



PO Box 180 Carole Park Qld 4300
Ph: (07) 37123800 Fax: (07) 38793255

Operational Management Plan



2006 MANGO PROJECT
KATHERINE, MATARANKA & DIMBULAH

For period
1 July 2009 to 30 June 2010

INTRODUCTION

Oolloo Farm Management is focused on the establishment and maintenance of efficient and highly productive 'B74' (Calypso™) mango orchards on behalf of investors in the 2006 Mango MIS.

This operational management plan (OMP) sets out the key management activities for the period from 1 July 2009 through to 30 June 2010.

For the period of the OMP the Katherine farm will be producing its first crop and the Mataranka and Dimbulah farms their second crop. The plan takes into account growing the fruit through to harvest by late 2009 and setting the trees up for cropping in the 2010/11 year.

The focus during this planning period is to:

- Grow and protect the crop under conditions that maximise fruit quality and yield
- Apply postharvest management strategies that will optimise subsequent production
- Protect summer/autumn growth and flowering from pests and diseases
- Maintain the orchard floor
- Promote growth in windbreaks
- Provide training for farm management and staff where appropriate

This OMP is structured around the key orchard activity areas of:

- Pest and disease management
- Nutrition management
- Irrigation management
- Canopy management
- Orchard floor management
- Site management

PEST & DISEASE MANAGEMENT

The objectives of pest and disease management activities are to maintain a constant awareness of pest loads throughout the orchard and to make decisions about pest control measures at the appropriate time to minimise economic cost and/or loss. The program also seeks to foster and maintain effective levels of beneficial predatory insects, birds and provide a safe environment for local indigenous fauna.

Disease and insect activity will be closely monitored and appropriate action taken to protect the flowers and developing fruit from economic damage.

Method of management:

Pest and disease management is based on several monitoring and control strategies. Monitoring is through the adoption of a structured integrated pest management (IPM) program to identify pest and beneficial populations and disease loads. This monitoring combined with daily observation by farm staff provides input on which response and control options can be based. When pest and disease loads are considered to have reached levels that may cause economic loss greater than the cost of control, appropriate control actions will be taken. These points of control will vary depending on the crop stage and sensitivity to damage.

Some control strategies are also based on proactive protection of the crop at defined phenological stages, e.g. disease protection during flowering and fruit development.

Pest and disease monitoring programme:

A number of IPM scout sites are used together with monitoring at random sites to give thorough coverage of the orchard. Insect traps at the scout sites provide a quantitative assessment of insect numbers and activities to assist in different control strategies. IPM monitoring will be done weekly from flower emergence (June/July) to harvest (November/December). From December/January through to flowering in June/July, scouting will be done monthly as pest and disease pressures are generally low. An external professional pest scout has been contracted to visit the site fortnightly from flowering to harvest and thereafter monthly.

Only chemicals registered for use on mangoes will be applied to control pest and disease problems and where appropriate the most environmentally-friendly pesticides will be used. The presence of beneficial predatory insects will be encouraged throughout the orchards by appropriately timed spraying, the use of biological control strategies, correct chemical choices, minimising chemical use and by providing on farm habitats (windbreaks and natural vegetation) for predatory insects. Opportunities to release predatory insects will be explored if appropriate circumstances arise.

Pest control programs will be driven in direct response to orchard observations and tree phenology rather than pre-programmed spraying however for budgeting purposes a standard spraying plan has been developed.

Pests of Interest:

Commercially significant pests are listed below:

Leaf Eating Caterpillars, Swarming Beetles and Tip Borers

These three insect pests groups can cause economic damage to new growth flushes and growth terminals. If outbreaks occur on growth that needs to be protected, the application of a chemical response is required (Carbaryl[®], Endosulfan[®], Success[®] or Methidathion[®]).

Mango Scale

'B74' fruit are particularly sensitive to mango scale, which can cause pink-spotting on fruit leading to a downgrade in quality. As trees grow larger scale becomes more difficult to control so it is anticipated that infection levels will increase as the orchard matures. Scale is a common pest and will take hold in orchards if not regularly monitored and controlled at appropriate life cycle stages. Best control is achieved with a combination of beneficial predators (such as *Chrysopidae* (lacewings) and *Cryptolaemus* (ladybirds)) and appropriately timed chemical sprays with the use of Carbaryl[®], Applaud[®] or if necessary Chlorpyrifos[®] or Methidathion[®] (the later also being registered for use against leaf miners, mango seed weevil, mango tip borer and pink wax scale). The most effective time for sprays to be applied is at the scale crawler stage when young scale move from the mother and egg cluster. This can be determined by regular monitoring of trees

Petroleum oil is also effective in controlling mango scale at both crawler and adult stages but can only be used during the cooler weather as phytotoxicity may occur when temperatures exceed 30°C.

Mango Plant hopper and Leaf hopper

Both these pests can cause significant economic loss if not appropriately controlled. Whilst Lacewing and other predators will help control these pests they are not effective in providing commercial control during fruiting when fruit damage can occur if populations get too high. Intervention with pesticides is usually required during the fruit production period.

When mango leaf hoppers are observed on the orchard immediate control action will be taken. For plant hoppers, we will apply Carbaryl[®] or Endosulfan[®] (which is also registered for use against flower caterpillars, fruit spotting bugs, mango shoot caterpillar, mango tip borer, and red banded thrips).

Flower Caterpillars

During flowering control of flower caterpillars may be required. The use of a biological control agent (*Bacillus thuringiensis* – product name Dipel®) will be adopted if caterpillars are at the appropriate life cycle stage (must be observed early). If significant outbreaks occur the use of “soft” chemicals will be considered. Success® and Dipel® specifically target caterpillars and do not harm beneficial predatory insects important to flower pollination.

Seed Weevil

Seed weevil is a concern from the point of view that it limits access to some export markets (e.g. China). There have been successful trials done with a chemical called Actara® however the product is very expensive and only would be considered if there was a known cost/benefit. Fruit cuts will be taken to assess if the orchard is naturally free of seed weevil.

Other insect pests

Several other potentially flower/fruit damaging pests may need to be controlled (e.g. red banded thrips, fruit spotting bugs and Monolepta beetles) and appropriate response measures will be driven by the IPM program.

Diseases of Interest:

Fungal (anthracnose, stem end rot and powdery mildew) and bacterial (Bacterial black spot) diseases are a significant threat during flowering and fruit development. The management of disease control in mangoes differs from the IPM approach used for insect and mite pests. Fungal and bacterial disease organisms are microscopic and cannot be easily detected until commercial damage appears. Hence in most cases disease control requires routine spraying to protect the crop from potential infection.

Despite the fact that disease pressure is relatively low in young orchards a full fungicide program will be maintained to ensure that high fruit quality is achieved. Two-monthly postharvest applications of copper-based fungicides during the shoot growth (flushing) period (January to June) will be applied using alternate copper products (Copper oxychloride® and Novofix®) to control anthracnose in juvenile leaves and reduce the likelihood of Bacterial black spot infection.

Anthracnose

Anthracnose is a fungal disease and is the most significant pathological problem affecting mangoes. ‘B74’ has a higher resistance to the disease than other commercial varieties grown in Australia but nevertheless can still become infected. The flowers are the most susceptible organs of the tree and are treated with fungicides as a precaution against the disease which can move rapidly if conditions are favourable for its development. Surface moisture generally from rain events during flowering provides the most favourable conditions for infection. Young fruitlets can also be infected causing premature drop resulting in reduced yields. Latent infection occurs on larger fruit which can initially prevent the disease developing however, once postharvest ripening begins the infection is released and rapid invasion of the fruit occurs.

To manage this disease there are two groups of fungicides with different modes of action:

- 1) protectant fungicides which include the coppers and Mancozeb®;
- 2) the systemics which include Octave® and Amistar®.

The protectant fungicides work by establishing a chemical barrier between the fungus and the flowers and/or fruit. As growth of these organs is rapid the barrier must be regularly replenished (3-weekly applications or more regularly if rain occurs) to maintain the protective barrier. Due to potential phytotoxicity with copper sprays Mancozeb® is the only fungicide in this group recommended for use during flowering but copper fungicides are safe to use after fruit set. Copper has the added advantage of controlling Bacterial Black Spot. The systemic fungicides are able to eradicate latent infections in flowers or fruit and are most useful to use after rain events. However, due to potential anthracnose resistance developing to these fungicides their use should not exceed four applications for Octave® and three

applications for Amistar[®]. In addition between each application of Octave[®] or Amistar[®] a protectant fungicide should be used. Amistar[®] is the most effective of the two systemic fungicides and once applied reactivates after rain hence has a long term effect on disease control. It may be used once during flowering if a significant outbreak of the disease occurs and then twice just prior to and during harvesting if rain falls. The use of Amistar[®] immediately pre-harvest is most effective in eradicating latent infections of anthracnose in mature fruit. Octave[®] is generally applied at mid-bloom and then during fruit growth if significant rain events occur. More than one spray may be applied during flowering if rain persists but it should be alternated with Mancozeb[®]. A preventative annual spray programme has been developed for each farm but actual applications will depend on observations.

Methods of weed and pest control

All orchards have spray units capable of covering the orchard in a short time. Where compatibility is not an issue tank mixes of pesticides and fungicides will be applied to keep production costs to a minimum.

All operators are required to have chemical certification and to wear necessary PPE. The tractors are fitted with chemical filters and maintained as per recommendations.

Records:

Records of all chemicals sprayed are kept detailing all required information (e.g. spray/dilution rates, weather conditions, which areas sprayed and operators name and signature).

Wallaby Control:

Wallabies have proved to be a problem in the drier months when grass sward is growing strongly due to orchard irrigation. Access is controlled by ring fencing where possible but fencing requires continuous maintenance and this is now part of monthly schedules.

NUTRITION MANAGEMENT

Nutrition:

Nutrition plays an important role in tree performance (yield) and fruit quality. General crop nutrition is monitored by soil and leaf analyses taken immediately pre-flowering and repeated immediately postharvest. Results are matched with the standards considered appropriate for the B74 variety and appropriate adjustments to nutrient application made where necessary to maintain tree nutrition within the defined standards. Key areas of management in crop nutrition are soil pH, and leaf N, K, Ca, B and Zn. In most instances the latter are the nutrients that require the greatest management due to leaching losses and crop removal. Nutrient application technology

Soil application is the most cost-effective means of applying nutrients. Applications will be made to the soil via the following methods:

Liquids and soluble solids – by fertigation

Solids – by blower machine and/or spreader on gators or tractor

The 2009/2010 Nutrition Programme:

Once trees reach fruiting the nutrition of the crop has two different targets in a 12 month production cycle:

1. From flowering thorough to harvest nutrition focuses on producing quality fruit (extended shelf life and flavour). The eight weeks from flowering through to stone-hardening is the only time available to enhance the calcium content of fruit. Calcium is mobile in low CEC soils (all soils on OFM farms have low CEC's) and leaches quickly through the profile hence the management strategy is to apply calcium as micro-gypsum on a 1-2 week schedule during this period. From stone-hardening through

to maturity the focus is on increasing sugar and acid levels in fruit as these help to define flavour. This is achieved by applying potassium in the sulphate form. Calcium and potassium should not be applied simultaneously since both are cations and compete for absorption sites on roots. Potassium will displace calcium thereby limiting its uptake.

2. At the completion of harvest the tree will be nutritionally depleted but a growth flush will be required prior to the next fruiting season. Calcium (as agricultural grade gypsum) and nitrogen are the two major nutrients applied at this time while leaf analyses will determine if other nutrients are needed.

Nutritional requirements over a 12 month fruiting cycle have been defined and are further validated by leaf and soil analyses (leaf analyses to be collected immediately postharvest and again prior to flower bud break while soil analyses collected prior to flower bud break).

IRRIGATION MANAGEMENT

Water Management:

Water is a valuable resource and is essential to grow quality mangoes since flowering and fruiting occur during the driest months of the year. The water management program aims to meet the demands of the crop both throughout the flowering and fruiting period and also to ensure that trees are supported postharvest so that renewal growth is encouraged to provide an optimum opportunity for sustainable cropping.

Method

“Real time” monitoring of soil moisture is carried out via electronic probes that collect data at 10, 30, 50, 80 cm below soil level. The probes are placed strategically across the farms covering the variations in soil types so that irrigation scheduling can be matched to water availability and tree requirements. Water is delivered to trees via micro-sprinklers emitting 70 L/hr covering 20 m² around trees.

Trees adjacent to soil moisture probes sites are also used as pest scout sites (IPM program) and tree phenology monitoring sites allowing fixed points for data collection.

Irrigation scheduling will seek to maintain soil moisture in the established ranges with frequency of watering determined by the rate of draw-down as reflected in the soil moisture readings

Irrigation Maintenance:

To maintain the irrigation infrastructure in optimal operational condition regular maintenance will be carried out. The system will be flushed monthly during the peak irrigation months to ensure the main and sub-main lines remain clear. This process will include phosphoric acid rinses twice annually to clear and build-up of deposits in lines. A pre-season irrigation system maintenance schedule will be carried out and any major repairs undertaken during the wet season when irrigation is less frequent.

Records:

Records of irrigation events and responsible personnel are kept. Any maintenance is also recorded.

CANOPY MANAGEMENT

The objective has been to achieve well-structured and erect trees that support high yields without significant propping of fruiting branches. While structural pruning will continue to a lesser extent over the next 1-2 years the main focus of canopy management will be to produce sustainable yields of high quality, coloured fruit. This will be achieved by strategic pruning operations designed to synchronise tree

growth and sustain high yields while maintaining open canopies for light penetration and ease of pest and disease control.

Tree Staking and Propping

Tree stakes have been removed from all of the larger trees that fruited for the first time in 2008. While trunks of trees were trained higher before branching than normal industry standard (Kensington Pride) to reduce the need for propping the precocity of 'B74' is such that some branch propping will be required.

Pruning

In fruiting trees, growth in the subtropics (Queensland) is much slower than in the tropics (NT) due to both lower mean temperatures and a longer cropping cycle reducing the time for vegetative growth to occur before the onset of winter. Pruning is designed to improve synchronisation of flowering on young trees in the following fruiting season.

Floral induction and Trunk Scoring

Standard industry practice is to encourage annual floral induction in mango trees in the Northern Territory and north Queensland via trunk drenching with paclobutrazol sold as Payback[®] or Austar[®]. Pricing of the two products is competitive and they appear to be as equally effective but in the past the Payback[®] formulation has proven easier to work with from both mixing and human health perspectives.

To build a useful database the following protocol will be adopted across all farms where paclobutrazol is recommended for floral induction:

Select a rate for treatment across the farm from published information based on soil type and tree size. Use this rate for the commercial treatment ensuring that it is adjusted downwards for any smaller trees in the block. Calculate a rate 30% higher and lower than the base rate and treat 50 trees per zone at each of these rates identifying these trees for future observations. Do not treat the same trees at the $\pm 30\%$ rate in consecutive years. Record any differences observed between the base rate and the $\pm 30\%$ rate to assist with choosing a base rate for the following season where the process will be repeated.

Trunk scoring on 'B74' trees has been developed as a useful tool for enhancing tree yields. Trunks are scored in April to manipulate a greater accumulation of carbohydrate in the top of the tree. The additional energy resource is available to drive flowering, fruit set and retention resulting in higher yields.

Tree replacements

Monthly tree audits are carried out across the blocks checking for tree losses so that replacements can be ordered and planted. A replacement allowance of 0.5% of the tree population was initially set but losses are now minimal and are expected to become insignificant with time.

ORCHARD FLOOR MANAGEMENT

Orchard floors have developed an inter-row sward that is maintained by slashing and a vegetative-free zone approximately one metre either side of the tree line that is maintained by application of herbicides. The vegetation-free zone along the tree-line is to reduce competition for water and nutrients and to ensure that the operation of micro-sprinklers is unimpeded.

Sward Management

The objective is to maintain an inter-row grass cover to minimise the risk of erosion. Additionally, slashing deposits grass residues onto tree line rows where it suppresses weed growth and contributes to soil organic matter. The slashing schedule is derived from a weekly weed report. Records of slashing progress are kept by the tractor operators.

To minimise weed growth slashing is carried out at intervals prior to the seeding of grasses in the sward. Based on past experience slashing is required monthly although there are a few exceptions where slashing is either not required or is carried out twice in a monthly period.

Weed Management

Herbicide application is scheduled according to the weekly weed report. Along with forward projecting weedicide application the report also provides QA on the previous application and its effectiveness on weed kill.

Basta[®] and glyphosate herbicides are used either individually or as a tank mix for control of weeds in the vegetation-free strip. The alternate use of these two herbicide groups along with strategic combined application provides effective control of a broad range of weeds and reduces the chance of resistance developing. The monthly application of herbicide from October to June has proven effective in managing the vegetation-free zone while an additional spray in July/August is required to control winter weed growth.

Testing different additives/stickers to improve the effectiveness of herbicides is ongoing and is also aim at reducing the concentration required thereby decreasing herbicide costs.

Equipment

Tractors or gators are used for applications depending on volume requirements. During the “wet season” gators are used more extensively as heavy equipment cannot get into the field due to soil conditions.

Protocols for Herbicide Application

Strict protocols are in place for the application of herbicides. Onsite weather stations monitor wind speed which is used to determine opportunities to spray weeds. Applications of herbicides can be safely made between wind speeds of 0-7 km/h. Above 7 km/h weedicide application must stop as spray drift with potential damage to trees becomes too great a risk. Experience has shown that herbicides are best made at night when wind is seldom an issue. The equipment is set up with lights to facilitate this activity.

Monitoring Outcomes

The successes of the spray program are measured by achieving scheduled weekly targets. These spray targets are set from the weekly weed report which includes a QA section. Progress is then monitored throughout the week. These targets are set off optimum spray conditions and rates. Weed kill rate is the most important criteria, so calibration of spray equipment is extremely important. Flow meters are on each unit to ensure constant and correct pressure is used.

Fence Line Weed Control

Fence line, building and windbreak-row weed control will be carried out regularly during the year as required. A glyphosate and/or Basta[®] herbicide program will be used.

SITE MANAGEMENT

The objective is to keep the site in good appearance at all times and make sure it remains operations friendly, i.e. to make sure it is a safe farm environment to work on.

Permanent full-time staff are employed to carry out all core farm activities associated with canopy management, pest and disease management, irrigation and nutrition management and site management. In addition, seasonal staff are employed to cover specific high labour demand activities such as harvest and pruning.

Consultants are employed where necessary to assist with pest and disease management and irrigation. Dr. Tony Whiley provides consultancy services for all other aspects of mango production including development of the OMP.

Hazard Management

A hazard plan showing all the major hazards is in place. Any hazards or potential hazards are reported to management for recording on the hazard plan as a standard procedure issued to all staff. These are included on job orders issued to staff. Any major hazards arising are to be dealt with immediately.

Erosion Control

The main erosion risks have been reduced with the good sward cover. There are no major erosion risk areas remaining but an erosion management plan is in place. This includes repairing any eroded contours/drains etc. promptly.

Slashing

Site slashing will be undertaken during the normal course of orchard maintenance.

Fence Lines

Herbicide will be sprayed to keep these areas clean.

Fire Control

Water tankers are available on all sites. These can be secured to any of the farm utilities or tractors at short notice. During the higher fire risk months water tankers are kept full and connected to either a farm utility or tractor.

Boundaries will be kept mown all times with roads either side of fences where possible as part of a firebreak plan. These firebreaks will be burnt where appropriate to provide a more effective fire break.

The Fire control plan includes an evacuation plan which is:

1. Raise alarm on farm two way radio
2. Despatch fire fighter tank to affected area
3. Alert local fire authorities
4. Where possible turn irrigation on along the threatened part of the orchard to help wet the area to reduce the risk of the fire spreading
5. Farm management to check all staff are accounted for at the designated assembly area.
6. Signage with telephone numbers displayed on operations buildings and on the farm gate. These numbers will be to contact the fire warden and the farm manager if necessary.

Infrastructure Maintenance:

Fences and Gates – A monthly check on the perimeter (boundary) fence is to be completed to identify any necessary repair work. Required repairs will then be added to the maintenance schedule.

Buildings and Sheds – Buildings are checked monthly and any defects recorded. Vermin in buildings are controlled with locked baits as per the EPA recommendations.

Dam (Dimbulah) – A monthly inspection report is carried out on the condition of the dam. An evaporation reducing agent will be added to the dam to see if water pumping costs can be saved.

Quarantine:

Entry to the farm will be controlled thereby reducing the exposure to pest and disease entry. A quarantine response plan is in place:

LEVEL 1 - Standard everyday entry:

1. Any visitors to the farm must have made an appointment.
2. All vehicles entering the farm to park in the designated visitor's car park, report to the office and sign a visitor book. Employees have a designated parking area.
3. **ONLY** Ooloo vehicles are to be used around the farm. These will be disinfected if they have been off the farm during disease alerts.

LEVEL 2 – If there is any cause to suspect an exotic disease outbreak in the region the following steps must be taken:

1. Signage erected at main gates.
2. All visitors to the farm must have an appointment.
3. All vehicles entering the farm are to be sprayed at the gate of the main entrance or pass through a vehicle bath if provided.
4. All people in vehicles are to use supplied footbaths at the entrance gate before entering the farm.

LEVEL 3 – A confirmed outbreak of any disease in the region the following steps must be taken:

1. Signage erected at main entrance gates.
2. Entry by all visitors to the farm will be by appointment only. Access will be denied without a prior appointment.
3. All gates onto property locked at all times.
4. No visitors vehicles will access the farm.
5. Pressure washer will be installed at the main gate for all Ooloo vehicles needing to enter the farm. Followed with sterilization spray.
6. Footbath use is essential by **EVERYONE** entering the farm.

Environmental Management:

The farm environment will be managed to meet the requirements of the OFM quality management system (QMS) and environmental management plan (EMP). It is expected that as part of this EMP periodic counts of flora and fauna will be made and assessments of the impact of farm operations on the environment using relevant indicators will be made. Annual water samples will be taken to monitor water quality.

The IPM system used on all farms is an environmentally sensitive approach to the management of pests and diseases and encourages the build up of populations of beneficial insects, fauna and flora.

Waste Management:

All farm wastes are managed in accordance with the OFM Waste Management Plan (WMP).