Advances toward Mechanical Harvesting of Florida Blueberries for Fresh Markets

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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.

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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

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Machine Harvesting of Blueberries:

At least 6 U.S. companies offer O-T-R mechanical harvesting equipment (from Dr. Fumi Takeda, USDA)

Haven Harvesters

Littau Harvester

A&B Packing

Oxbo International

AG Harvesters

BlueLine Manufacturing

Over-the –row blueberry harvesters

- Over-the –row harvesters are expensive and cost prohibitive for many medium to small sized blueberry farms.

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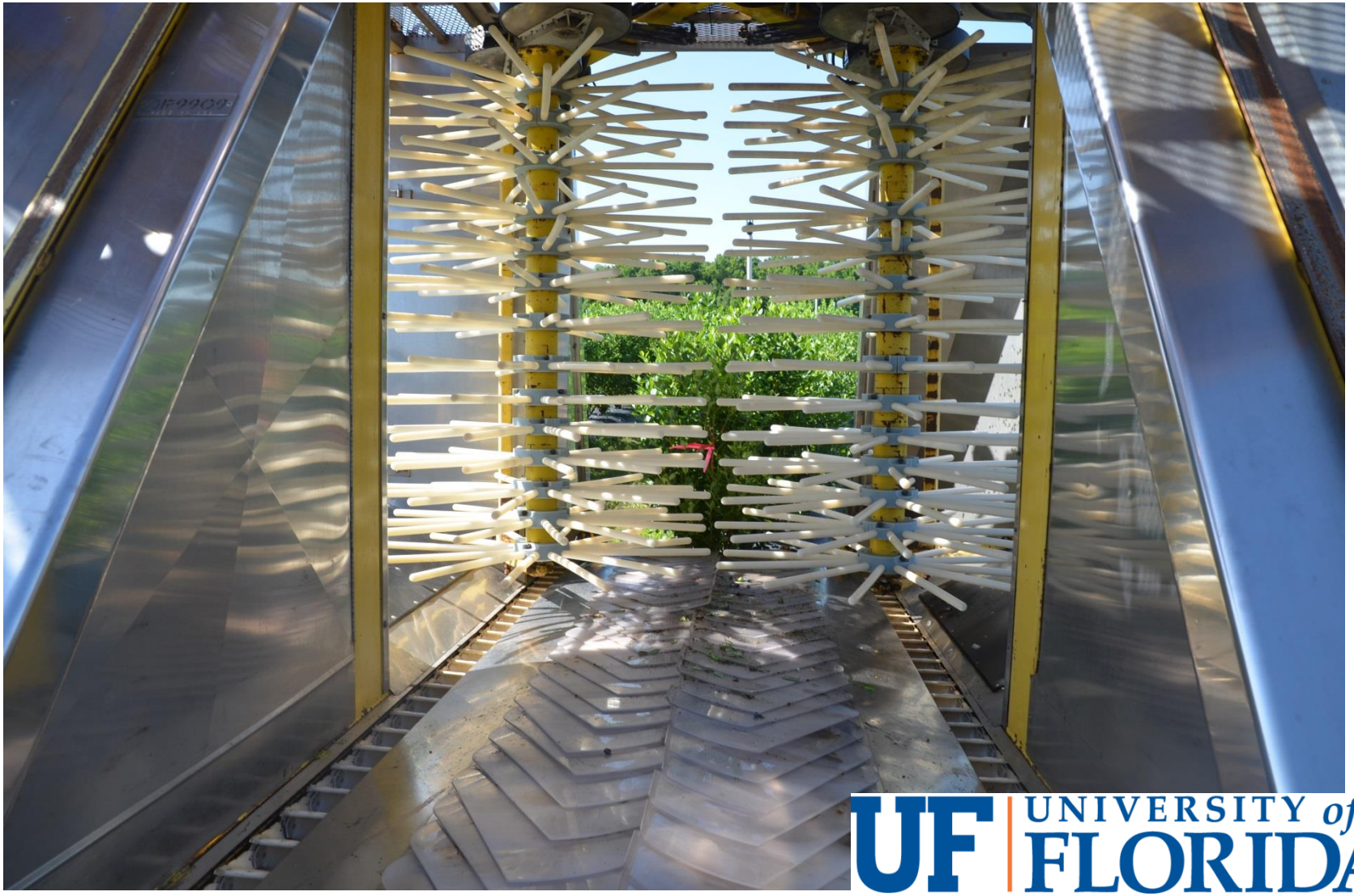
Berries dropping to catch plates are a major source of bruising



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Inside an over-the-row blueberry harvester

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Berries dropping into lugs are another source of bruising

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Berries dropping into lugs. Note: some immature berries

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DSC_4830.MOV

DSC_4851.MOV

Front of BEI harvester- catch plates are angled up toward the middle, several inches above the soil surface

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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

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Narrower crowns result in fewer ground drops

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Catch plates

Beds should taper-off at the shoulders

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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.

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What is a good mechanical harvestable blueberry cultivar?

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Plant architecture

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

From Dr. Jim Olmstead

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‘Meadowlark’- an example of narrow crowns

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From Dr. Jim Olmstead

Timing

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

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Scar



- Small, dry stem scar

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Detachment

- Low detachment force for mature blue fruit

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Clusters/Stems

- Loose clusters
- No stem retention

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Color

- Full color – no green or red on stem end

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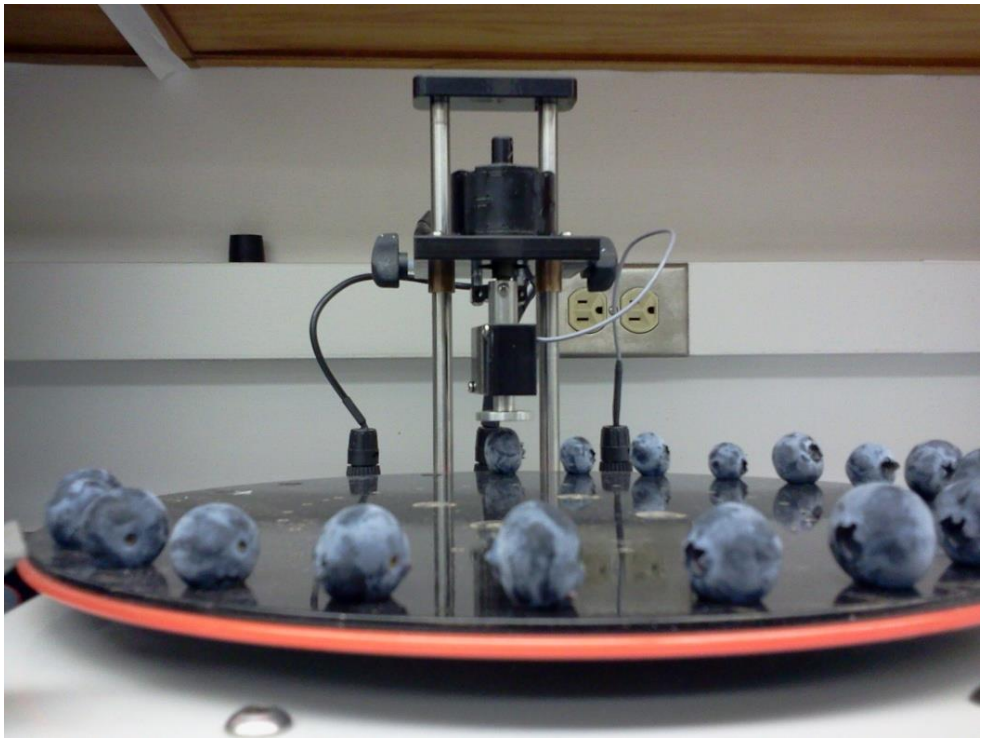
Firmness



- High firmness
- Crisp fruit?

From Dr. Jim Olmstead

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Preliminary Studies of Mechanically Harvested Blueberries for Fresh Markets in Florida

Jeff Williamson, Steve Sargent, and Jim Olmstead

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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

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‘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

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‘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

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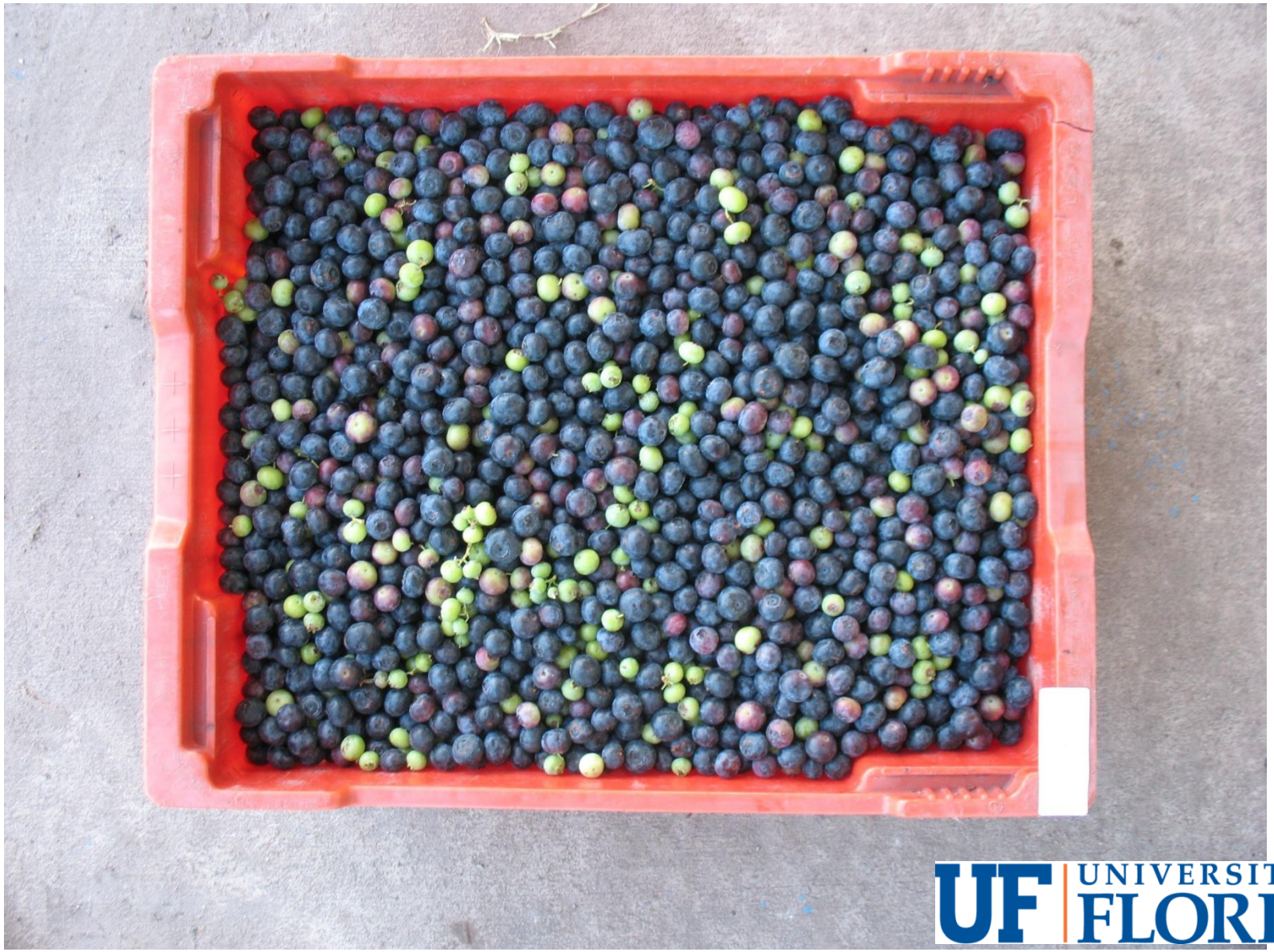
‘Sweetcrisp’



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‘Meadowlark’

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‘Farthing’

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Fruit grading on packing line

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Seasonal Packout of three SHB cultivars harvested by hand and by machine

'Farthing'

Harvest Method	Marketable (%)	Immature (%)	Soft (%)
Hand	94.3	4.5	1.2
Machine	80.5	17.3	2.2
Significance	0.0039	0.0051	0.0356

'Meadowlark'

Harvest Method	Marketable (%)	Immature (%)	Soft (%)
Hand	92.1	6.2	1.7
Machine	84.1	11.9	4.0
Significance	0.0058	0.0133	0.0005

'Sweetcrisp'

Harvest Method	Marketable (%)	Immature (%)	Soft (%)
Hand	95.3	3.7	1.0
Machine	77.4	20.6	1.9
Significance	0.0030	0.0006	0.0682

Combined seasonal packout for ‘Sweetcrisp’, ‘Meadowlark’ and ‘Farthing’

Harvest method	Marketable	Immature	Soft
Hand	93.9	4.8	1.3
Machine	80.7	16.6	2.7
Significance	0.0001	0.0001	0.0008

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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

	Hand harvested and stored				Mechanically harvested and stored			
	7 days		14 days		7 days		14 days	
Cultivar	Appear-ance	Soft (%)	Appear-ance	Soft (%)	Appear-ance	Soft (%)	Appear-ance	Soft (%)
Mlark	4.0	15.0	2.0	10.0	4.0	25.0	2.0	32.5
Farthing	4.0	10.0	3.0	30.0	4.0	25.0	2.0	75.0
SwCrisp	4.0	10.0	2.9	15.0	4.0	42.5	2.0	70.0

1 = poor, 5 = excellent, 3 = limit of marketability

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MLark	4.0	15.0	2.0	10.0	4.0	25.0	2.0	32.5
Farth	4.0	10.0	3.0	30.0	4.0	25.0	2.0	75.0
SwC	4.0	10.0	2.9	15.0	4.0	42.5	2.0	70.0

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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.

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Would a single-trunk blueberry “tree” increase harvest efficiency?

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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

cas.vanderbilt.edu

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Objectives

- Use sparkleberry as a rootstock to:

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

2. Improve mechanical harvesting potential for SHB.

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Grafted ‘Meadowlark’, 2013 – Citra, FL

‘Meadowlark’, 2013 – Archer, FL

Grafted

Own-rooted

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Grafted ‘Farthing’, 2013 – Archer, FL

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Hand-harvesting vs. simulated mechanical harvesting
Straughn Farms, Archer - 2013

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Simulated mechanical harvest

- Yield?
- Fruit quality?
- Pack out?
- Postharvest storage?

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Total yield

Treatment	Total yield (g/plant)							
	Farthing				Meadowlark			
	HH		MH		HH		MH	
	2013							
Own-rooted/amended	5192	aA	2572	aB	3323	aA	1601	aB
Own-rooted/non-amended	1980	bA	1329	bA	1418	bA	889	bA
Grafted/amended	2568	bA	1699	bB	1281	bA	913	abA
Grafted/non-amended	2009	bA	1291	bB	1679	bA	880	bB
	2014							
Own-rooted/amended	4943	aA	2257	aB	5036	aA	2384	aB
Own-rooted/non-amended	1927	cA	1132	bB	1715	cA	914	bA
Grafted/amended	4298	abA	2302	aB	2792	bcA	1904	aB
Grafted/non-amended	3263	bA	1661	abB	3323	bA	1807	aB

- HH plants generally yielded more than MH plants

From Casamali, et al.

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Marketable berries and berry losses

Treatment	MY (%)[z]	GLBH (%)	GLDH (%)	PL (%)	BLP (%)
			Farthing		
Own-rooted/amended	53.1 b	18.0 a	9.5 a	15.9 ab	3.5 a
Own-rooted/non-amended	57.0 ab	18.9 a	8.9 a	13.9 b	1.3 b
Grafted/amended	57.7 ab	15.7 a	6.1 b	18.5 a	2.0 b
Grafted/non-amended	59.1 a	17.5 a	5.8 b	15.7 ab	1.7 b
			Meadowlark		
Own-rooted/amended	60.7 a	9.9 ab	11.2 a	14.0 a	4.2 a
Own-rooted/non-amended	64.5 a	7.7 b	10.1 a	12.9 a	4.8 a
Grafted/amended	62.7 a	12.9 a	6.9 b	13.5 a	3.8 a
Grafted/non-amended	64.6 a	10.2 ab	6.4 b	14.1 a	4.7 a

[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.

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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.

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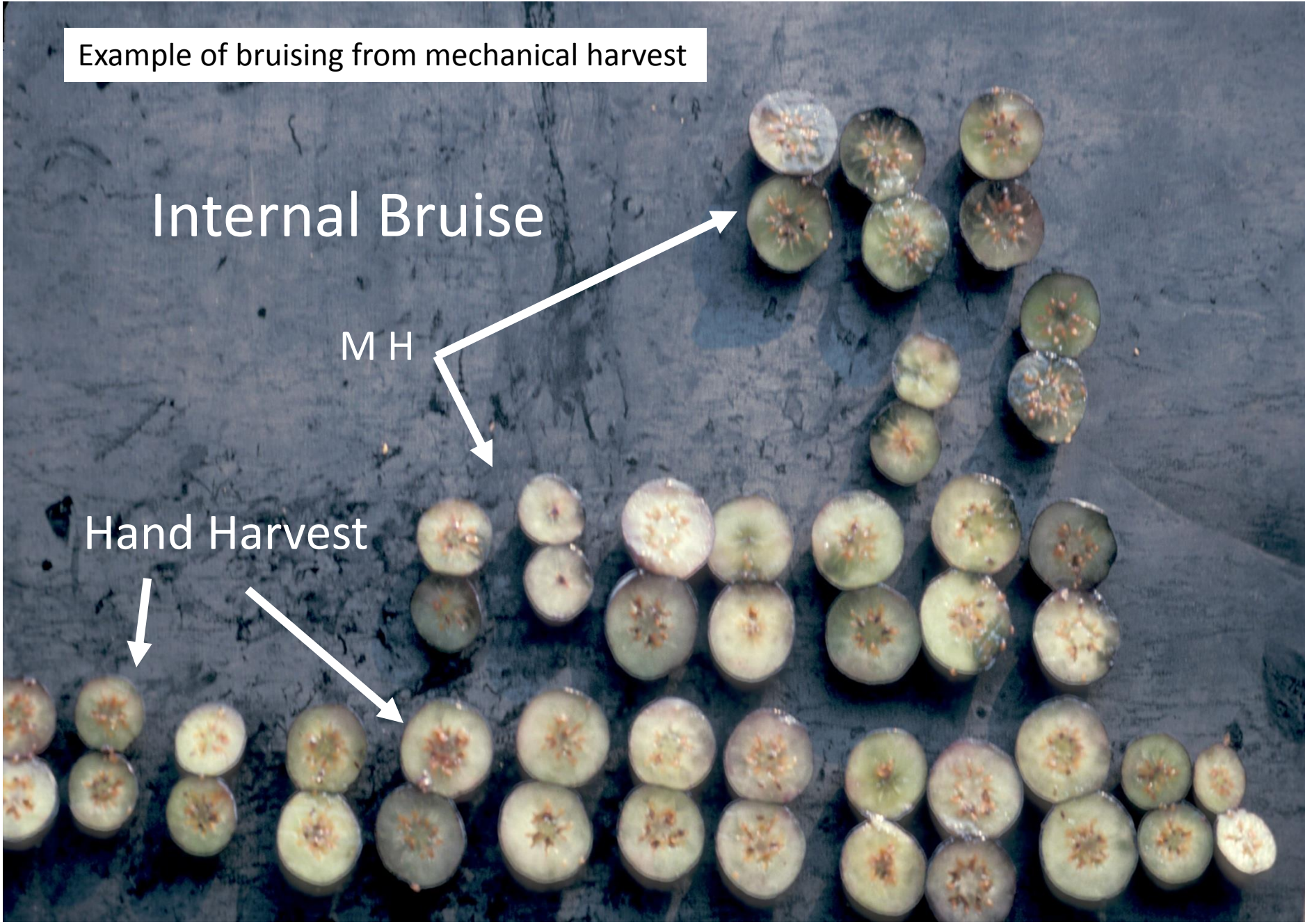
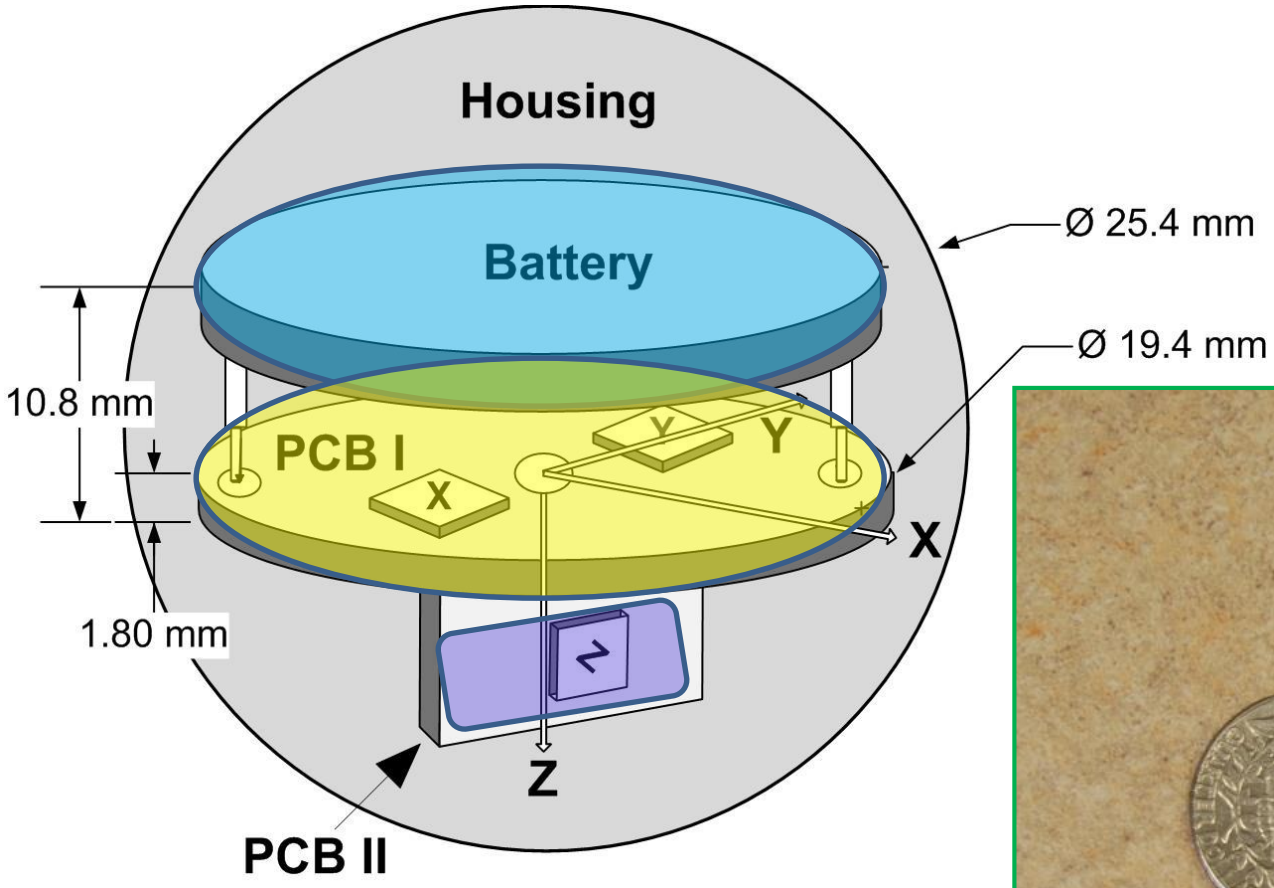
Fruit Quality and Yield Loss



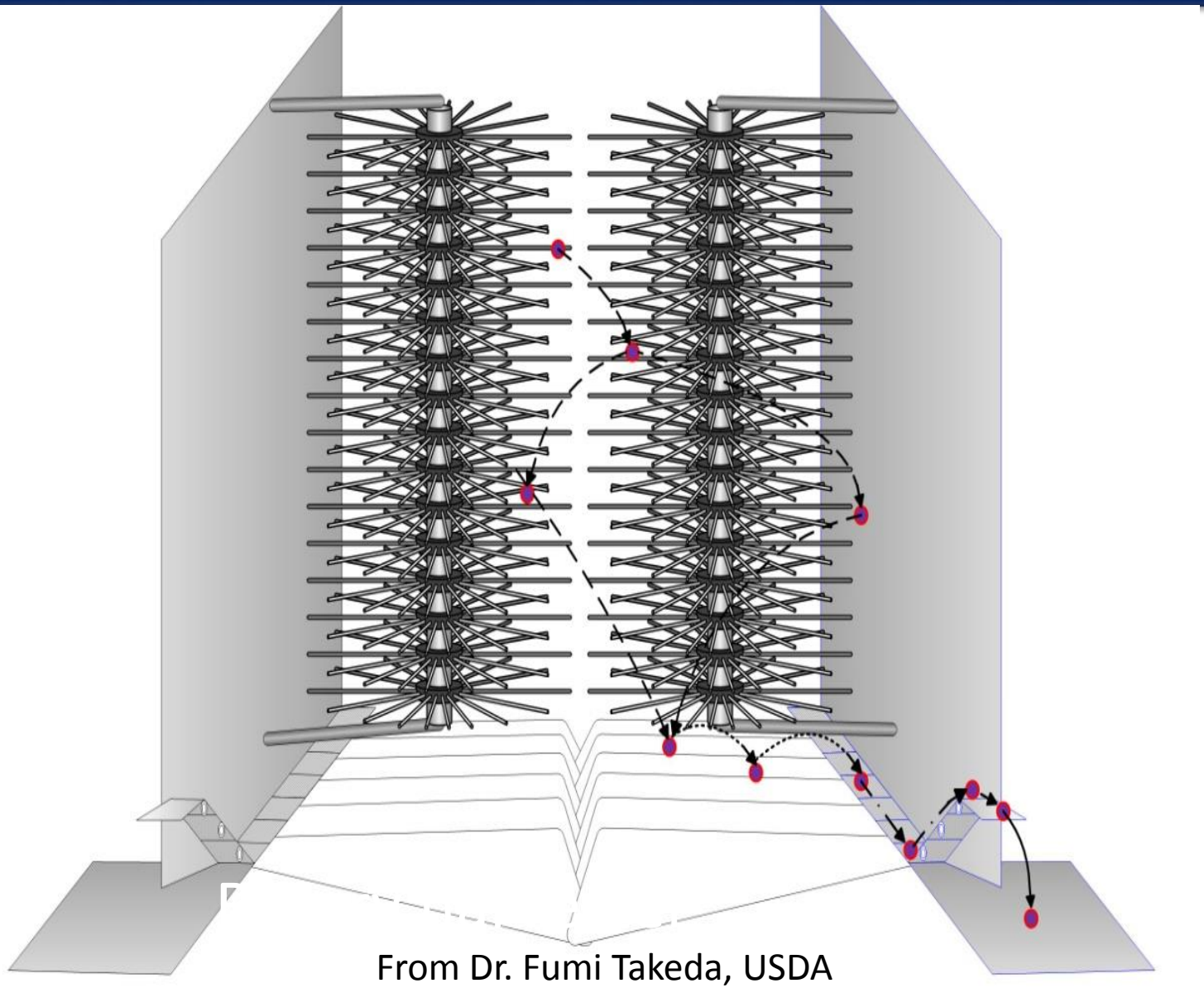
From Dr. Fumi Takeda, USDA

BIRD Sensor: Assembly



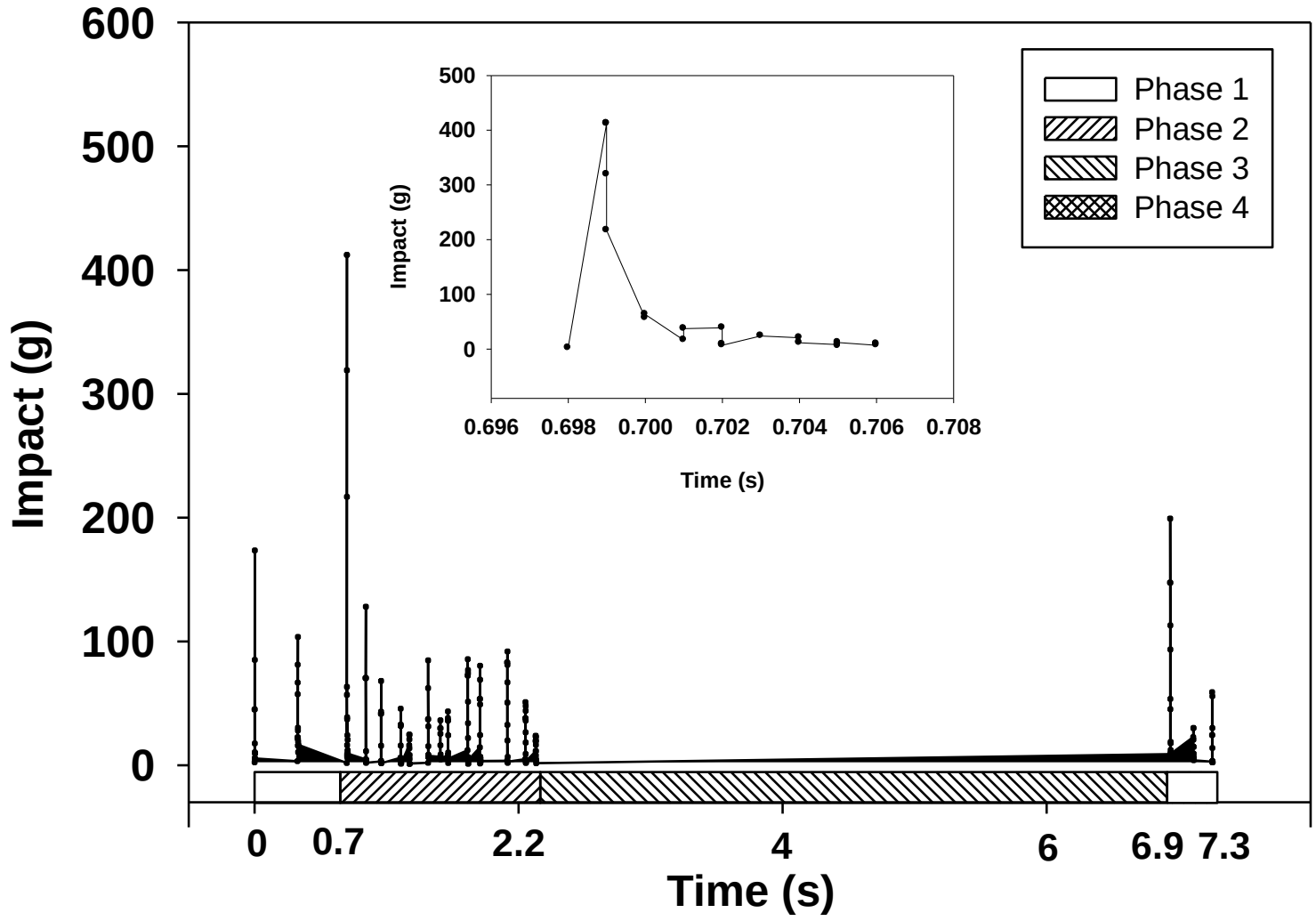
From Dr. Fumi Takeda, USDA

Mechanical Harvest Process



From Dr. Fumi Takeda, USDA

Real Time Impacts



From Dr. Fumi Takeda, USDA

O-T-R Mechanical Harvesting

Advantages:

High capacity harvesting
Need fewer workers
Less cost per harvested fruit

Bruising

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 <u>manually</u> 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

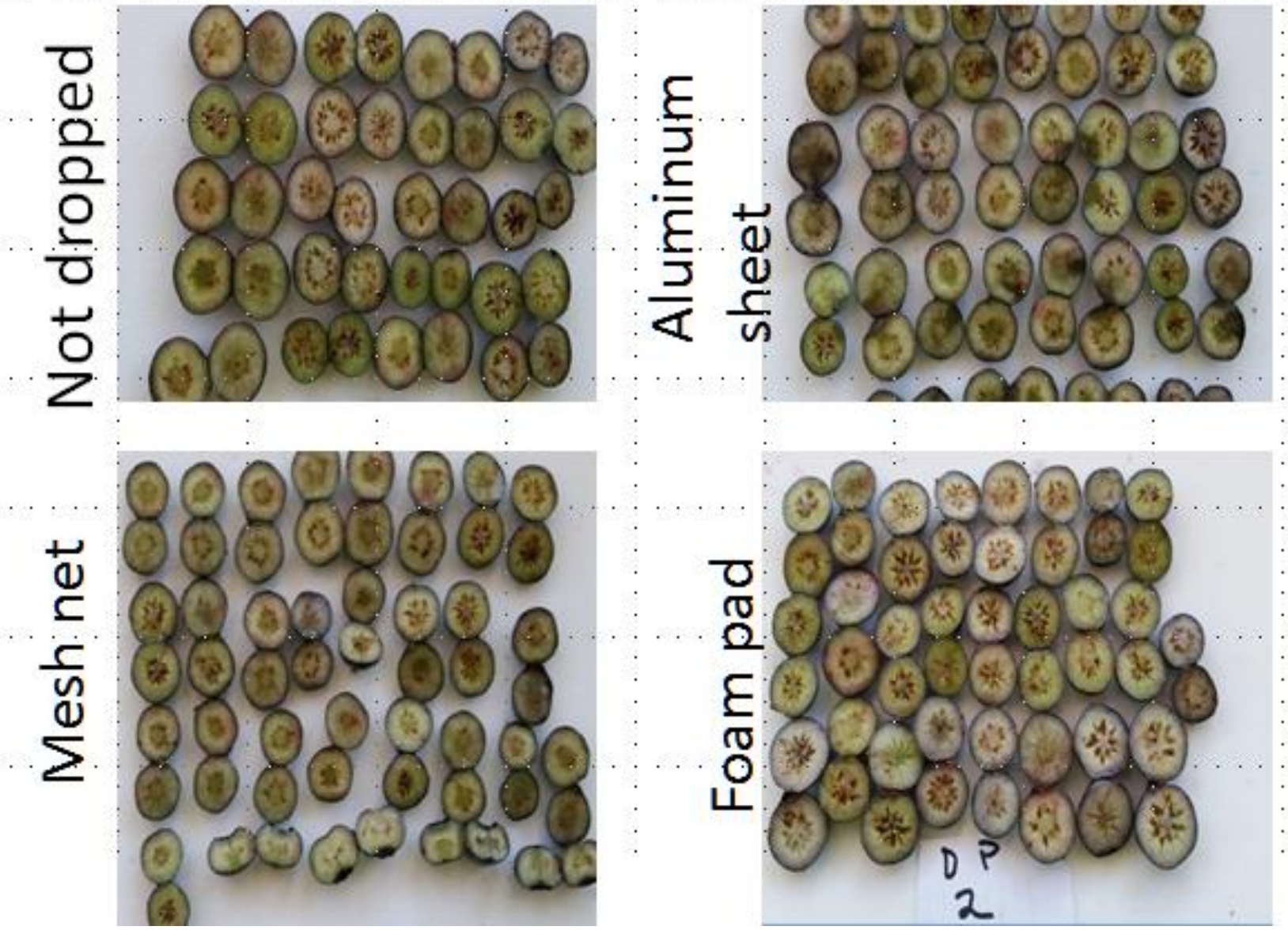
Fruit ‘Flicker’, ‘Kestrel’, ‘Springhigh’) dropped from 1, 2 or 3 feet onto:

- 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.