Precision Harvesting System: A Promising Technology to Improve Harvestable Berry Yield and Quality

WBPANS Annual Meeting
Dalhousie Agricultural Campus
November 22, 2013
Objectives

- Develop improved integrated harvesting management systems = coupling of mechanical, biological and environmental processes

- Increase the berry picking efficiency of blueberry harvester = LOWER cost of production
Improved Integrated Harvesting System

- Sensor Fusion System to Identify Sources of Error
- Quantification of Multiple Fruit Losses during Harvesting
- Impact of Relative Velocity and Different Header Forces on Fruit Picking Efficiency
- Development of Bio-System Modeling for coupling of biological, environmental and mechanical processes
- Design Analysis of Harvester Heads
- Comparison of Different Harvester Heads
- On-Line Computer Program for Precise Berry Harvesting Recommendations
Precision Agriculture Research Team
Background

Harvesting expense, shortage of labor and short season were the basis for mechanized harvester. Research on the development of the mechanical harvester started in early 1950s, a viable mechanical harvester was not produced until the 1980s.

Gray 1969 developed hollow reel raking mechanism to pick wild blueberries (Chisholm-Ryder Co.).

DBE harvester commercialized harvester in early 1980.

Quantify losses during the harvesting with existing commercial blueberry harvester.

Factors responsible for fruit yield losses to improve berry picking efficiency.

Develop integrated harvesting system to increase harvestable fruit yield and quality.
Sites: Nova Scotia, New Brunswick, Maine

NS:

Cooper Field
Small Scott Field
Frankweb Field
Hardwood Hill Field
Robie Glenn Field

NB:

Tracadie

Maine: Cherryfield
Wymans
Sensor Fusion System

- RTK-GPS
- μEye Camera
- Quadrant
- Ultrasonic Sensor
- Slope Sensor
Real-time Performance of SFS
Quantification of Multiple Fruit Losses

Fruit Losses during harvesting:

- Total fruit yield
- Un-harvested berries on the plants
- Berries on the ground,
- Pre-harvest fruit loss
- Pan loss (Fruit collected in the pan behind head and
- Berries through blower
Mechanical Process: (Machine Parameters)

- Effect of different ground speed and head revolution on harvesting efficiency
- Effect of teeth length, angle and shape on berry picking efficiency
- Effect of wear and tear of harvester’s parts on berry picking efficiency
Biological Process

Plant and Field Parameters:
- Plant height
- Plant density
- Fruit zone,
- Fruit size
- Stem thickness
- Weeds and Grasses
- Soil conditions (texture, slope)
Environmental Processes

Seasonal and Climatic Effect (Time of Harvest):

**Seasonal Effect:**
- Early season
- Mid season
- Late season

**Climatic Effect:**
- Rainfall
- Degree days
- Humidity
- Wind speed
- Temperature
Comparison of Different Harvester Heads
Harvester efficiency with 12 bars head vs. 16 bars head
Design Analysis of Harvester Heads
Bio-System Modeling

Coupling of mechanical, biological and environmental processes
Operator Skill and Field Conditions:

Harvester efficiency at different head heights and comparison with control head height

- Rocks, stumps, sticks and debris
- Slope of the field
- Tall weeds, grasses
- Height of blueberry plants
- Bare patches of the field
- Plants density of blueberry plants
- From bare patch to blueberry plant zone and vice versa
On-Line Computer Program for Precise Berry Harvesting Recommendations
Site Selection

Cooper Site

Area = 3.2 ha
Bare/weed = 17%

Small Scott Site

Area = 1.9 ha
Bare/weed = 15.3%

1.6 ha
Bare/weed = 7.1%
### Quantification of Losses

#### Experiment Design Parameters

<table>
<thead>
<tr>
<th>Speed (mile/hr)</th>
<th>Revolutions (rpm)</th>
<th>Sample Collection</th>
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</thead>
<tbody>
<tr>
<td>0.75, 1.0, 1.25</td>
<td>26</td>
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**Variables/Treatments**

- **Ground Speed:** 0.75, 1.0 and 1.25 mph
- **Header Rotations:** 26, 28 and 30 rpm
Quantification of Losses – Cooper site

Treatment 1 @ Speed 0.75 mph and 26 rpm
Treatment 2 @ Speed 0.75 mph and 28 rpm
Treatment 3 @ Speed 0.75 mph and 30 rpm
Quantification of Losses – Cooper site

- Treatment 4 @ Speed 1.0 mph and 26 rpm
- Treatment 5 @ Speed 1.0 mph and 28 rpm
- Treatment 6 @ Speed 1.0 mph and 30 rpm
Quantification of Losses – Cooper site

- Treatment 7 @ Speed 1.25 mph and 26 rpm
- Treatment 8 @ Speed 1.25 mph and 28 rpm
- Treatment 9 @ Speed 1.25 mph and 30 rpm
Quantification of Losses – Cooper Site

Trt. 1: 0.75 mph and 26 rpm
Trt. 2: 0.75 mph and 28 rpm
Trt. 3: 0.75 mph and 30 rpm
Trt. 4: 1.0 mph and 26 rpm
Trt. 5: 1.0 mph and 28 rpm
Trt. 6: 1.0 mph and 30 rpm
Trt. 7: 1.25 mph and 26 rpm
Trt. 8: 1.25 mph and 28 rpm
Trt. 9: 1.25 mph and 30 rpm

Fruit Yield: 3700 (kg/ha)
Trt. 1: 0.75 mph and 26 rpm
Trt. 2: 0.75 mph and 28 rpm
Trt. 3: 0.75 mph and 30 rpm
Trt. 4: 1.0 mph and 26 rpm
Trt. 5: 1.0 mph and 28 rpm
Trt. 6: 1.0 mph and 30 rpm
Trt. 7: 1.25 mph and 26 rpm
Trt. 8: 1.25 mph and 28 rpm
Trt. 9: 1.25 mph and 30 rpm

Fruit Yield: 2600 Kg/ha
Quantification of Losses – Tracdie site

Trt. 1: 0.75 mph and 26 rpm
Trt. 2: 0.75 mph and 28 rpm
Trt. 3: 0.75 mph and 30 rpm
Trt. 4: 1.0 mph and 26 rpm
Trt. 5: 1.0 mph and 28 rpm
Trt. 6: 1.0 mph and 30 rpm
Trt. 7: 1.25 mph and 26 rpm
Trt. 8: 1.25 mph and 28 rpm
Trt. 9: 1.25 mph and 30 rpm
Trt. 10: 0.6 mph and 18 rpm
Trt. 11: 0.6 mph and 20 rpm
Trt. 12: 0.6 mph and 22 rpm

Fruit Yield: 5500 Kg/ha
Overall Losses

- **Small Scott site**
- **Cooper**
- **Tracadie**

<table>
<thead>
<tr>
<th>Losses (%)</th>
<th>Fruit Yield (Mg/ha)</th>
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<tbody>
<tr>
<td>Small Scott</td>
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<tr>
<td>Cooper</td>
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<td>Tracadie</td>
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Sensor fusion system (hardware and custom software) was efficient to provide pre-harvest fruit yield to identify overall loss.

Mapping of wild blueberry fruit yield, plant height, and topographic features will be valuable to develop relationships and will serve as input for modeling.

Results showed that a treatment combination of 0.75 mph\(^{-1}\) and 26 rpm can result in significantly lower losses in wild blueberry fields with yield over 3000 kg ha\(^{-1}\).

Develop integrated harvesting system using bio-modeling and precision agriculture technologies to improve berry picking efficiency and fruit quality.
ACKNOWLEDGEMENTS

Precision Agriculture Research Team
Questions