A Vision for Future Apple Orchards

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In the Last 50 Years Orchards Have Evolved from Multi-Leader Trees on Seedling Rootstocks at 40 Trees/Acre to the Tall Spindle on M.9

Where will we be in 20 more years?
There exists a confluence of technologies that make apple growing very interesting in 2013.

- High Early Yield (150 t/ha)
- High Mature Yield (60-80 t/ha)
- Improved Fruit Quality
- New Rootstocks
- New Varieties
- Reduced labor costs

A Vision for the orchard of the future
1. New Rootstocks from Geneva® which tolerate fire blight and replant disease

M.27 Size

M.9 T337

M.9 PAJ 2

M.26

Seedling

M.7-MM106

G.65

G.11

G.41

G.214

G.935

G.202

G.969

G.890

G.30

G.210

G.222

G.213
Several Geneva® Rootstocks Tolerate Replant Disease
Very high productivity compared to traditional stock
2. High Early Yields will Pay Back the Initial Investment by the End of Year 4 or 5

The Potential
Fuji/CG.007
85 fruits/tree in the second leaf X 1365 trees/acre = 950 bu/acre

NY Targets for Early Yield
• 300 bu/ac in the second leaf
• 600 bu/ac in the third leaf
• 1,000 bu/ac in the fourth leaf
• 1,400 bu/ac in the fifth leaf
A total of 3,300 bu/ac over the first 5 years
Strategies for Early Fruit Production
-No Pruning at Planting (except the removal of large feathers)
-Limb bending below horizontal soon after planting
Principles of the Tall Spindle System

- **High Early Production**
  - Feathered trees + minimal pruning
  - 3,300 bu/ac in first 5 years

- **High Mature Yields**
  - Rapidly achieving high light interception 70-75%
  - Tree height = 0.9 * row width (~ 10-11 ft)
  - 1400 bu/ac with Gala
  - 2000 bu/a with Fuji

- **High Fruit Quality**
  - Good light distribution in the canopy
  - thin conical canopy
  - no permanent branches
  - limb renewal pruning of limbs larger than 2 cm diameter.
  - columnarized (simplified) fruiting branches
  - balanced vigor and calm trees

- **Improved Labor Efficiency**
  - Simplified pruning recipe
Precision Orchard Management

Precision apple orchard management is related to precision grain crop agriculture but has a broader focus.

• Central focus is to maximize orchard profitability
• POM views each orchard management practice through the lens of what will be the impact of this practice on orchard profitability.
• With fruit crops there is substantially more management of the crop than with grain crops.
  -pruning and training,
  -thinning,
  -fruit quality
  -fruit maturity management.
• It also includes traditional precision row crop management of soil fertility, pest and weed control, water and yield.
Precision Orchard Management may Help Capture Profits We Don’t Know We are Losing

An important question to ask is:

• What potential income are we losing or not capturing by not managing our crop more precisely.

• How much money are we leaving on the table and can precision orchard management help capture that money?
5. Simple and Thin Canopies are More Adaptable to Partial Mechanization Than Thick Complex Canopies

- Pruning
- Hand Thinning
- Tree Training
- Trellis Construction
- Pheromone Dispensing
- Summer Pruning
- Harvest
The simple pruning recipe of the Tall Spindle is well adapted to the use of motorized platforms to reduce pruning costs.

- The best fruit growers in NY have reported reductions in dormant pruning labor of 25-40% if the trees are grown in the Tall Spindle system.
Simple and Inexpensive Platforms

New 2012 Kubota mounted Trimming Platform with self-steering mechanism (designed/built by Dan LaGasse, Lyons, NY)

$25,000

$12,500

The Wafler and Vandewalle Experience

Previous Hand Pruning for Gala = 40 hours/acre X $10/hour = $400 per acre
With Simple Platforms = 18 hours per acre X $10/hour = $180/acre
Savings per acre = $220/acre
Mechanical Summer Pruning to Reduce Labor Cost

• Disastrous results in the 1960’s and ‘70s
• What is different now
  - Orchards are more suitable
  - Dwarfing rootstocks
  - Calm trees
  - Small pendant fruiting branches
• Summer pruning timing
  - Less regrowth
  - Flower buds on end of regrowth
• High labor costs are pushing labor savings approaches
### NY Summer Shearing Studies

#### Shoot Regrowth (cm)

<table>
<thead>
<tr>
<th>Variety</th>
<th>June</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuji/M.9</td>
<td>18.4</td>
<td>18.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Golden/M.9</td>
<td>8.8</td>
<td>14.1</td>
<td>12.9</td>
</tr>
<tr>
<td>Jonagold/M.9</td>
<td>12.8</td>
<td>16.0</td>
<td>15.2</td>
</tr>
<tr>
<td>Gala/M.9</td>
<td>8.7</td>
<td>12.3</td>
<td>11.3</td>
</tr>
<tr>
<td>Average</td>
<td>12.2 b</td>
<td>15.2 a</td>
<td>13.3 ab</td>
</tr>
</tbody>
</table>

#### Flower Clusters per Cut

<table>
<thead>
<tr>
<th>Variety</th>
<th>June</th>
<th>July</th>
<th>August</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuji/M.9</td>
<td>2.8</td>
<td>2.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Golden/M.9</td>
<td>2.8</td>
<td>2.4</td>
<td>1.8</td>
</tr>
<tr>
<td>Jonagold/M.9</td>
<td>2.5</td>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>Gala/M.9</td>
<td>1.5</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Average</td>
<td>2.4 a</td>
<td>2.1 b</td>
<td>1.8 c</td>
</tr>
</tbody>
</table>
Strategy for Summer Hedging

- One possible pruning strategy is:
  1. Begin in year 5 with a good dormant pruning leaving only small branches.
  2. Use mechanized summer hedging for 2 years then
  3. A corrective dormant pruning to remove limbs that have become too large and remove small weak wood.
Harvest Assist Machines Offer Greater Opportunities

-Motorized platforms can improve harvest labor efficiency of the Tall Spindle by 15-25%.

European Platforms have not been adopted in the US
1. Picking rates are already higher in the US (5-8 bins per day) than many other places in the world (3 bins/day)
2. The increase in efficiency has been small (20%) compared to the cost of the machine ($100k).
3. The bin fillers are believed to cause some bruising.
Are Mechanical Transport Systems of the Fruit to the Bin Better?
Is it Better to Fill the Bins by Humans?
Cost: Benefit ratio of Picking Assist Machines

The limitation on picking speed is the human hand.

Thus the picking assist machine can only go as fast as the number of human hands picking.

What is the cost (new steel and electronics) per hand:
- If machine costs $250,000 and uses 4 pickers, cost per hand = $31,250
- If machine costs $150,000 and uses 4 pickers, cost per hand = $18,750
- If machine costs $100,000 and uses 8 pickers, cost per hand = $6,250
- If machine costs $75,000 and uses 6 pickers, cost per hand = $6,250
- If machine costs $40,000 and uses 8 pickers, cost per hand = $2,500
Brazilian Machine – Imperador
Move the bins to the picker with bin management efficiency

Traditional harvest with ladders = 3 bins/person/day

Tall Spindle with platform = 5.6 bins/day

Traditional Orchard (45 t/ha with 3 bins/person/day) = 320 hours/ha
Tall Spindle with platform (60 t/ha with 5.6 bins/person/day) = 214 hours/ha
The Wafler Harvest Assist Machine
Positions the bins close to the worker in an innovative slanted system to eliminate the inefficiencies of climbing ladders and walking to the bin.

- A crew of 8 pickers works on and operates the machine.
- They partially grade the fruit when emptying their picking buckets.
An Innovative Bin Handling System Empties and Load 5 bins at a time
### Preliminary estimates of harvest assist machine performance, cost per bin and labor savings per bin

<table>
<thead>
<tr>
<th>Machine</th>
<th>Number of Pickers</th>
<th>Bins per Day</th>
<th>Acres/Season</th>
<th>Bins/Season</th>
<th>Cost of Machine (Season)</th>
<th>Cost/bin harvested</th>
<th>Labor Savings/bin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human w Ladder</td>
<td>1</td>
<td>6</td>
<td>4.8</td>
<td>288</td>
<td>~$12.5</td>
<td>0.04</td>
<td>0</td>
</tr>
<tr>
<td>Platforms (Blosi)</td>
<td>4</td>
<td>32</td>
<td>51</td>
<td>1536</td>
<td>~$60,000</td>
<td>3.90</td>
<td>6.25</td>
</tr>
<tr>
<td>DBR</td>
<td>4</td>
<td>32</td>
<td>26</td>
<td>1536</td>
<td>~$150,000</td>
<td>9.76</td>
<td>6.25</td>
</tr>
<tr>
<td>Picker Tec</td>
<td>4</td>
<td>32</td>
<td>26</td>
<td>1536</td>
<td>~$250,000</td>
<td>16.27</td>
<td>6.25</td>
</tr>
<tr>
<td>Pluck-O-Trac</td>
<td>6</td>
<td>48</td>
<td>38</td>
<td>2304</td>
<td>~$80,000</td>
<td>3.47</td>
<td>6.25</td>
</tr>
<tr>
<td>Argiles</td>
<td>8</td>
<td>64</td>
<td>51</td>
<td>2448</td>
<td>~$125,000</td>
<td>5.10</td>
<td>6.25</td>
</tr>
<tr>
<td>Imperador (Brazil)</td>
<td>4</td>
<td>32</td>
<td>51</td>
<td>1536</td>
<td>~$40,000</td>
<td>2.60</td>
<td>6.25</td>
</tr>
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<td>Bandit Xpress</td>
<td>4</td>
<td>32</td>
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The possibility of reducing labor costs by combining the Tall Spindle system with partial mechanization

<table>
<thead>
<tr>
<th>Labor Inputs</th>
<th>Traditional VA Trees (1000 bu/ac with ladders)</th>
<th>Tall Spindle Trees (1500 bu/ac with machines)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dormant Pruning</td>
<td>50 hours/acre</td>
<td>20 hours/acre</td>
</tr>
<tr>
<td>Tree Training</td>
<td>10 hours/acre</td>
<td>10 hours/acre</td>
</tr>
<tr>
<td>Hand Thinning</td>
<td>60 hours/acre</td>
<td>30 hours/acre</td>
</tr>
<tr>
<td>Summer Pruning</td>
<td>40 hours/acre</td>
<td>1 hour/acre</td>
</tr>
<tr>
<td><strong>Total Pre-harvest</strong></td>
<td><strong>160 hours/acre</strong></td>
<td><strong>61 hours/acre</strong></td>
</tr>
<tr>
<td>Harvest</td>
<td>75 hours/acre</td>
<td>70 hours/acre</td>
</tr>
<tr>
<td></td>
<td>(6 bins/person/day)</td>
<td>(10 bins/person/day)</td>
</tr>
<tr>
<td><strong>Total annual labor input =</strong></td>
<td><strong>235 hours/acre</strong></td>
<td><strong>131 hours/acre</strong></td>
</tr>
</tbody>
</table>
Partial Mechanization can Significantly Improve Profitability

NPV 20 years ($/acre)

Tree Density (trees/acre)

- Summer Hedging
- Mechanized
- Whips
- 1 year Grafts
- Poor Early Management
What will the orchard of the future look like?

• Orchards will have high yields in the first 5 years (3,300 bu) using feathered trees.

• Orchards will have tall, thin, narrow canopies which will have high yields and uniform fruit quality and will be more adaptable to harvest and pruning assist machines.

• Orchards will have more uniform fruit quality through precision orchard management.

• Orchards will have densities between 1,000-1,400 trees/acre