Making the change to high density mango orchards

Why intensify?

Maintaining profitability in an environment of ever-increasing costs is a major challenge facing Australian mango growers. A key priority for the Australian mango industry is to increase industry productivity per hectare through increased yields and reduced costs (Hort Innovation, 2017). To achieve these goals, improved productivity is essential, however, this is challenging with conventional planting densities often less than 200 trees per hectare. Yields per hectare vary annually, but on average, Kensington Pride (KP, the main industry variety) yields 35 – 70kg per tree or 7 – 13 tonnes per hectare at a spacing of 185 trees/ha (DPI, 1999). Opportunities exist to improve productivity through intensification.

An intensification program within the apple and pear industry (Future Orchards®) initiated in 2006, has substantially increased industry average production from 10-20 up to 35-55 tonnes/ha, with some orchards achieving over 100 tonnes/ha (Crawford, 2016). This success has been achieved through the adoption of new canopy systems including trellis and non-trellis designs, which incorporate smaller trees, grown at higher densities, with narrow, more open canopies. These systems increase canopy surface area per hectare and improve light interception and light distribution, which in turn results in improved productivity.

Figure 1. Apples grown on trellis systems. The success of high-density orchards in the apple and pear industries (Future Orchards®) has inspired high density trials in other tree crops, including mango.

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Challenges for mangoes

High density systems also have great potential for mango orchards, however, one of the main challenges posed by intensifying mango trees is vigour control (Bally and Ibell, 2015; Menzel & Le Lagadec, 2017). Most mango varieties grown in Australia are vigorous (particularly Kensington Pride) and if left unmanaged can easily grow to heights greater than 10m. The use of trellising and/or intensive branch training and pruning methods has been successfully used as a tool by the apple and pear industry to manage vigour (Crawford, 2016). These methods may also enable mango orchards to be grown at higher densities and significantly improve productivity.

Other expected advantages of smaller trees grown at higher densities include;

- more efficient harvesting, better adaptation to mechanisation and robotics,
- greater efficiency of pest and disease management (Bally and Ibell, 2015; Bally *et al*., 2020; Menzel & Le Lagadec, 2017) and,
- greater cyclone resilience (Drinnan *et al.* 2018).

Figure 2. The Kensington Pride mango variety is extremely vigorous, making it less suitable for high density orchards.

Industry adoption

The Australian mango industry has experienced a gradual shift towards increased planting density over the past 20 years, as new varieties with less vigour than KP have been planted. These include R2E2, Keitt, Honey Gold and Calypso®. There are a number of established, well managed R2E2 and Keitt orchards with up to 555 trees/ha. Semi-dwarf varieties such as Calypso®, have been commercially planted at densities up to 357 trees/ha.

Figure 3. An example of an R2E2 mango orchard in Bowen, Queensland, planted over 20 years ago at high density (6x3m or 555 trees/ha).

Research Trials

A study by Drinnan *et al*. (2018) found that mangoes grown at Mareeba under a high-density trellis system (5x3m) also showed good applicability to this system. In response to these national orchard system trends, the Queensland Department of Agriculture and Fisheries (DAF) commenced the Small Tree High Productivity Initiative in 2012. This initiative aims to help transform tropical and sub-tropical fruits from low-yielding, low density orchards into high yielding, high density orchard systems. Under this initiative and with funding support from Hort Innovation using the cross-industry R&D levy, a large, replicated, planting systems trial (PST) was established at the DAF Walkamin Research Facility in 2013, incorporating three mango varieties grown at a range of planting densities using conventional and trellis methods. Early results from this trial have been very promising and suggest mangoes have high potential for improved productivity when grown in higher density systems (Bally *et al*., 2020).

Figure 4. A mango planting systems trial that includes trellised and non-trellised planting densities of 1250 trees/ha has been running at Walkamin Research Facility since 2013. The new hybrid variety NMBP-1243 (pictured) is one of three varieties being trialled, along with Calypso® and Keitt.

Table 1. Advantages and disadvantages of high-density mango orchards

Advantages	Disadvantages
Higher yields/ha	Higher establishment costs per hectare
Greater input efficiency per kg of fruit produced	Higher early management costs per hectare
Higher profitability	More management complexity
Smaller trees are easier to harvest	Cannot use large machinery
Suited to robotic harvest technology	More pruning required
More efficient pesticide use per hectare	Requires staff training
Less prone to cyclone damage	Difficult to manage tree vigour
	Risks of greater fruit sunburn

Economic implications

Adopting a new orchard management system poses numerous risks, but of chief concern among growers are the economic implications of this decision. High density systems – particularly trellis systems – require significant upfront investment in infrastructure and additional labour for pruning and training. In new systems, these costs are challenging for growers to accurately estimate, and subsequently make informed decisions about moving to higher density designs.

For more information on the economic implications of high-density orchards, see the Economics of high-density mango orchards fact sheet. For a gross margin analysis see the CRCNA report 'Economic Case Study of Intensive Mango Systems: A comparison of the profitability of conventional (low, medium & high-density) and trellis (high-density) mango canopy systems in north Queensland based on early trial results', available at the above link or at the Cooperative Research Centre for Northern Australia's (CRCNA) website under Resources > Publications > An economic case study of intensive mango systems.

Key references

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