What’s Next??
Future varieties, practices and cost of establishment

Tom Auvil
Orondo, WA
Big, new plantings with trees from in-house nursery.
Washington apple production
000’s packed boxes


Red Delicious  Golden Delicious  Fuji  Gala  Granny Smith  Cripps Pink  Honeycrisp  Other
Varieties Decreasing:
Golden Delicious
less colored Red Delicious, Gala and Fuji
Cameo
Braeburn
Jonagold
Varieties Increasing:

- Honeycrisp + Redder Honeycrisp (??)
- Really Red Gala
- Really Red Fuji
- Club- Jazz, SweetTango, Envy, Opal
- Cripps Pink sports (earlier, Redder)
- WA 38 – great texture, shelf life, flavor
Consumer studies: Wa Apple Commission- 1980’s
#1. Crisp texture
#2. Juicy – Sweet
#3. Flavor
New Varieties:

Better than present commercial products
Shelf life of 7+ days at room temperature
Fewer problems (great packouts)
Bitterpit
Sunburn
Poor texture
Internal Browning

Flavor
Higher Acid + Higher sugar content = 
More flavor
Less ‘storage’ or box flavor
Less astringency from the peel
(Gala, Honeycrisp, Sweetie)
Harvest Timing of varieties/ Picking Schedule
Effective use of resources
Bins/day for 10 weeks

Early season is busy
Late season is risky:
  Fuji, Pink Lady, Other late harvest.
Gala production cost -- 2005

From Clark Seavert, Oregon State University
Gala production cost per bin - 2014

$30 / Bin variable cost

Bins per acre

$ per bin

- 10: 550
- 20: 290
- 30: 203
- 40: 160
- 50: 134
- 60: 117
- 70: 104
- 80: 95
- 90: 88
- 100: 82
Gala production cost per bin - 2014

$ per bin

Bins per acre

- 10: $550
- 20: $290
- 30: $203
- 40: $160
- 50: $134
- 60: $117
- 70: $104
- 80: $95
- 90: $88
- 100: $82

$ per bin
Gala production cost per bin - 2014

$ 35 / Bin = 43% increase

Bins per acre

$ per bin

550
290
160
134
117
104
95
88
82
70
60
50
40
30
20
10
0

10
20
30
40
50
60
70
80
90
100
Gala production cost per bin - 2014

$1000/acre = $10/bin
Cost of production in a 10 x 4 fifth leaf Gala orchard = $10,757/a

$300 / bin @ 35 bins per acre = Negative return

$200/bin@ 60 bins per acre = Positive return
2009 to 2016:
Payback the capital investment of vertical trellis systems with 5th leaf crop (3 crops)

Is current planting rate creating over supply?
Orchards planted today should accommodate technologies of the future — Craig Hornblow, AgFirst, NZ
Ground covers: Extenday / Mylar
Trellis for crop and covers requires precision in construction. Retrofitting a crop trellis = $$$$
Night harvest
Tall trellis = mechanical assist
V trellis Gala
Yield 100 bin/acre of 250 g/fruit
The trees are not planted in a single line. Trees for each arm of the trellis are planted in rows offset one foot.
V trellis Gala
Yield 100 Bin/acre of 250 g/fruit
72 count box size
Tall spindle Cripps Pink
planted 2005, picture 2010
Spatial distribution of limbs and fruit at Waffler Farms in New York allows every apple to be seen from different aspects by a camera/robotic harvester.
A 12-foot angle canopy (compared to a vertical system with a 10-foot drive row) will increase the number of leaders spaced at 22 inches by 66 percent per acre.

Very organized canopies, where all fruiting wood is fastened to wires (or is very short bourse shoots or spurs) should be compatible with robotic harvesting.

There should be nothing between the “end effector” and the fruit.

System approach for automation

For best results with the current version of the technology, there should be nothing between the “end effector” and the fruit. Posts, tree limbs, trunks and wires all can be barriers to reach the fruit. In addition, long limbs (>10 mm or 3/8” caliper) can be sucked into the end effector, causing fruit that subsequently enters to develop bar bruises or cuts by passing along it. To prevent damaged fruit, growers should fasten those fruiting limbs to prevent them from being taken into the harvester.
Production Systems
3 leader Cripps – from sleeping eye, 3rd leaf
Capital cost $42,000 per acre to harvest of third leaf crop
3rd Leaf crop

$65,000 investment to first crop.
Tall spindle Gala 6th leaf 70 bin / acre
Bi-axe planting in Chelan, 2011
Bi-axe planting in Chelan, with 55 bin/acre crop in 2013
Bi-axe planting in Chelan, with 55 bin/acre crop in 2013
Pedestrian system
Types of planting material
WTFRC rootstock trials conclusions are based on

15 trials from 2003 to 2016
69 different rootstocks

Frenchman Hills  2003
Replant Tolerant Geneva® Rootstocks by Tree Size

Small M.9:
- Mark B.9
- T337
- Pajam 2, EMLA Nic29
- G.30
- G.210
- G.969

Large M.9:
- ‘M.26 Class’
- M.7 MM106
- Bud 118 Seedling
- Nic29
- G.935
- G.41
- G.214
- G.890
- G.30

Woolly Aphid resistant

Modified for Washington State conditions from Terence Robinson, Cornell University; Gennaro Fazio, USDA
Tree size: Rootstock comparison to seedling rootstock with a NON-SPUR scion on NEW Ground

Scion varieties have different tolerance to replant: Golden Delicious the best, Red Delicious the worst

Soil texture / base materials can range from high vigor potential down to ‘problem’ potential due to hard pan, sodium, no phosphorous, rock, sand, gravel
## Rootstock Traits –2017

<table>
<thead>
<tr>
<th>Rootstock</th>
<th>Percent Tree size</th>
<th>Replant resistant</th>
<th>Root rot resistant</th>
<th>Fireblight Resistant</th>
<th>Woolly Resist</th>
<th>Cold hardy</th>
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<tbody>
<tr>
<td>Mark</td>
<td>25</td>
<td>NO</td>
<td>No</td>
<td>S</td>
<td>No</td>
<td>Good</td>
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<tr>
<td>Bud 9</td>
<td>15 to 25</td>
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<td>R</td>
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<td>M.9-Fl.56</td>
<td>&lt;30</td>
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<td>Tol</td>
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<td>G.11</td>
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<td>Good</td>
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<tr>
<td>G.41</td>
<td>30</td>
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<td>Very Tol</td>
<td>R</td>
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<tr>
<td>M.9-337</td>
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<tr>
<td>G.214</td>
<td>35</td>
<td>YES</td>
<td>Very Tol</td>
<td>R</td>
<td>Yes</td>
<td>TBD¹</td>
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<tr>
<td>M.26</td>
<td>25 to 40</td>
<td>SUSEPT</td>
<td>SUSEPT</td>
<td>S</td>
<td>No</td>
<td>Good</td>
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<tr>
<td>G.935</td>
<td>35</td>
<td>YES</td>
<td>Very Tol</td>
<td>R</td>
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<td>Yes</td>
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<tr>
<td>M.9 Emla-Pajam 2</td>
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<td>G.222</td>
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<td>M.9-Nic 29</td>
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<td>S</td>
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<td>Fair</td>
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<td>G.969</td>
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<td>45</td>
<td>YES</td>
<td>Very Tol</td>
<td>R</td>
<td>NO</td>
<td>Yes</td>
</tr>
</tbody>
</table>

¹To Be Determined

**Geneva Genotypes NOT listed:** G.202, G.16,
'06 Wapato Gala Geneva Rootstock Trial - 2013

M.9 “EMLA is the standard for the Wapato trial. Tree spacing is 10 x 3 feet = 1450 trees per acre, 30 sq.ft/tree
Mark is the standard for the Vantage trial. Tree spacing is 12x1.5 feet = 2420 trees per acre

18 Square feet / tree
1452 trees/acre

2424 trees/acre
Replant Tolerant Geneva® Rootstocks by Tree Size

SMALL M.9:
- T337
- 'M.26 Class'
- M.7 MM106

Mark B.9
- 15-25%
- 30-35%
- 35-40%
- 40-50%
- 50-75%
- 75+%  

- G.41
- G.935
- G.969
- G.210
- G.30
- G.890  

'Veggie' Seedling

Modified for Washington State conditions from Terence Robinson, Cornell University;  Gennaro Fazio, USDA-ARS
Third leaf replacement trees in difficult replant site
Fumigation will help growth of new trees in old sites:
Application is done right
  Right soil temperature
  Good soil moisture / water application rate (metam)
  Equipment in good working condition
Uniform water / nutrition application??
Factors that limit canopy development

Mildew

Cropping too soon

Not enough trees per acre

2013 HC planting on G.41 - July

2013 – September
Replant disorder symptoms:
Drought stress
Mildew leaf roll
Small caliper shoots
Scions – higher vigor / replant tolerant
Golden Delicious
Granny Smith
WA 38 – Cosmic Crisp
Jonagold

In new ground or good performing sites:
More precocious rootstocks:
Mark, B.9, G.11
G.41, M.9 337

In new ground or good performing sites:
G. 41, G.210, G. 214, M.9 Pajam 2
in multi leader systems
More trees?

Rootstock – Bud 9

G.41, G.935
‘bud union
Bench graft union?
Scion Rooting ??
‘Rooting line’
Regardless of tree type (bench graft, sleeping eye or finished trees):

Irrigate day of planting,
24 hr + set with micro sprinkler
Terraced planting in Chelan, 2014
To achieve strong vertical growth, all branches were removed:

- Stubs
- ‘Dutch’ or Flat cut
Creating opportunity by Grafting
Notch / Beaver graft
End of first leaf
First Leaf Sugarbee
End of second leaf Envy
Second Leaf Envy
Third Leaf Envy
Nurse Limb stump to be removed with a reciprocating saw, spring of second leaf.
What NOT to graft:

- Scion rooting
- Trunk Injury
Establishment and testing of MSU sweet cherry rootstocks

Amy Iezzoni, Matt Whiting, Tom Auvil

Trial of MSU rootstocks with Gi5 & Gi6 controls. Planted in 2009 At WSU-Prosser.

Photo taken in spring 2011 →
5 promising MSU rootstocks based on flowering
Precocious, dwarf trees fail when forced into a tree size bigger than it can support.
Leaf to fruit ratio, (5 to 1 on sweet cherry) becomes too low, resulting in small fruit, low vigor, tree decline
Cherry Rootstocks by Tree Size

Gi 12, Mazzard, Colt, Mahaleb
Maxma 14,

Gisela 6
Krymsk 5

Krymsk 6

Gisela 5

90+%  80-90%  60-80%  50-60%  40-50%  35-40%

Clinton
Lake, Cass Crawford
Clare

MSU rootstocks
Cherry Rootstocks by Tree Size

- **Gi 12, Mazzard, Colt, Mahaleb Maxma 14,**
- **Gisela 6, Krymsk 5**
- **Krymsk 6**
- **Gisela 5**

- **MSU rootstocks**

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Rootstocks</th>
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</thead>
<tbody>
<tr>
<td>90+%</td>
<td>Gi 12, Mazzard, Colt, Mahaleb Maxma 14, Gisela 6, Krymsk 5, Krymsk 6, Gisela 5</td>
</tr>
<tr>
<td>80-90%</td>
<td>Gi 12, Mazzard, Colt, Mahaleb Maxma 14, Gisela 6, Krymsk 5</td>
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<tr>
<td>60-80%</td>
<td>Gi 12, Mazzard, Colt, Mahaleb Maxma 14, Krymsk 5</td>
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<tr>
<td>50-60%</td>
<td>Gi 12, Mazzard, Colt, Mahaleb Maxma 14</td>
</tr>
<tr>
<td>40-50%</td>
<td>Gi 12, Mazzard, Colt, Mahaleb Maxma 14</td>
</tr>
<tr>
<td>35-40%</td>
<td>Gi 12, Mazzard, Colt, Mahaleb Maxma 14</td>
</tr>
</tbody>
</table>

- **~1000 trees per acre**
All 5 MSU cherry rootstocks have canopy volume of Gi5 or smaller
All 5 MSU cherry rootstocks induced scion flowering greater or equal to Gi5 and Gi6 in 2011

Means that are significantly different (P < 0.05) are denoted by different letters.

1Means that are significantly different (P < 0.05) are denoted by different letters.
Earlier and **condensed** bloom on some MSU rootstocks resulted in earlier harvest (4-8 days)

Fruit harvested on 26 June 2013

‘Bing’/CASS | ‘Bing’/CASS | ‘Bing’/Gi 5
Issues with precocious rootstocks:

Crop density above 40 cherries/foot