Example of mechanical cut
Mechanical pruning (right) and hand pruning (left)
Pear Quality Optimization

- Pruning physiology
- Pear cultivar habit
- Main training systems
- HDP pruning technique
- LDP pruning technique
- Quality
## Novel pruning practices

<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
<th>Intended effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>Watersprouts removal after fruit set</td>
<td>• reduce shoot vs fruit competition for nutrients&lt;br&gt;• reduce psylla presence</td>
</tr>
<tr>
<td>Fall</td>
<td>Remove large branches and watersprouts</td>
<td>• remove leaves to reduce carbohydrate storage by roots&lt;br&gt;• increase light penetration, flower bud formation and better fruit distribution in the canopy</td>
</tr>
</tbody>
</table>
Fall and summer pruning to control vigor and psylla in Anjou pear

HOBO data loggers under trees to measure light intensity from around 9 am to 4 pm.
Fall pruning 2015
Fall pruning 2015
Pear Quality Optimization

- Pruning physiology
- Pear cultivar habit
- Rootstocks
- Nursery products
- Main training systems
- HDP pruning technique
- LDP pruning technique
- Quality (Light, Growth regulators, Nutrition, Harvest and Mechanization)
Factors Affecting Fruit Quality

Environmental factors
- Light
- Temperature
- Humidity
- Wind
- Training system

Genetic factors
- Variety
- PGRs
- Rootstock

Agronomic factors
- Soil
- Nutrition
- Crop load/thinning
- Pruning
- Pollination
Large open vase trained d’Anjou tree

- Large canopy volume
- Fruit mostly in upper-medium portion
- Drawbacks in orchard management
- Mechanization and fruit sorting is not possible
- Different light exposure causes fruit variability within canopy.

Same maturity???
Same quality???
Same storability???
Picking fruit by canopy position: **internal** vs **external**

Internal fruits show slower degreening of chlorophyll but lose weight more rapidly after 3 weeks at RT than external ones.

Biochemical changes associated with maturity.....

(Rudell et al., 2017)
Production is mainly on the top-middle of tree.

Smallest pears are in the lowest zone of the tree.

(Zhang et al., 2016)
Effect of light microclimate on the quality of ‘d’Anjou’ pears in mature open-centre tree architecture

Jingjin Zhang, Sara Serra, Rachel S. Leissa, Stefano Musacchi

* School of Agriculture and Biology, Shanghai Jiaotong University, Shanghai, 200240, China
* Crop Fruit Research and Extension Center, Washington State University, Wenatchee, WA, 98801, USA
* Department of Horticulture, Washington State University, Pullman, WA, 99164, USA
* Tree Fruit Research Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Wenatchee, WA, 98801, USA.

Sample fruit from different light penetration levels illustrating the difference of red blushed surface area of fruit. Light penetration level: LP-1 = 0%–20%, LP-2 = 20%–40%, LP-3 = 40%–60%, LP-4 = 60%–80%, and LP-5 = 80%–100%.

(Zhang et al., 2016)
Destructive d’Anjou quality assessment after 3 month of storage + 7 d of ripening period (T-4):

**Light penetration level:** LP-1 = 0%-20%, LP-2 = 20%-40%, LP-3 = 40%-60%, LP-4 = 60%-80%, and LP-5 = 80%-100%.

*One half bar represents standard error. In each figure, values denoted by same letter are not significantly different (p > 0.05).*

(Zhang et al., 2016)
Considerable light variability affecting fruit development and maturity exists within the large canopy of an open vase tree.

(Zhang et al., 2016)
Harvest by fruit position following the intensity map
Fruit diversity within the canopy was assessed using metabolic profiling to identify metabolism associated variability within the canopy.

“Metabolic profiling: powerful approach to understand plant physiological reactions to stresses or environmental variations”

(Rudell et al., 2017)
Levels of photosystem metabolites (left) and volatile metabolites (right) in D’Anjou peel

Anjou ripening is influenced by tree position

(Rudell et al., 2017)
Cork spot visible on outside of fruit at harvest
PEAR TREATMENT TO ENHANCE FRUIT SET

- NAA
- Promalin
- Promalin
- NAA+NAD

- 10% flower open
- Petal drop

- Bud brake
- Full bloom
- Petal drop
Parthenocarpic fruit
FROST DAMAGE
About 70% of pear acreage in Emilia-Romagna is irrigated: avg. Seasonal volume about 2000 m³/ha = 40 million m³/yr
CONTROLLED WATER STRESS

Anconelli and Mannini, 2002
Water-saving: micro-irrigation

It entails:
• Water near plants
• Frequently scheduled inputs
• Long on-times
• Low-pressure release

Advantages
• Water- & energy-savings
• Less nutrient wash-out
• Less pesticide input
• Better uniform coverage
• Greater irrigation precision
• Easy scheduling
• Lower system & overhead costs (on wide-row crops)

Drop on line
Drop on line integral
Microjet

Anconelli and Mannini, 2002
IMPORTANCE OF FERTILIZATION

Yield (Nitrogen)

Vegeto-yield balance

Fruit quality & storage

Susceptibility to pathogens & environmental stress
## Ferilization experiment in Abbé Fétel high density orchards

### Total quantity of distributed elements for each fertilization plan

<table>
<thead>
<tr>
<th>Year</th>
<th>Fertilization plan</th>
<th>Dose (kg/ha/year)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N</td>
<td>P$_2$O$_5$</td>
<td>K$_2$O</td>
<td>MgO</td>
</tr>
<tr>
<td>2010-2011</td>
<td>Plan 1</td>
<td>62</td>
<td>50</td>
<td>177</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Farm fertilization</td>
<td>100</td>
<td>70-80</td>
<td>150</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ammonium sulfate 1x</td>
<td>52,5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ammonium sulfate 2x</td>
<td>105</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ammonium sulfate 3x</td>
<td>157,5</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Ammonium sulfate 4x</td>
<td>210</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2011</td>
<td>Plan 2</td>
<td>87</td>
<td>55</td>
<td>184</td>
<td>27</td>
</tr>
</tbody>
</table>
Fertigation experiment in Abbé Fétel high density orchards

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2010</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pruning weight (kg/tree)</td>
<td>Calculated pruning weight (t/ha)</td>
</tr>
<tr>
<td>Ammonium sulfate 1X</td>
<td>0.29</td>
<td>2.17</td>
</tr>
<tr>
<td>Ammonium sulfate 2X</td>
<td>0.32</td>
<td>2.42</td>
</tr>
<tr>
<td>Ammonium sulfate 3X</td>
<td>0.33</td>
<td>2.53</td>
</tr>
<tr>
<td>Ammonium sulfate 4X</td>
<td>0.41</td>
<td>3.13</td>
</tr>
<tr>
<td>Farm</td>
<td>0.24</td>
<td>1.81</td>
</tr>
<tr>
<td>Plan 1</td>
<td>0.25</td>
<td>1.84</td>
</tr>
<tr>
<td>Plan 2</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td>Significance</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

Values with same letters means no significance difference (test SNK).
Fertigation experiment in Abbé Fétel high density orchards

Productivity (kg/tree) and average fruit weight (g) in years 2010-2011

Values with same letters means no significance difference (test SNK).
Fertigation experiment in Abbé Fétel high density orchards

Supplied nitrogen:
- Ammonium sulfate 3x (158 kg N/ha)

Pruning weight:
- Production

Production and fruits size:
- Ammonium sulfate 2x (105 kg N/ha)
  - Fruits size: % dry matter buds, % dry matter wood

210 kg N/ha:
- No toxic effect noted
Thank you for your attention!!
Thank you!

WSU TREE FRUIT ENDOWMENT
YouTube Videos

WSU CAHNRS Channel; WSU Tree Fruit playlist

Recorded and Being Edited:

Pruning Bartlett Pears to Optimize Fruit Size and Quality (Musacchi)

WSU Expert Videos

Direct link to the WSU Tree Fruit playlist:
https://www.youtube.com/playlist?list=PLajA3BBVvyv1zkicqf3Of_Ka_PTSAddqu
Stefano Musacchi

Associate Professor Endowed Chair –
Tree Fruit Physiology and Management
Washington State University
Tree Fruit Research and Extension Center (TFREC)
1100 N. Western Ave.
Wenatchee, WA 98801-1230
Phone: (509) 663-8181

stefano.musacchi@wsu.edu

http://horticulture.wsu.edu/people/musacchi/