Alternative Approaches to Growing and Harvesting Tart Cherry
Dr. Ron Perry
Department of Horticulture, Michigan State University, East Lansing, MI 48824

HISTORY:
Traditional Harvesting System Developed in 1960s
• Growth of the tart cherry industry accelerated in early 1960s with adoption of new technology which deployed branch and trunk shakers and catch-frame/tarps.
• The protocols called for growing large trees of the ‘Montmorency’ variety, planted at typical spacings of 15 X 20 feet (145 Trees / Acre)

Traditional Trunk-Shake Harvest System Used for Montmorency Cherry in Michigan Since the 1960’s

Double-incline harvester

Tree / Orchard Longevity reduced – productive capacity years 6-22

Jacob McManus
"GROWER DECISION SUPPORT TOOL FOR CONVERSION TO A HIGH-EFFICIENCY TART CHERRY ORCHARD SYSTEM"
MS Thesis, MSU, AFRE, 2012

Standard Yield average peak per acre 8200 lbs / acre, mature trees.

NASS shows 6500 lbs/A 1984-2010
• Profitability in the future
• Need to minimize input costs and/or maximizing returns.
• Produce with a minimal environmental footprint
Project objective initiated in 2008

“Investigate and develop alternative approaches to overall tart cherry production systems that address economic and environmental sustainability challenges through a combined/integrated approach of automation and orchard production systems”

Dr. Dan Guyer, Professor, BSAE, and Ron Perry, Professor, Hort, MSU

Michigan Cherry Producers – “Charge”

- Improve Economics/Profitability
  - Yield / Acre
  - Fruit uniformity
  - Years to commercial production / output
  - Extend orchard longevity?
- Sustainability
  - Productive cherry land = productive real estate
  - Avoid use of “Ethephon” to induce ripening and pedicel abscission
  - Spray drift / noise (smaller canopy = smaller sprayer)
- Fruit Quality
  - Returns to growers
  - Market utilization (including pit issue)

Continuous or Over The Row Harvesters

1. High pressure air
2. Rotary-Tine, Spindle Tower
3. Grape / Berry harvesters: Bow–Rod or Slap-Bar harvesters
4. Sideways Harvesters

“Side-ways” Harvester

Used successfully to harvest Haskap and Bush Cherries in Canada

Dr. Bob Bors, Department of Plant Sciences, University of Saskatchewan

Bow-Rod Grape Harvesters tested in Germany on Tart Cherry

No Success !!!
Olive Harvesters viewed in Calif; all Bow-Rods

Viewed several Olive harvesters in operation in Northern Sac Valley, Calif, F 2010
All were Bow-Rod mechanism (Grapes) and none appeared to have value for Cherry. Narrow threshold and Canopy of Olive much more willowy than cherry.

Oxbo Bow-Rod harvester which is a grape harvester modified to accommodate olives.

Oxbo tested On Monts in WA

BEI Blueberry Slap Harvester, attempted but failed to source for test in 2011

BEI Black Ice Berry Harvester Tested July 2010
High Power Air mechanism tested at Cherry Bay Orchards and Coloma on Tarts and Sweets

BEI Black Ice Berry Harvester Tested July 2010
High Power Air mechanism tested at Cherry Bay Orchards and Coloma on Tarts and Sweets; Not effective
Predecessor to Rotary-Tine harvesters – Oxbo Orange Harvesters
Concept by Dr. Don Peterson, USDA Ag Engineer, Kearneysville, WV

Pomegranate harvester; Coe Co., Live Oak, CA

Preliminary Evaluations........Tart Cherry

Poland 1992
Tractor Driven Continuous Move Harvester for Sour Cherry
Rotary-tine raspberry harvester

Over The Row Harvest of Tart Cherry research began July 2008
Oxbo International 7420 @ Clarksville Research Center

P. Wawrzylczak, et al, Research Institute of Pomology and Floriculture, Dept. of Horticultural Engineering, Skiernewice, Poland

Dr. Iezzoni’s seedlings; CRC, bush/hedge initial test specimen
Oxbo 930 Tested at CHES July 2009
proved too narrow thresh hold and aggressive...
severe damage to trees.

Oxbo 9000 Tested at CRC July 2009
proved effective and efficient in harvesting MSU tart
selections, seedlings and Monts in bush form, without
damaging trees.

Oxbo 9000 Tested at Wright Orchard, Belding, MI July 2009
harvested 4 acres of 5 yr old Monts efficiently and little tree
damage.

Rojo Bell
Oxbo Int'l

Oxbo 9000 Tested at Wright Orchard, Belding, MI July 2009
Rotary-Tine Tower Mechanism

BEI 3000 Tested July 2010
Rotary-Tine Tower harvester tested at Cherry Bay Orchards,
Hartford, MI of 4 yr old Monts.

BEI 3000 Tested July 2010
Rotary-Tine Tower harvester tested at Cherry Bay Orchards,
Rotary-Tine Tower mechanism.
**Alternative Approaches**

- Reducing canopy volume to accommodate berry harvesters
  1. Compact scion genotypes
  2. Practices such as pruning, summer hedging, root pruning
  3. Dwarfing rootstocks
- Larger dimension harvesters – Rotary - Tine
  – Current commercial harvesters have tunnel dimensions 48” X 96” (exception; Littau ORXL 55”X96”)

**Challenges and Future Work**

- ‘Montmorency’ standard tart cherry is a large tree – can we manage to keep it compact for current berry harvesters?
- Will equipment manufacturers build a larger dimension model to accommodate Montmorency?
- Need to evaluate genetically compact varieties to fit berry harvesters. Can they satisfy processing market?
- Is there a rootstock that can dwarf canopies?
- Can we harvest in research plots and retain treatment integrity?

1. Determine tart cherry genotypes that are naturally compact.
2. Identify practices that compact canopy volume to accommodate harvester.
3. Identify desirable canopy architecture that facilitates efficient fruit removal using berry harvesters.

**Compact scion genotypes**

- Carmine Jewel and others Univ of Saskatchewan
- P. Cerasus x Fruticosa hybrids

MSU Tart Cherry Breeding program, A. Iezzoni
Horticultural Practices

- Bush form
- Recycling branches
- Avoid branches perpendicular to row
- Summer Hedge
- Root pruning?

Early Adopters

Oxley Farms
Lawton, MI

Ed Oxley, Lawton
20 acres

Ken Engle, Williamsburg
20 acres

Hypotheses

- Bush form will lead to compact canopy
- Pruning in winter
  - Hedging
  - Recycling branches > 1” diameter
- Summer hedging at 45 days post bloom will reduce canopy vigor.
- Core frame of branches @ 3’ X 6’
- Varieties, including Montmorency respond differently to pruning
- Root pruning maybe an alternative treatment to check canopy vigor.

Top View

2’ - 3’

Dotted branches are recyclable, maintained within the 2’ - 3’ threshold for O.T.R. harvest. Jamie Burns, Res. Assistant, MSU, BSAE

Winter Hedge

Summer Hedge
Summer Hedging Treatment; 45 days Post Bloom

July 9, Harvest

Root Pruned – Bloom @ Oxley and NWHRC

Separate study: Accomplished twice on Mont/Mah guard trees at NWHRC: Bloom and RH Hardening

Univ. of Saskatchewan, Bush Varieties

2013

Carmine Jewel

Crimson Passion

2015; Littau ORXL Berry Harvester supplied by Spring Brook Supply, South Haven, MI

Video OTR Harvest

Cursory fruit quality assessment
Yield of 5 tart cherry varieties; No Canopy or root pruning treatments, 2015

Canopy Volume of 5 tart cherry varieties; No Canopy or root pruning treatments

Yields per acre, 4&5th Growing Seasons

<table>
<thead>
<tr>
<th>Variety</th>
<th>Treatment</th>
<th>Year 4 (kg)</th>
<th>Year 5 (kg)</th>
<th>Total (kg)</th>
<th>lbs/Acre*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mont/Mah</td>
<td>Winter Hedge</td>
<td>4.37</td>
<td>3.76</td>
<td>8.12</td>
<td>17.90</td>
</tr>
<tr>
<td></td>
<td>Sum Hedge</td>
<td>3.90</td>
<td>4.42</td>
<td>8.32</td>
<td>18.40</td>
</tr>
<tr>
<td></td>
<td>Root Prune</td>
<td>5.92</td>
<td>5.95</td>
<td>11.87</td>
<td>25.94</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>8.51</td>
<td>8.55</td>
<td>17.06</td>
<td>37.73</td>
</tr>
</tbody>
</table>

| MSU 27 12 (2) | Winter Hedge       | 3.89        | 4.30        | 8.19      | 17.96     | 13107     |
|               | Sum Hedge          | 3.61        | 3.72        | 7.33      | 16.26     | 12103     |
|               | Root Prune         | 2.78        | 3.15        | 5.93      | 13.06     | 9776      |
|               | Control            | 5.88        | 6.02        | 11.90     | 26.13     | 19125     |

| Nana     | Winter Hedge       | 8.12        | 8.44        | 16.56     | 36.40     | 26890     |
|          | Sum Hedge          | 5.64        | 6.03        | 11.67     | 25.64     | 19144     |
|          | Root Prune         | 6.07        | 6.39        | 12.46     | 27.60     | 20450     |
|          | Control            | 5.80        | 6.17        | 12.07     | 26.82     | 19006     |

* At 673 trees / acre 5 x 13 feet spacing

Standard Yield average peak per acre 8200 lbs / acre, mature trees (McManus, 2012)  * 5 X 13 feet spacing = 670 trees / Acre
Effects of treatments of 3 varieties on fruit size 2015

Effects of time of root pruning on yield, vigor, and average fruit size of Montmorency 2015

Mean yield per acre in pounds*, 2015.

High Density apple and sweet cherry systems today, owe success to adoption of dwarfing rootstocks!!

Dwarfing rootstocks may be critical to success of high density tart cherry Over The Row Harvest systems in the future?

Traditional industry / standard system - rootstock
Large trees on Mahaleb seedling rootstock.
3/9/2016

**1987/88 NC 140 Cherry Rootstock Trial: MI**

**Canopy vigor of Montmorency on 5 rootstocks at NWHRC (2014)**

HD Montmorency rootstock trial established in 2010 by Rothwell and Lang at NWHRC, Traverse City, MI.

From: Report to MCC by N. Rothwell, 2015

**Yield Efficiency of Montmorency on 5 rootstocks at NWHRC (2014)**

HD Montmorency rootstock trial established in 2010 by Rothwell and Lang at NWHRC, Traverse City, MI.

From: Report to MCC by N. Rothwell, 2015

**Mont / Cass**

Guard Rows in OTR Plot, NWHRC 2014, Extreme precocity, sacrifice shoot growth

**Mont / Clinton**

Mont / Mahaleb

Guard Rows in OTR Plot, NWHRC 2014, Extreme precocity, sacrifice shoot growth

**Montmorency / Clinton**

Mont / Mahaleb

Guard Rows in OTR Plot, NWHRC 2014, Extreme precocity, sacrifice shoot growth
Effects of rootstock and canopy treatments on yield of Montmorency, NWHRC 2016

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean berries kg</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Recycle</td>
<td>4.2</td>
<td></td>
</tr>
<tr>
<td>Summer Hedge</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Winter Hedge</td>
<td>4.8</td>
<td></td>
</tr>
<tr>
<td>2011 OTR Trial, Trees est. 5 X 13'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*2 large branches cut back to 8” stubs

Effects of rootstock and canopy treatments on vigor of Montmorency, NWHRC 2016

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean Canopy Values</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Recycle</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>Summer Hedge</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Winter Hedge</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>2011 OTR Trial, Trees est. 5 X 13'</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Benefits of OTR System

- Gentler system - can work with trees/plants in 2nd leaf vs 5th/6th leaf after planting
- Less drop height (collection point)
- Will affect fruit quality and condition
- Can possibly avoid application of Ethephon
- Decrease trunk damage / disease
- Increase harvest efficiency w/ continuous harvest
- Increased fruit uniformity
- Can need less labor for harvest

Preliminary Conclusions

- Rotary-Tine Harvesters are very effective and efficient in fruit removal with minimal damage to canopy.
- Ethephon applications to induce fruit abscission may not be necessary
  - Harvested fruit at Oxley Farms at 95%+ rate @ 650-750 g pull force
  - Harvested fruit at NWHRC at 98%+ rate @ 360-540 g pull-force
- Fruit is removed and delivered in clean state with little damage and few stems and leaves.
  - Need to demonstrate empirical evidence of improved delivered product re: fruit quality in future research. “perceived” or “real”

Questions..... ??????????????
- To keep trees compact for smaller harvesters as trees age, what will be the horticultural protocol omitting use of dwarfing rootstocks??
- Do we need to canopy prune / root prune annually or biennially??

Pull force (g) required to separate fruit from pedicels* at NWHRC 2015**

<table>
<thead>
<tr>
<th>Variety</th>
<th>Pull Force (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial</td>
<td>605</td>
</tr>
<tr>
<td>LA331</td>
<td>200</td>
</tr>
<tr>
<td>Mont/Mah Ctrl</td>
<td>500</td>
</tr>
<tr>
<td>Mont/Mah Summer Hedge</td>
<td>400</td>
</tr>
<tr>
<td>Mont/Mah Winter Hedge</td>
<td>300</td>
</tr>
<tr>
<td>Mont/Mah Recycle</td>
<td>200</td>
</tr>
<tr>
<td>Commercial</td>
<td>500</td>
</tr>
<tr>
<td>LA331</td>
<td>200</td>
</tr>
<tr>
<td>Mont/Mah Ctrl</td>
<td>500</td>
</tr>
<tr>
<td>Mont/Mah Summer Hedge</td>
<td>400</td>
</tr>
<tr>
<td>Mont/Mah Winter Hedge</td>
<td>300</td>
</tr>
<tr>
<td>Mont/Mah Recycle</td>
<td>200</td>
</tr>
</tbody>
</table>

* 50 randomly selected, fruit samples
** Control treatments only, no Ethephon treatment

Thank You..s

- Ed and Chris Oxley; plot cooperators and management Oxley Farms, Lawton, MI
- Nikki Rothwell; plot cooperators NWHRC
- Luis Hull; 2015 harvester operator
- Tammy Wilkinson; data processing
- NWHRC Farm manager Bill Klein and staff
- Spring Brook Supply; harvester source and cooperators