Designing labour efficient canopies

Prepared by
Ross Wilson and Steve Spark
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The fundamentals of pomefruit canopy design need to be understood first.
Light Interception drives yield
Light Interception (LI) drives yield

25% LI = 30t/ha

60% LI = 80t/ha
Yield makes money?

### Rosy Glow House

<table>
<thead>
<tr>
<th>Block Description</th>
<th>2017 Forecast</th>
<th>2016 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trees</td>
<td>Age</td>
</tr>
<tr>
<td></td>
<td>3653</td>
<td>12 yrs</td>
</tr>
</tbody>
</table>

#### Yield

<table>
<thead>
<tr>
<th></th>
<th>Kg/Tree</th>
<th>Gross Kg/ha</th>
<th>Class 1 Kg/ha</th>
<th>Tonnage/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross yield</td>
<td>37.5</td>
<td>100,000</td>
<td>80,000</td>
<td>100.0</td>
</tr>
<tr>
<td>Submitted to Packhouse</td>
<td>100%</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Recovery and Returns

<table>
<thead>
<tr>
<th></th>
<th>Class 1</th>
<th>Class 2</th>
<th>Process</th>
<th>Av gms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packouts</td>
<td>80%</td>
<td>0%</td>
<td>20%</td>
<td>170</td>
</tr>
<tr>
<td>Returns</td>
<td>$2.00</td>
<td>$0.00</td>
<td>$0.00</td>
<td></td>
</tr>
</tbody>
</table>

#### Direct Financial Result

<table>
<thead>
<tr>
<th></th>
<th>$/Tree</th>
<th>$/Gross Kg</th>
<th>$/Class 1 Kg</th>
<th>$/Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>INCOME</td>
<td>60.01</td>
<td>1.60</td>
<td>2.00</td>
<td>160,000</td>
</tr>
<tr>
<td>Packing</td>
<td>13.13</td>
<td>0.35</td>
<td>0.44</td>
<td>35,000</td>
</tr>
<tr>
<td>Packaging</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0</td>
</tr>
<tr>
<td>Coolstorage</td>
<td>9.60</td>
<td>0.26</td>
<td>0.32</td>
<td>25,600</td>
</tr>
<tr>
<td>Freight</td>
<td>0.75</td>
<td>0.02</td>
<td>0.03</td>
<td>2,000</td>
</tr>
<tr>
<td>Total post harvest costs</td>
<td>23.48</td>
<td>0.63</td>
<td>0.78</td>
<td>62,600</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>$/Tree</th>
<th>$/Gross Kg</th>
<th>$/Class 1 Kg</th>
<th>$/Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORCHARD GATE INCOME</td>
<td>36.53</td>
<td>1.22</td>
<td>1.22</td>
<td>97,400</td>
</tr>
<tr>
<td>Prune</td>
<td>1.75</td>
<td>0.05</td>
<td>0.06</td>
<td>4,666</td>
</tr>
<tr>
<td>Thin</td>
<td>3.00</td>
<td>0.08</td>
<td>0.10</td>
<td>7,999</td>
</tr>
<tr>
<td>Harvest</td>
<td>4.13</td>
<td>0.11</td>
<td>0.14</td>
<td>11,000</td>
</tr>
<tr>
<td>Other orchard exp</td>
<td>6.75</td>
<td>0.18</td>
<td>0.23</td>
<td>18,000</td>
</tr>
<tr>
<td>Management fee</td>
<td>0.75</td>
<td>0.02</td>
<td>0.03</td>
<td>2,000</td>
</tr>
<tr>
<td>Total orchard expenses</td>
<td>16.38</td>
<td>0.44</td>
<td>0.55</td>
<td>43,666</td>
</tr>
</tbody>
</table>

| TOTAL EXPENDITURE      | 39.85  | 1.06       | 1.33         | 106,266 |
|                        | 28.28  | 1.26       | 1.40         | 75,412  |

| PROFIT                 | 20.15  | 0.54       | 0.67         | 53,734  |
|                        | 12.22  | 0.54       | 0.60         | 32,588  |

*Source: Horticulture Innovation Australia*
Light Distribution impacts quality

All parts of the canopy must receive 20-30% of total light to grow good quality fruit.

Figure 1. Light penetration into the canopy of a large apple tree. (From Heinicke, 1975, USDA Agri. Handbook 458).
Labour efficiency is critical

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**Cost of production ($/ha)**

- Depreciation
- Overhead costs
- Orchard working costs
- Labour costs
- Postharvest costs

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**Costs of production ($/gross kg)**

- Depreciation
- Overhead costs
- Orchard working costs
- Labour costs (incl wom)
- Postharvest costs
Therefore: the fundamentals of an apple canopy are:

- A canopy that intercepts a minimum of 70% of total available light (TAL)
- A canopy that has light distribution (>20-30% (TAL) throughout the entire canopy capable of colouring fruit to market specification
- A canopy that gives a low vigour, calm tree at maturity with good precocity and high yield efficiency
- The combination of rootstock, system and density that is able to fill the allotted space quickly ie within 6 years
- A canopy that allows for maximum labour efficiency = Total labour cost below 40c/kg
- Tree density/canopy option must make good economic sense i.e. IRR > 15%
What canopies are in common use now?
The 1990 Model

- 1.5m
- 1.5m
- 1.5m
- 4.5m
The 2010 Model
So what of the future?

• Is a pedestrian orchard possible?
• Will robots be able to pick our crop?
• Will ladders become a thing of the past?
• Will we all be using platforms?
• Will we be picking under light 24 hrs a day
• Is 170t/ha of quality fruit really possible?
Yield potential of different canopy structures

Slide provided by Dr. Alberto Dregoni (Italy)
4 and 6 leader Golden Delicious 2.7 rs x 2.25 ts
1650 trees/ha x 53kg/tree = 87 tons/ha
Multi-leader fruit wall

Slide provided by Dr. Alberto Dregoni (Italy)
Experimental canopies 2020 ??

Dr Doregoni (Italy)
• Create a true pedestrian canopy that can match current yield potential.

Dr Tustin et al (Plant and Food NZ)
• Maximise light interception to lift Class 1 yield potential
Doregoni Pedestrian

- 2.0 – 2.5 m row space
- 2.4 – 2.8 m tree space
- Multiple uprights 0.4-0.5 m apart
- Upright canopy allowing access to both sides
- Mechanical trimming
- Canopy no more than 2.5 m tall
- True pedestrian with yield potential of 100t/ha
Double Guyot

Spacing: 2m (between rows) x 2.4 and 2m (between rows) x 2.8

Slide provided by Dr. Alberto Dregoni (Italy)
“Super Orchard”

- 1.5-2.0 m row widths
- 3.0 m plant spacing
- 10 uprights per plant
- 1666 trees per ha or 16660 stems per ha
- 10.2 kg/stem or 50 apples per stem = 170 tonnes per ha
- Canopy height target = 1.5 x row width. Will light distribution be maintained above 20%
To grow a ‘super orchard’

Apple trees could theoretically yield more than 150 bins per acre, says New Zealand scientist Dr. Stuart Tustin, but it would require a complete orchard redesign.

Trees are planted 10 feet apart. Each tree has 10 upright shoots, or stems, trained from the cordons every 12 inches.

Rows are planted 5 to 6 feet apart.

Stems can grow up to 11.5 feet.

Yields theoretically could range from 150 to 200 bins per acre. (U.S. apple production currently averages around 35 bins per acre.)
Summary

• Dwarfing rootstocks
• Canopy full of calm low vigour fruiting units
• Canopies that are narrow not deep
• Canopies that minimise the need for structural wood
• Canopies that intercept a minimum of 70% of light preferably more
Summary continued

• Canopy options are multiple.
• Choose the one that you can make work
• The one that will give your business the best economic return
• The one that produces a high yield of good quality fruit