Opportunities to improve sweet cherry production efficiency

Tree Fruit Research at the Intersection of Biology and Technology

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Key Production Trends:
To remain competitive, the US sweet cherry industry must improve efficiency.
Cherry orchard of the future

- Profitability
- Sustainability
- Right genetics
- Right location
- Right management

Efficient, consistent, balanced production
Output vs. Input:

Production systems
Is this the orchard of the future?
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Keys to future orchards:

- Profitable + sustainable
- Simple pruning/training
- Precocious + consistently productive

- Ability to utilize automation/mechanization
Is this the orchard of the future?
What is successful in other crops?

Jazz/M9 – 100+ tons/ha
Old Systems

- Complex, large canopies
- Too much interpretation
- Dangerous
- Slow
Middle Age Systems

- Complex, large canopies
- Too much interpretation
- Dangerous
- Slow
- Compact, fruiting wall
- Repeated processes
- Efficient
- Suitable for mechanization/automation
Pruning rules:

1. Remove all lateral wood (leave short stubs)
2. Renew vigorous uprights (leave renewal sites)
Upright fruiting wood:
- Improved fruit quality
- Balanced fruit:leaf area
- Improved nutrition
- "Protected" from bird damage
PAR interception of vertical and angled fruiting walls

Vertical UFO

Y-trellised UFO
Mobile measurement system

1 – AccuPAR LP-80
2 – LI-COR quantum sensor
3 – I-O interface control box
4 – Deere E-Gator
5 – TRD-S encoder
Diurnal trend was nearly symmetric around solar noon

**Yield potential** on angled canopies is greater than planar canopies
- 5 year-old ‘Santina’/Gisela12 – 35 tons/ha  (Y-trellis UFO)
- 4 year-old 27 tons/ha
What difference does training system make?
Labor Monitoring System, LMS

Research tool 2011
Harvest efficiency

Preliminary tests in sweet cherries and apples show a clear role of training system in harvest efficiency/costs.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Training System</th>
<th>Mean Harvest Rate (kg/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sweet Cherries</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bing/‘Mazzard’</td>
<td>Traditional open center</td>
<td>0.47 ± 0.12</td>
</tr>
<tr>
<td>Chelan/‘Mazzard’</td>
<td>steep leader (4-5 upright leaders)</td>
<td>0.53 ± 0.13 (+13%)</td>
</tr>
<tr>
<td>Tieton/‘Gi5’</td>
<td>Central leader</td>
<td>0.64 ± 0.19 (+36%)</td>
</tr>
<tr>
<td>Sweetheart/‘Mazzard’</td>
<td>KGB</td>
<td>0.72 ± 0.17 (+53%)</td>
</tr>
<tr>
<td>Cowiche</td>
<td>UFO</td>
<td>0.81 ± 0.18 (+72%)</td>
</tr>
<tr>
<td><strong>Apple</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuji (Apple)</td>
<td>moderate density (7 x 13) central leader</td>
<td>3.58</td>
</tr>
<tr>
<td>Braeburn (Apple)</td>
<td>high density tall spindle</td>
<td>5.61 (+60%)</td>
</tr>
</tbody>
</table>
Mechanical harvest

- Harvest costs are >50% of all
- Labor cost increasing
- Labor availability decreasing
Mechanical harvest

• Taking short- and long-term look using total systems approach
  – Mechanical assist (shake-and-catch)
  – Fully mechanical harvest
Goal: Improve labor efficiency & safety with mechanical or mech-assist technologies

- 3-4 fold improvement in harvest efficiency with shake-and-catch system
- Worked with 10 growers in 2013/2014 to test/demonstrate the system
- Sold stem-free and stem-on cherries (same price, package, orchard)
Efficient harvest technologies

Shake-and-catch harvest testing

Chelan – high PFRF
14 Hz, 1’ stroke

Skeena – low PFRF
18 Hz, 1”
Harvest time < 0.22 s
In domestic and export markets, stem-free cherries are accepted/preferred.
New packaging + marketing by Chelan Fresh
Utilizing platforms:

- Limb tying
- Thinning
- Pruning
- Harvest
- Work at night
Mechanical pruning

- Simplified planar systems – simplify pruning
- Investigated potential for mechanical pruning in UFO since 2010
Objective

Determine best management practices for pruning sweet cherry and apple mechanically, by understanding equipment and orchard requirements.
Mechanical pruning

- Gillison’s GVF Center Mount Topper and Hedger
- Side shift ca. 1.2 m on either side of the tractor
- Height adjustment of 1 m to 6.5 m
- 360° rotation of cutting head
- $24,000 USD
YEAR 1
1. Hand pruning
2. Mechanical pruning (1)
3. Mechanical pruning (2)

YEAR 2
1. Hand pruning
2. Mechanical pruning
3. Mechanical pruning + Hand pruning
Mech pruning 23 and 29 times faster than hand pruning (hedging and topping) in 2014 and 2015

Combination of manual and mech. pruning was twice as fast as hand pruning (ca. 2.0 km/h)
Results: Efficiency 2015

• Mech + hand pruning was 66% more efficient than hand pruning alone
• Mech pruning was 11 times more efficient than hand pruning
Results: Yield and fruit quality 2015

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Weight (g)</th>
<th>Firmness (g/mm)</th>
<th>SS (%)</th>
<th>Diameter (mm)</th>
<th>Row size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand pruning</td>
<td>12.1 a</td>
<td>313</td>
<td>16.1</td>
<td>29.2 a</td>
<td>9</td>
</tr>
<tr>
<td>Mechanical pruning 1</td>
<td>11.3 b</td>
<td>302</td>
<td>15.7</td>
<td>28.3 b</td>
<td>9</td>
</tr>
<tr>
<td>Mechanical pruning 2</td>
<td>11.6 b</td>
<td>310</td>
<td>16.0</td>
<td>28.5 b</td>
<td>9</td>
</tr>
</tbody>
</table>

P-value ($\alpha=0.05$)

- Hand pruning: 0.042
- Mechanical pruning 1: 0.223
- Mechanical pruning 2: 0.503
- Mechanical pruning 2: 0.006

• Hand pruning: 7.6 tons/acre
• Mechanical pruning 1: 9.1 tons/acre
• Mechanical pruning 2: 8.5 tons/acre
Economic assessment

ASSUMPTIONS:

- 1 acre of UFO ‘Tieton’/‘Gisela5’
- Full canopy
- 1350 trees/ha

1 person
8 hours work/day
$12/h

UFO pruning rules

- Hand pruning is 4x machine costs
- 2x over 2 years
- 23 ha to cover machine cost in 1 yr

<table>
<thead>
<tr>
<th>Estimated pruning costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hand (4x machine)</td>
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<tr>
<td>Hand (2x machine)</td>
</tr>
<tr>
<td>Machine</td>
</tr>
</tbody>
</table>
Trial 3: ‘Rainier’/‘Gisela®5’
2016

- 5 reps of 10 trees
- Stihl® manual hedger

Treatments:
- Control (unpruned)
- Hand-pruned
- 20 days before harvest
- 10 days before harvest

- Yield, quality, timing, return bloom, vegetative regrowth
Results:

• Mech-assist pruning was 7 times faster than hand
• Slight improvement (+12%) in color with both timings
• Slight reduction (-9%) in soluble solids at 20 dbh
• Return bloom, regrowth TBD
Conclusion

• Adoption of innovation has been slow in cherry industry
• Market pressures will continue to force innovation
• Plan orchards to account for these challenges
  – Not about now, but what is next.....