Advances toward Mechanical Harvesting of Florida Blueberries for Fresh Markets

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IFAS, University of Florida
Hand harvesting is the single greatest expense for Florida blueberry production

- Florida’s industry is based on fresh fruit.
- Berries are hand-picked at 2 to 4-day intervals.
- Labor supply can limit harvest operations.
- Seasonal prices can decline to a point where hand-harvesting is not profitable.
- Florida must reduce production costs to remain internationally competitive.
Mechanical harvesting presents challenges

- Marketable yield can be reduced by –
  - Fruit dropped on ground during harvest
  - Harvest of immature fruit
  - Mature fruit left on the bush
  - Fruit drop between harvest intervals
  - Fruit bruising from harvester
  - Plant injury from harvester
Machine Harvesting of Blueberries:
At least 6 U.S. companies offer O-T-R mechanical harvesting equipment (from Dr. Fumi Takeda, USDA)
Over-the –row blueberry harvesters

- Over-the –row harvesters are expensive and cost prohibitive for many medium to small sized blueberry farms.
Berries dropping to catch plates are a major source of bruising
Inside an over-the-row blueberry harvester
Berries dropping into lugs are another source of bruising
Berries dropping into lugs. Note: some immature berries
Front of BEI harvester- catch plates are angled up toward the middle, several inches above the soil surface.
Bed Configuration

• Raised beds bring the catcher plates closer to the base of the crown.
• Bed height – varies.
• Beds 12 to 18 inches wide at the top allow catcher plates to be lower on the plant.
• Wider beds should taper-off at edges.
• Pine bark beds?
• Remove suckers and low-hanging shoots from lowest 14” of plant.
• Keep crowns narrow
Wide crowns result in excess ground drops
Narrower crowns result in fewer ground drops
Catch plates
Beds should taper-off at the shoulders
Plant Spacing

- Minimum of 9 -10 ft. between-row spacing.
  - Need a minimum of 30’ clearance at end of rows for equipment turn around.
  - Periodic row breaks (at 400 ft) suggested for unloading harvester, etc.
- In-row spacing – minimum of 3 feet between plants.
  - Exact spacing may depend on cultivar and site.
What is a good mechanical harvestable blueberry cultivar?
Plant architecture

- Good anchorage, upright, narrow base, not too dense

From Dr. Jim Olmstead
‘Meadowlark’- an example of narrow crowns

From Dr. Jim Olmstead
Timing

- Even, condensed maturity period
- Fruit holding ability on bush

From Dr. Jim Olmstead
Scar

- Small, dry stem scar

From Dr. Jim Olmstead
Detachment

• Low detachment force for mature blue fruit

From Dr. Jim Olmstead
Clusters/Stems

• Loose clusters
• No stem retention

From Dr. Jim Olmstead
Color

- Full color – no green or red on stem end

From Dr. Jim Olmstead
Firmness

• High firmness

• Crisp fruit?

From Dr. Jim Olmstead
Preliminary Studies of Mechanically Harvested Blueberries for Fresh Markets in Florida

Jeff Williamson, Steve Sargent, and Jim Olmstead
Meadowlark™
‘FL01-173’ – (USPP # 21,553)

- Part sparkleberry
- Early bloom, starts ripening ≈ 10 days before ‘Star’
- Very upright growth
- Very open fruit clusters
- High yield potential
- Larger scar, particularly on young plants
‘Farthing’ (USPP # 19,341)

- Vigorous, compact growth habit, good survival
- Blooms mid-late (between ‘Emerald’ and ‘Star’)
- High yield potential, long picking season
- Very firm fruit
- Poor color with large crop
‘Sweetcrisp’ (USPP # 20,027)

- Higher chill requirement (Gainesville-north)
- Crisp flesh texture, very sweet taste
- Very vigorous, sprawling growth habit
- Blooms 1 week before and ripens with ‘Star’
- Medium yield potential
‘Sweetcrisp’
‘Meadowlark’
‘Farthing’
Fruit grading on packing line
## Seasonal Packout of three SHB cultivars harvested by hand and by machine

### ‘Farthing’

<table>
<thead>
<tr>
<th>Harvest Method</th>
<th>Marketable (%)</th>
<th>Immature (%)</th>
<th>Soft (%)</th>
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</thead>
<tbody>
<tr>
<td>Hand</td>
<td>94.3</td>
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<td>Machine</td>
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### ‘Meadowlark’

<table>
<thead>
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<th>Immature (%)</th>
<th>Soft (%)</th>
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### ‘Sweetcrisp’

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<th>Immature (%)</th>
<th>Soft (%)</th>
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<tr>
<td>Hand</td>
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<tr>
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Combined seasonal packout for ‘Sweetcrisp’, ‘Meadowlark’ and ‘Farthing’

<table>
<thead>
<tr>
<th>Harvest method</th>
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<th>Immature</th>
<th>Soft</th>
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<td>Hand</td>
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Visual quality and firmness of blueberry fruit hand or mechanically harvested then stored for 7 or 14 d at 1°C

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Hand harvested and stored</th>
<th>Mechanically harvested and stored</th>
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<tr>
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<td>7 days</td>
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<tr>
<td>Appearance</td>
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<td>Soft (%)</td>
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<tr>
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<tr>
<td>Appearance</td>
<td>4.0</td>
<td>10.0</td>
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<tr>
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<tr>
<td>Appearance</td>
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<td>Soft (%)</td>
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1 = poor, 5 = excellent, 3 = limit of marketability
Visual quality and firmness of blueberry fruit hand or mechanically harvested then stored for 7 or 14 d at 1°C

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<tr>
<td></td>
<td>Appearance</td>
<td>Soft (%)</td>
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<td>MLark</td>
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1 = poor, 5 = excellent, 3 = limit of marketability
Summary

• Significant packout losses occurred from the harvest of immature fruit.
• Marketable packout was about 81% for machine and about 94% for hand harvested fruit.
• Apart from packout, significant losses occurred from fruit dropped on the ground by the harvester.
• Mechanically harvesting resulted in a high incidence of soft berries after storage.
Would a single-trunk blueberry “tree” increase harvest efficiency?
V. arboreum - Sparkleberry

- Native to the southeastern U.S.
- Shrub or small tree: 6 to 30 feet high
- Deep root system – drought tolerant
- Tolerates soil pH up to 6.5
- Tree-like growth habit – single trunk
- Sand or sand-clay soils
- Low organic matter
- Low Fe and NH$_4$
Objectives

• Use sparkleberry as a rootstock to:

1. Increase adaptability of SHB to non-amended soils.

2. Improve mechanical harvesting potential for SHB.
Grafted ‘Meadowlark’, 2013 – Citra, FL
‘Meadowlark’, 2013 – Archer, FL

Grafted

Own-rooted
Grafted ‘Farthing’, 2013 – Archer, FL
Hand-harvesting vs. simulated mechanical harvesting
Straughn Farms, Archer - 2013
Simulated mechanical harvest

- Yield?
- Fruit quality?
- Pack out?
- Postharvest storage?
## Total yield

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Farthing</th>
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<td>aA</td>
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<td>1661</td>
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- HH plants generally yielded more than MH plants

From Casamali, et al.
# Marketable berries and berry losses

<table>
<thead>
<tr>
<th>Treatment</th>
<th>MY (%)</th>
<th>GLBH (%)</th>
<th>GLDH (%)</th>
<th>PL (%)</th>
<th>BLP (%)</th>
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<tr>
<td>Farthing</td>
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\(^z\) Values are percentages of the potential total yield for each treatment. MY = marketable yield; GLBH = ground losses before harvest; GLDH = ground losses during harvest; PL = packout losses; BLP = berries left on the plant after harvest.

- MH had ~40% reduction in marketable berries compared to HH

From Casamali, et al.
Visual ratings and weight loss

– For either harvest method, berries stored at 7 and 14 days had lower appearance rating, and higher percentage of soft and shriveled fruit

– After storage, MH berries had lower appearance rating, and higher percentage of soft and shriveled fruit than HH berries

– No decay was observed

– Weight loss increased during storage for either harvest method

From Casamali, et al.
Fruit quality and firmness

- MH berries had lower TTA and greater TSS and TSS:TTA ratio than HH berries

- HH berries had greater berry firmness than MH

- HH berries did not have a reduction in firmness during storage; however, firmness of MH reduced after 14 days in storage

From Casamali, et al.
Fruit Quality and Yield Loss
Example of bruising from mechanical harvest

Internal Bruise

M H

Hand Harvest

From Dr. Fumi Takeda, USDA
BIRD Sensor: Assembly

From Dr. Fumi Takeda, USDA
From Dr. Fumi Takeda, USDA
Advantages:
High capacity harvesting
Need fewer workers
Less cost per harvested fruit

Disadvantages:
More greens and reds More bruised fruit
More soft fruit Less pack-out Shorter shelf-life
More postharvest decay
Not acceptable for long, trans-oceanic transport

Expensive (US $140K to $240K)

From Dr. Fumi Takeda, USDA
Can a less expensive mechanical harvesting aid be developed with reduced fruit damage?

BEI McKibben’s Walk-A-Long “stand-and-pick” machine and H1 berry stripper from >50 years ago

Photos – Bernie Newton

From Dr. Fumi Takeda, USDA

Rethinking for the future
Current semi-mechanical harvesting (harvest-assist) machines

A. BBC Push-pull or tractor-pulled
(walk along, $6 ~ 11K)

B: GH Machine self-propelled
(riding platform, $45 ~ 60K)

- Platform is stationary while harvesting blueberries
- Fruit catching apparatus is manually operated
- Do not have powered fruit conveyance system
- Harvested fruit lands on metal surface

From Dr. Fumi Takeda, USDA
SPRING 2016: CENTRAL FLORIDA FIELD TESTS WITH MOBILE CATCH FRAME
DR. FUMI TAKEDA SHOWING SUSPENDED SHAKER CONCEPT

From Dr. Fumi Takeda, USDA
INITIAL TESTS FOR SURFACE OF MOBILE CATCH FRAME

Fruit ‘Flicker’, ‘Kestrel’, ‘Springhigh’) dropped from 1, 2 or 3 feet onto:
• Bare metal
• Foam pad
• Suspended poly net
Held overnight at room temp

From Dr. Fumi Takeda, USDA
‘Draper’ fruit dropped 3 feet, sliced after 12 hours

From Dr. Fumi Takeda, USDA
Conclusions

• Research is ongoing to increase machine harvest efficiency, reduce fruit injury, and develop less expensive berry harvesters for small to medium-sized berry farms.

• Breeders are selecting for desirable horticultural traits.

• Researchers are testing harvest assist platforms that are less expensive than over-the-row harvesters.

• Various shaking devices and catch frame surfaces are being evaluated.

• Fruit bruising, storage quality, and detachment of immature fruit during harvest are major challenges.