## Slide 1

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# Mechanical Harvesting of Hazelnuts

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## Slide 2

# BEI Harvester Issues

- Issues
  - Sticks get caught on the partition at the inclined conveyor
  - Cleaning system plugs easily - sticks get caught at the end of the conveyor
  - Requires 3 people
- Two Stage air cleaning system
- Solution – Remodel cleaning system to better handle sticks and high leaf load

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## Slide 3

# BEI cleaning system

- 2 fans
- 2 stage – not needed for nuts
- Sticks jammed on hinged baffle

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## Slide 4

# Rear view of cleaner

- Bottom fan – secondary cleaner

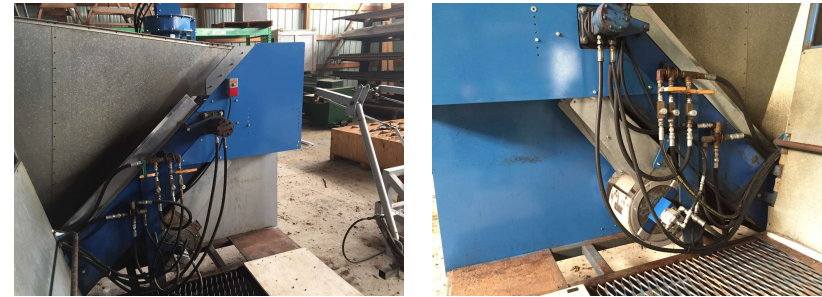- Baffle / swing flap causes plugging

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## BEI Cleaning System Remodel

- Removed old air cleaning system
- Replaced with one fan under inclined conveyor
- Stick Tray to remove longer stick



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## Under Elevator fan with Stick Tray



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## Under Elevator fan with Stick Tray

Air duct outlet – blows air between conveyor and stick tray



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## Under Elevator fan with Stick Tray

Stick Tray                    Conveyor side extension



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## Alternative Design: Top Fan

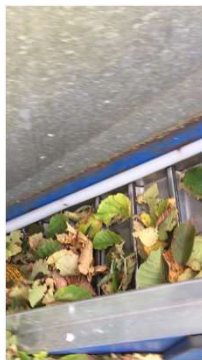•Top Fan to suck leaves up similar to the Oxbo cleaning fans but smaller size



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## Top Fan

- Interfered with stick removal
- Raised Fan – then too high to effectively remove leaves
- Conclusion – won't work in current design

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## Videos of new system



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## Field Trials



Blue Mound Hazelnuts, LLC

- 6 acres
- 7-8 year old bushes
- 12 / 18 foot row spacing
- 30 foot headlands
- 800 foot rows

Stoughton Planting

- 11 rows – 45 plants
- 360 feet long x 15 ft spacing
- Planted 2011

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## 2021 Harvest Experimental Design

Harvester Ground Loss Determination
- Randomly selected a 50 ft section in each row
- Count the number of bushes in each section
- Rake any dropped clusters or old nuts from under bushes
- Run harvest pass
- Hand pick up any clusters or nuts from under bushes – weigh and record
- Days later before next harvest run, hand pick up any clusters or nuts from under bushes
- Run harvest pass
- Pick up any clusters or nuts from under bushes – weigh and record
- Hand pick any clusters still on bush - weigh and record

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## Data Extrapolation

- Estimate of ground losses and unharvested clusters
  - Wt per row = plot weight   X   # of plants in row
  
    # of plants in test section

  Cautions: 1) Only had one plot per row
  
  - should be 3 to be statistically valid
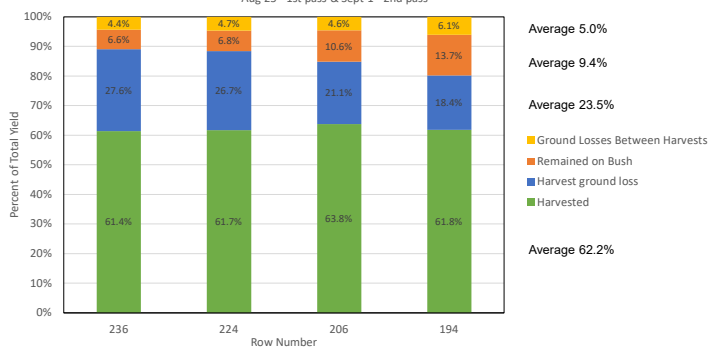  
  2) Large variation of genetics in rows (non-clones)

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## Harvesting - Oxbo Harvester

- 4 rows
- First Pass August 25
  - Despite hot summer, hazelnuts were still green
- 2nd Pass Sept 1 (7 days later)



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Oxbo Harvester
Aug 25 - 1st pass & Sept 1 - 2nd pass

| Row Number | 236 | 224 | 206 | 194 | |
|---|---|---|---|---|---|
| Ground Losses Between Harvests | 4.4% | 4.7% | 4.6% | 6.1% | Average 5.0% |
| Remained on Bush | 6.6% | 6.8% | 10.6% | 13.7% | Average 9.4% |
| Harvest ground loss | 27.6% | 26.7% | 21.1% | 18.4% | Average 23.5% |
| Harvested | 61.4% | 61.7% | 63.8% | 61.8% | Average 62.2% |

Previous years we reported harvest rates exceeding 90% but that didn't take into account ground losses

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## Harvesting - BEI

- 7 rows
- 1st pass – Sept 6
- 2nd pass – Sept 10

**BEI Harvester**
Sept 6 - 1st pass & Sept 10 - 2nd pass



| Row Number | Remained on Bush | Harvest Ground Loss | Harvested Yield |
|---|---|---|---|
| 176 | 15.9% | 15.1% | 69.0% |
| 164 | 0.7% | 10.0% | 89.4% |
| 146 | 16.3% | 25.2% | 58.5% |
| 134 | 32.4% | 13.3% | 54.3% |
| 116 | 52.2% | 11.6% | 36.2% |
| 98 | 34.4% | 13.4% | 52.3% |
| 86 | 20.9% | 29.4% | 49.7% |

Average 24.7%

Average 16.9%

Average 58.5%

**Harvest Rate by Pass**



- Oxbo Harvester - Aug 25 & Sept 1 -     ------------------- BEI Harvester - Sept 6 & Sept 10 -------------------

Average 2nd Pass – 31%

Average 2nd Pass – 18.9%

Average 1st Pass – 69%

Average 1st Pass – 81.1%

1st Harvest Pass    2nd Harvest Pass
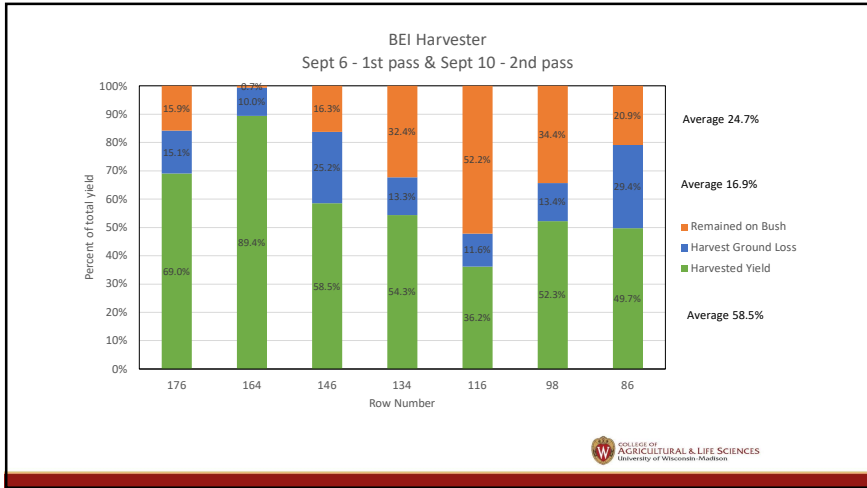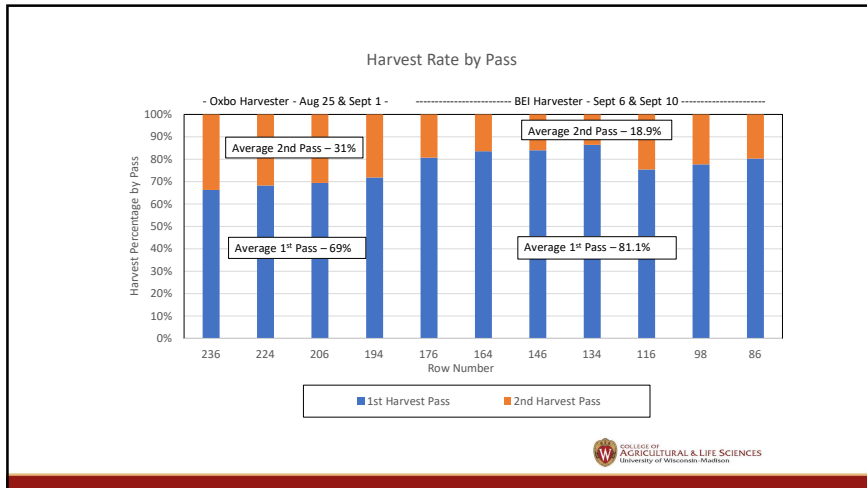
## Comparison of Harvesters

|  | Oxbo^ | BEI |
|---|---|---|
| Harvested Clusters | 65.5% | 54.7% |
| Harvester ground losses | 24.2% | 17.0% |
| Remain on Bush | 10.3% | 28.3% |

^ Between harvest losses omitted

2021 Hazelnut Yield Summary (lb/row)
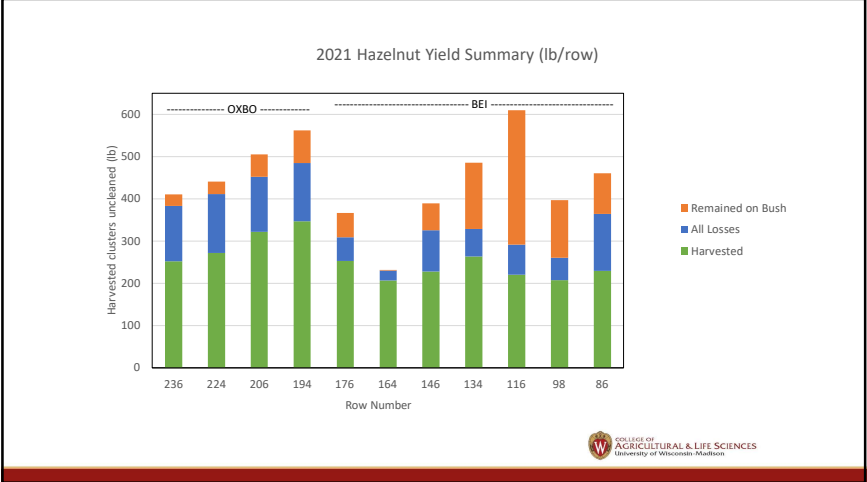
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## Other issues

- Wide base bushes = flattening bushes
  - Harvesters can't back up without damage to catch-plates
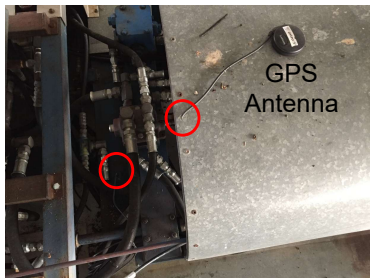


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## Other BEI issues
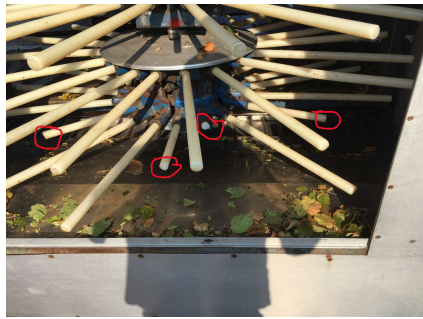
Heavy stems = Broken rods

Rodents!!!!!!

GPS Antenna



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## Future work

- Address ground losses – 15 – 20% is too high
- Agronomic
  - Single stem plants
  - Narrower bush bases
- Machine Design
  - Split row harvester – bend the bushes to the side so falling clusters won't fall between stems and onto the ground
  - A&B packing Fulcrum Harvester

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Questions?

Northern Walking Stick
(*Diapheromera femorata*)

Hazelnut Thief?

Shamrock Orb-weaver spider
(Araneus trifolium)