock and sulphate potash); - elemental sulphur. 	Must not be chemically treated to promote water solubility.
Epson salt (magnesium sulphate)	None
Microbiological, biological and botanical preparations	Products derived from genetic modification technology are prohibited.
Mined carbon-based products	Peat to be used for plant propagation only.
Naturally occurring biological organisms (e.g. worms) and their by-products	None
Plant by-products	From chemically untreated sources only.
Perlite	For potting/seedling mixes only.
Sawdust, bark and wood waste	From chemically untreated sources only.
Seaweed or algae preparations	None
Straw	From chemically untreated sources only.
Trace elements and natural chelates, e.g. ligno sulphonates and those using the natural chelating agents, e.g. citric, maleic and other di-/tri-acids	Not synthetically chelated elements.
Vermiculite	For use in potting/seedling mixes only.
Wood ash	From chemically untreated sources only.
Zeolites	None

Permitted materials for plant pest and disease control

Where wetting agents are required, caution needs to be exercised with commercial formulations as these may contain substances prohibited under this Standard. Acceptable wetting agents include some seaweed products, plant products (including oils) and natural soaps.

Plant pest control

Substances	Specific conditions/restrictions
Ayurvedic preparations	None
Baits for fruit fly	Substances as required by regulation. Baits must be fully enclosed within traps.
Boric acid	None
Biological controls	Naturally occurring cultured organisms, e.g. <i>Bacillus thuringiensis</i> .
Diatomaceous earth and naturally occurring chitin products	None
Essential oils, plant oils and extracts	None
Homeopathic preparations	None
Hydrogen peroxide	None
Iron (III) phosphate	None
Light mineral oils, such as paraffin	None
Lime	None
Natural acids (e.g. vinegar)	None
Natural plant extracts excluding tobacco	Obtained by infusion and made by the farmer without additional concentration.
Pheromones	None
Potassium permanganate	None
Pyrethrum	Extracted from <i>Chrysanthemum cinerariaefolium</i>
Quassia	Extracted from <i>Quassia armara</i>
Rotenone	Extracted from <i>Derris elliptica</i>
Ryania	Extracted from <i>Ryania speciosa</i>
Seaweed, seaweed meal, seaweed extracts	None
Sea salts and salty water	None
Sodium bicarbonate	None
Sterilised insect males	Need recognised by certification organisation where other controls are not available.
Stone meal	None
Vegetable oils	None

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Plant disease control

Substances	Specific conditions/restrictions
Ayurvedic preparations	None
Biological controls	Naturally occurring cultured organisms only.
Copper, e.g. Bordeaux and Burgundy mixture	Hydroxide is the preferred form, Bordeaux only on dormant tissue. Annual copper application must be less than 8 kg/ha.
Essential oils, plant oils and extracts	None
Granulose virus preparations	Need recognised by certification organisation.
Homeopathic preparations	None
Light mineral oils (such as paraffin)	None
Lime	None
Lime-sulphur	None
Natural plant extracts excluding tobacco	Obtained by infusion and/or made by the farmer without additional concentration.
Potassium permanganate	None
Potassium soap (soft soap)	None
Propolis	None
Seaweed, seaweed meal, seaweed extracts	None
Sea salts and salty water	None
Skim milk or skim milk powder	None
Sodium bicarbonate	None
Sodium silicate (water-glass)	None
Sulphur	In wettable or dry form only.
Vegetable oils	None
Vinegar	None

APPENDIX 3

Alternative approaches to soil management

Management of soil fertility for biological systems has attracted a number of alternative approaches to understanding soil conditions and plant growth. The following outlines indicate several concepts for consideration.

- **Dr Rudolf Steiner** – was the initiator of the concepts that form the basis of biodynamic agriculture. Biodynamic farming is a method designed biologically to activate the life of soil and plants. Plants are fed naturally through the soil ecosystem and not primarily via soluble salts in the soil water.

Essential features relate to the use of special preparations and other techniques that enhanced soil biological activity, humus formation and soil structural development as the basis for allowing plants to selectively assimilate nutrients as dictated by sun warmth and light. Biodynamic farms aim to be closed, self-sufficient units.

- **Dr William Albrecht** – was primarily concerned with a soil fertility approach based on nutrient balance (or ratios) as the foundation for achieving proper fertility relevant to optimal plant growth. The nutrient balance equations he developed are related to soil total exchange capacity.

Ideal ratios or percentages of cations and anions are defined for different soil types, with the total availability of these nutrients generally increasing (except magnesium and manganese) with their percentage saturation. The optimal base saturation (cation exchange) ratios are 60 per cent Ca, 20 per cent Mg on sandy soil and 70 per cent Ca, 10 per cent Mg on heavy soil, with 3 to 5 per cent K, 10 to 15 per cent H and 2 to 4 per cent for other bases. The relative values and relationship between nutrients, especially Ca and Mg is considered of great importance.

- **Dr Carey Reams and Dr Phil Callaghan** – this work is based on the concept of defining the potential for plant growth and fertiliser performance in terms of energy release and energy exchange. The contention is that fertilisers in themselves did not stimulate plant growth. It is the energy released (electromagnetic influence or paramagnetic energy fields) from these fertilisers that enhanced production.

A distinction is made between fertilisers (nutrients) that produce growth energy, i.e. calcium, potash, chlorine, and nitrate nitrogen, to those that produce reproductive (fruiting energy), i.e. ammonium nitrogen, sulphate sulphur, manganese and phosphate. The approach also involves a proposition that the nutrient energy potential was dependent on microbial activity, and that energy availability is determined by nutrient balance.

The approach also argues that phosphate is the primary catalyst in photosynthesis and subsequent plant sugar production. Increasing sap sugar levels is believed to reduce susceptibility to pest and disease and that plant sap sugar level (brix) is directly related to plant pest and disease susceptibility.

Various approaches and analyses relating to soil conditions and plant growth continue to be developed and a vast array of alternative input products are available. Scientific verification of many of these contentions and products has yet to be established. As a consequence the decision to adopt particular approaches tends to rely on anecdotal information and practical experience.

organic

mangoes

Notes
