Dalhousie University
Inspiring Minds
Faculty of Agriculture

Doug Bragg Enterprises

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










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Background

Harvesting expense, shortage of labor and short season were the basis for mechanized harvester [1]

Research on the development of the mechanical harvester started in early 1950s, a viable mechanical harvester was not produced until the 1980s [2]

Gray 1969 developed hollow reel raking mechanism to pick wild blueberries (Chisholm-Ryder Co.) [1]

[1]Yarbrough, D. E, 1992. HortScience. 27:60.
[2] Dale et al., 1994. Hort. Review. 16:255-382.
[3] Rhodes, R. B. 1961. Paper # NA61-206 (ASAE).

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Background

- DBE harvester commercialized harvester in early 1980.
- Quantify losse... ...isting commercial blueberry harv...
- Factors respo... ...nprove berry picking effici...
- Develop integ... ...ease 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

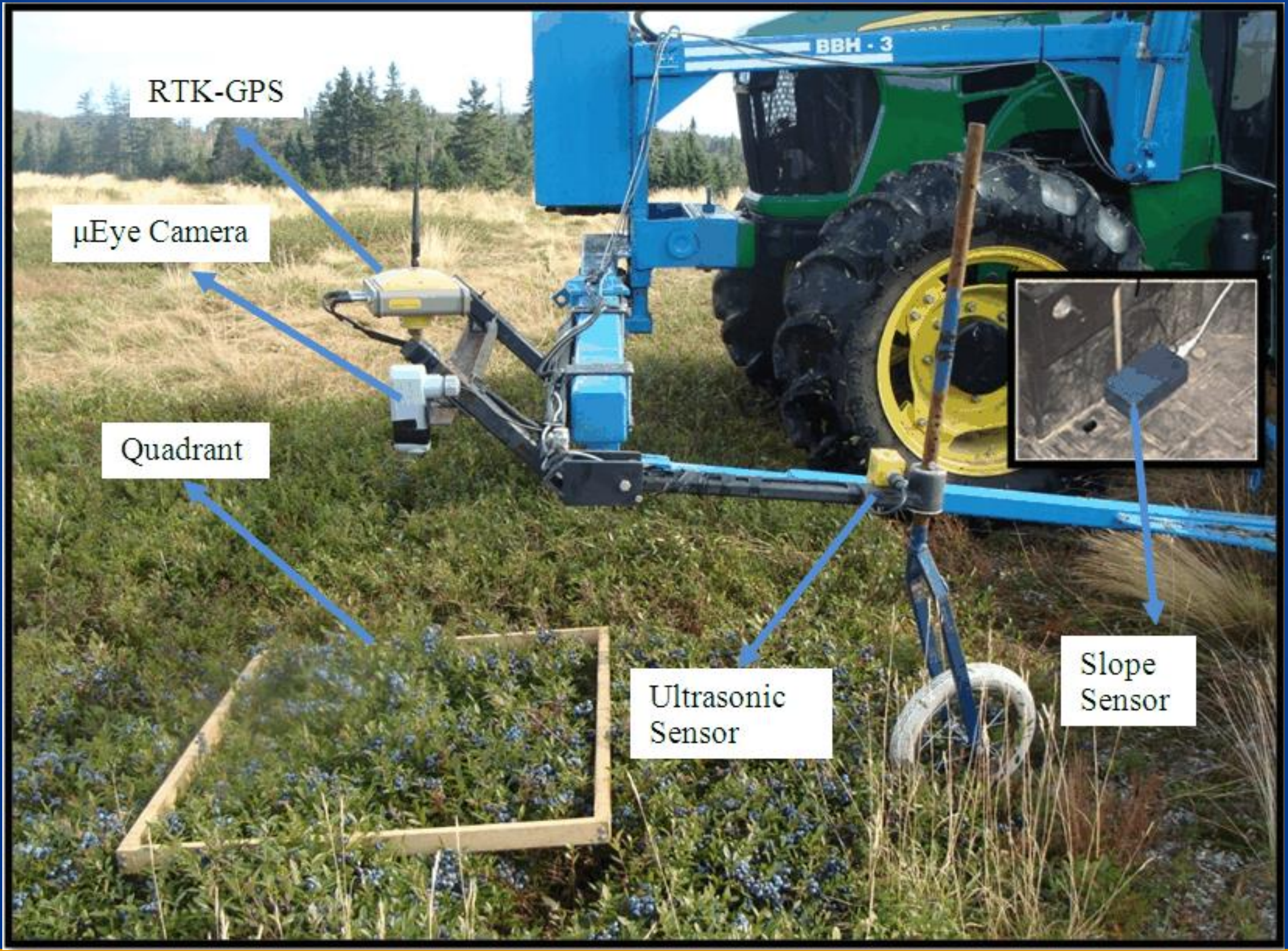
NB:

- Tracadie

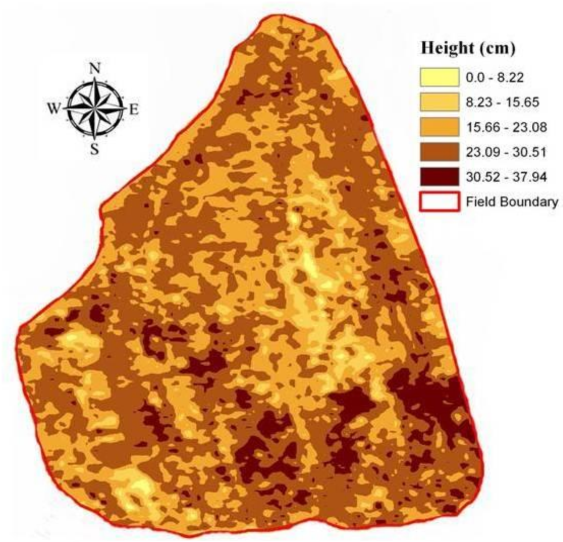
Maine:

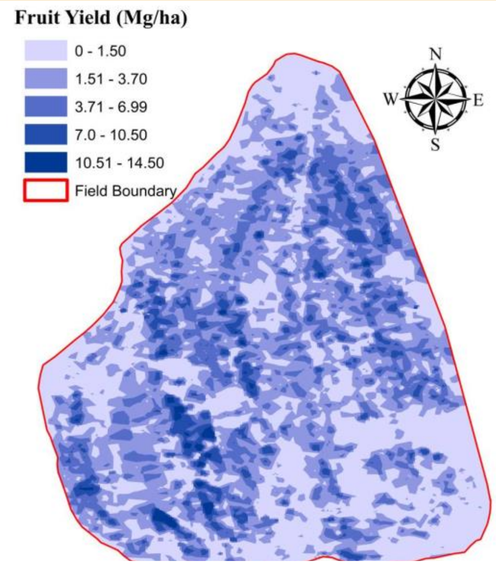
- Cherryfield
- Wymans

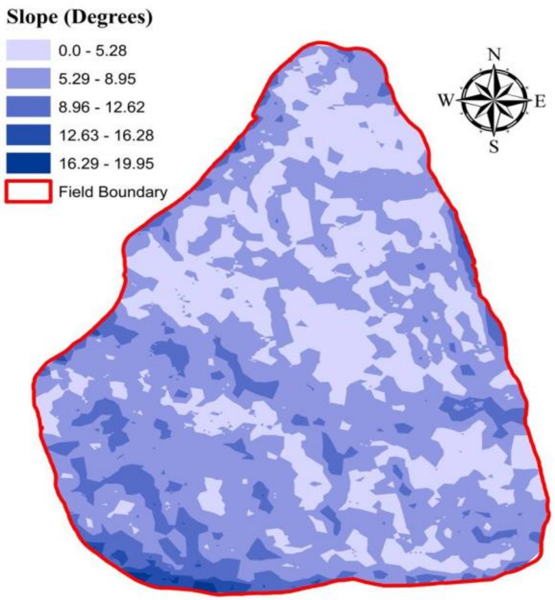
Sensor Fusion System

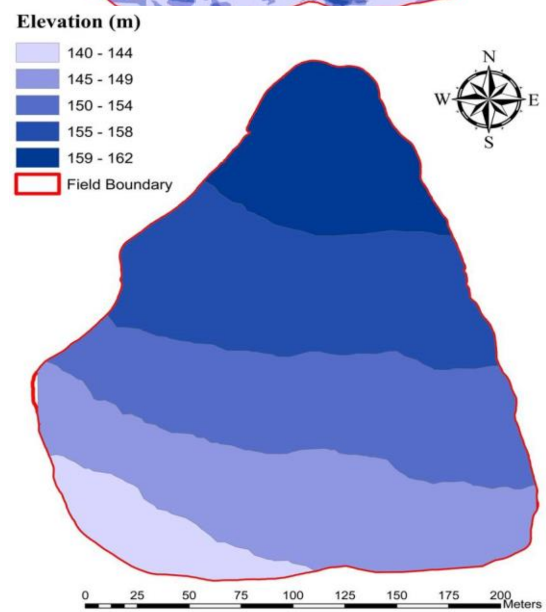


Real-time Performance of SFS









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



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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

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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

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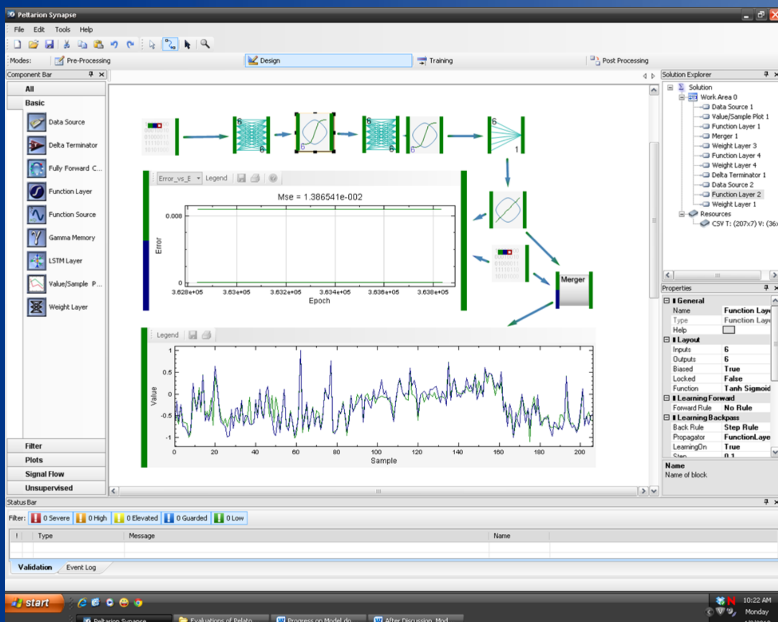
Bio-System Modeling

Coupling of mechanical, biological and environmental processes



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Operator Skill and Field Conditions:

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

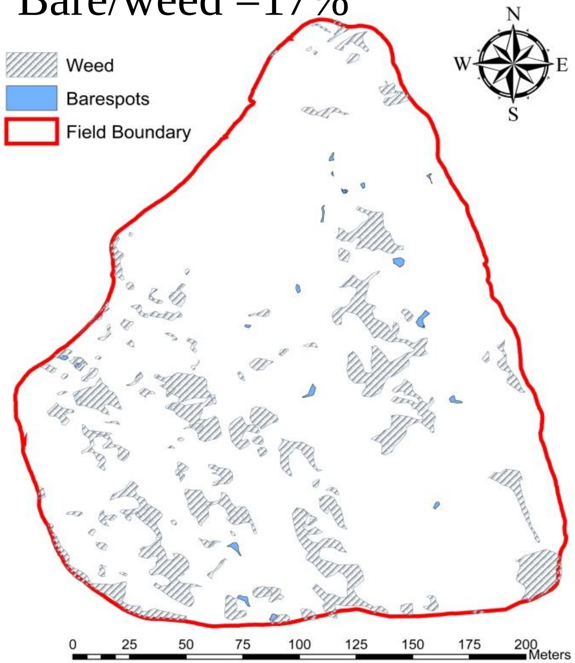
- Rocks, stumps, sticks and debris
- slope of the field
- Tall weeds, grasses
- Height of blueberry plants
- Bare patches of the field
- Plants density of blueberry plants
- From bare patch to blueberry plant zone and vice versa

- **On-Line Computer Program for Precise Berry Harvesting**

Recommendations

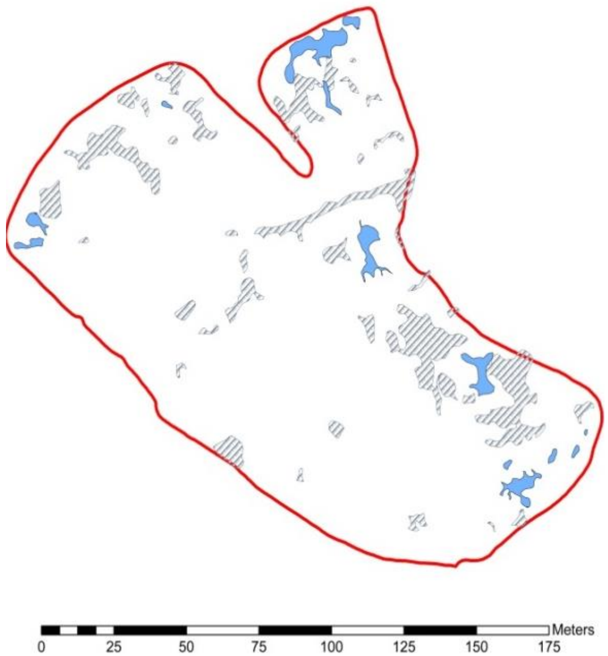
Site Selection

Area = 3.2 ha
Bare/weed =17%



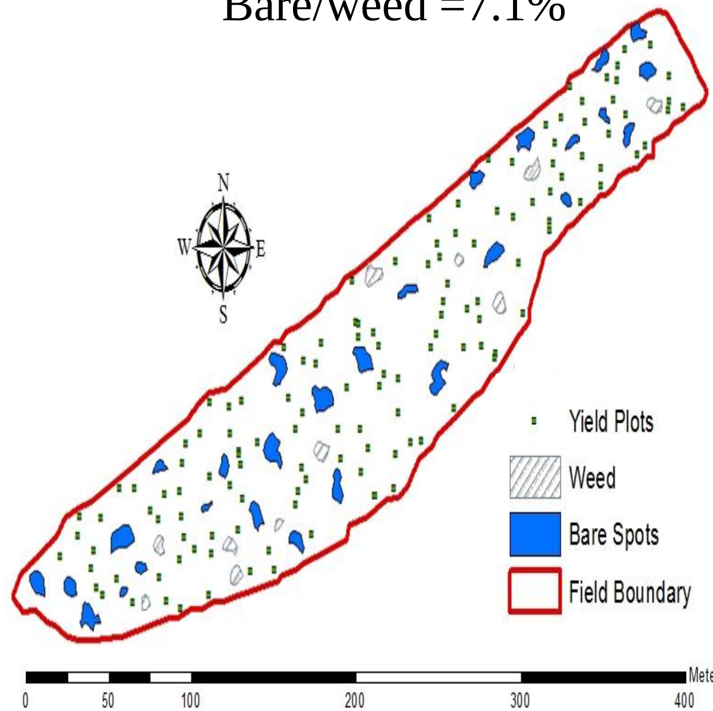
Cooper Site

Area = 1.9 ha
Bare/weed =15.3%



Small Scott Site

1.6 ha
Bare/weed =7.1%



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Quantification of Losses

Experiment Design Parameters

Speed (mile/hr)	Revolutions (rpm)	Sample Collection		
0.75, 1.0, 1.25	26			
	26			
	26			
0.75, 1.0, 1.25	28			
	28			
	28			
0.75, 1.0, 1.25	30			
	30			
	30			

Variables/Treatments

Ground Speed: 0.75, 1.0 and 1.25 mph

Header Rotations: 26, 28 and 30 rpm

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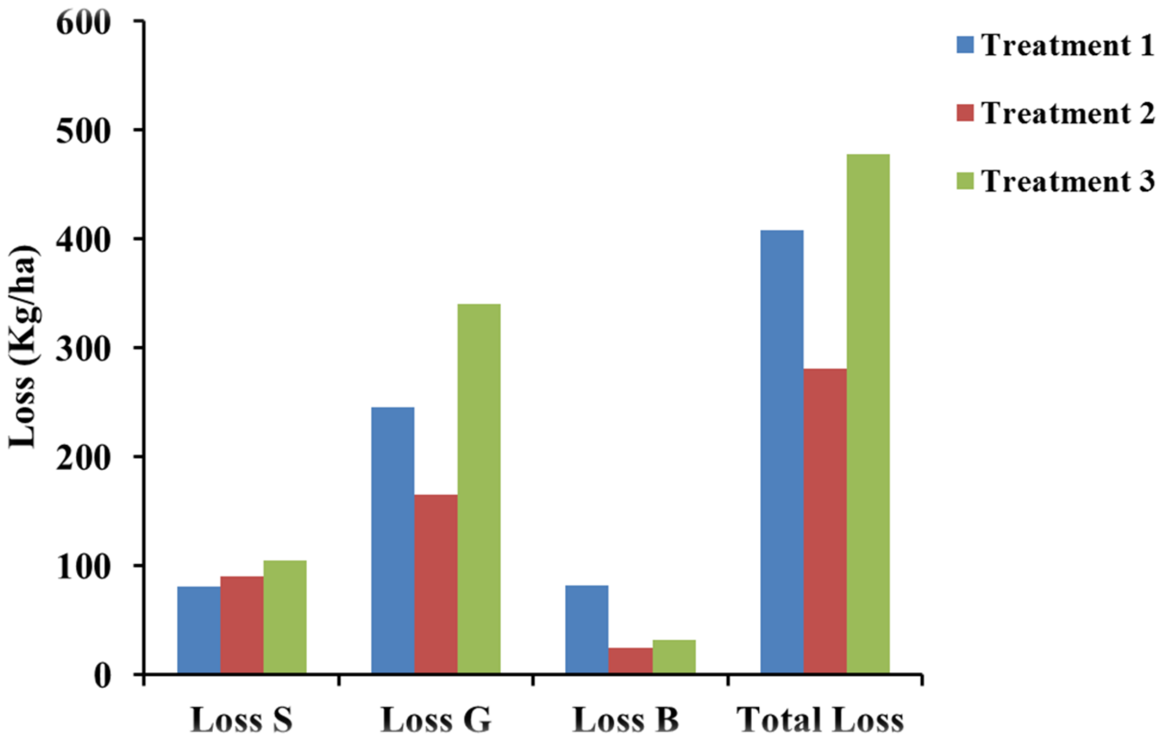
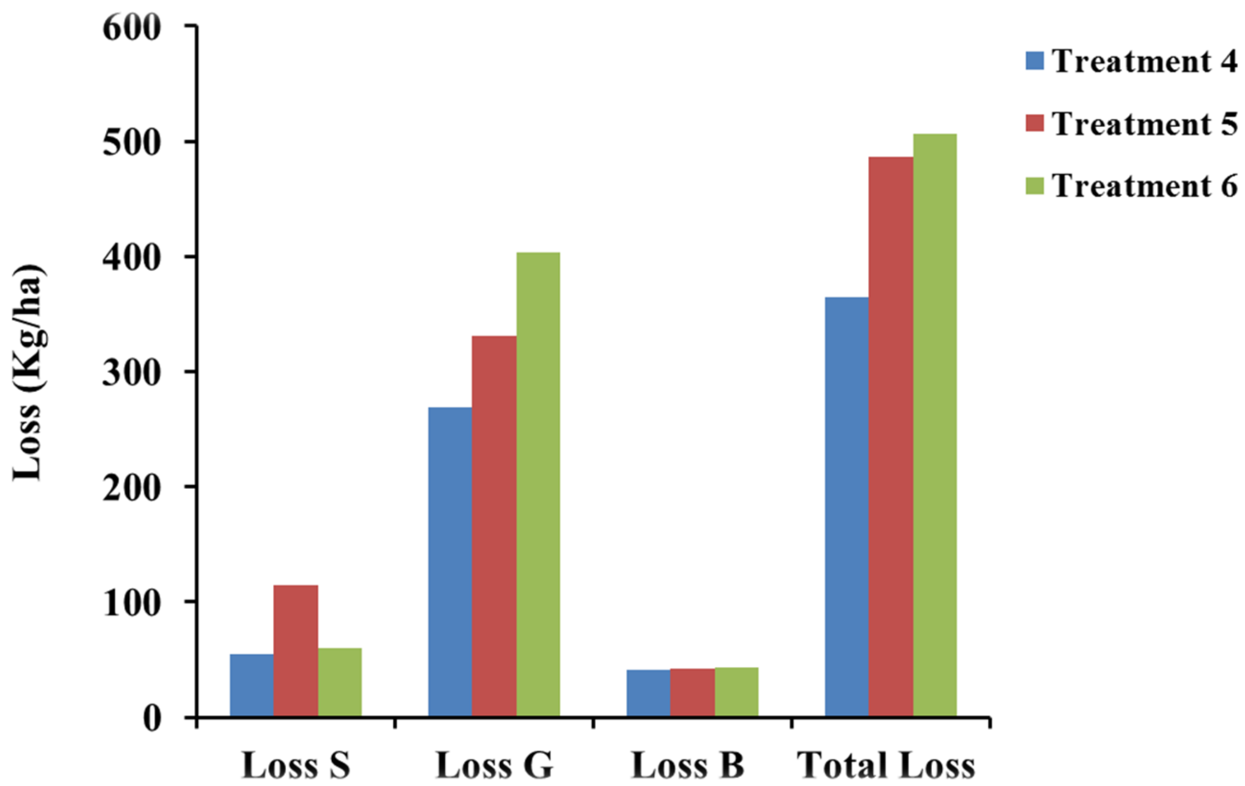
Quantification of Losses – Cooper site



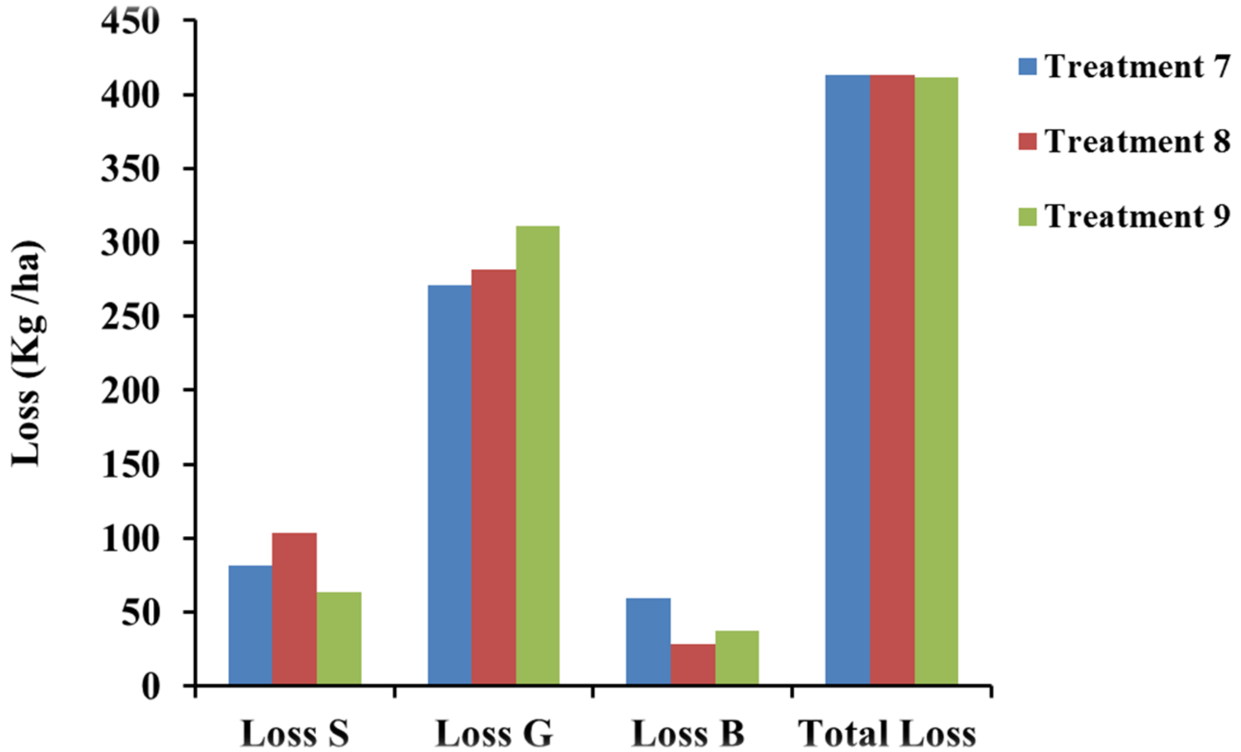
Treatment 1 @ Speed 0.75 mph and 26 rpm
Treatment 2 @ Speed 0.75 mph and 28 rpm
Treatment 3 @ Speed 0.75 mph and 30 rpm

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

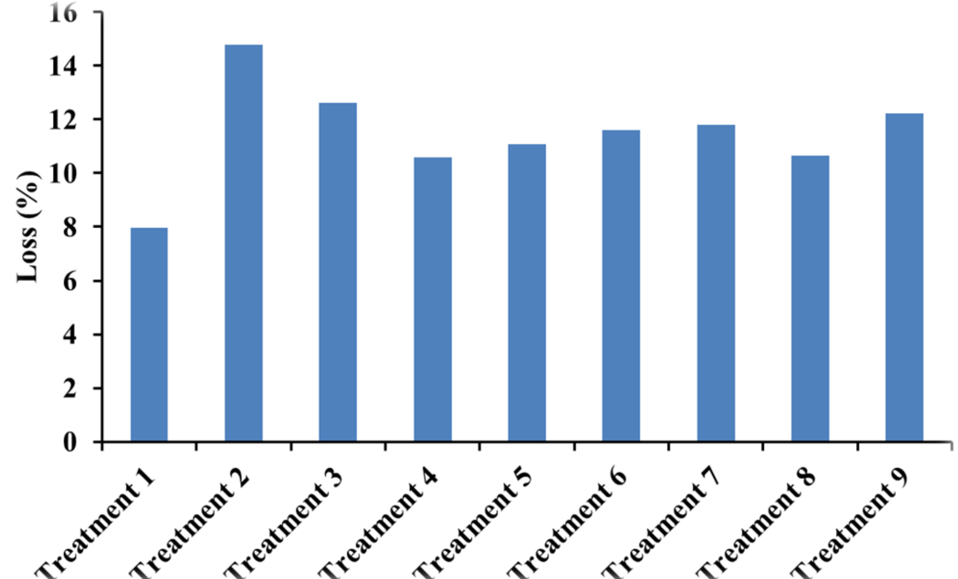
Quantification of Losses – Cooper site

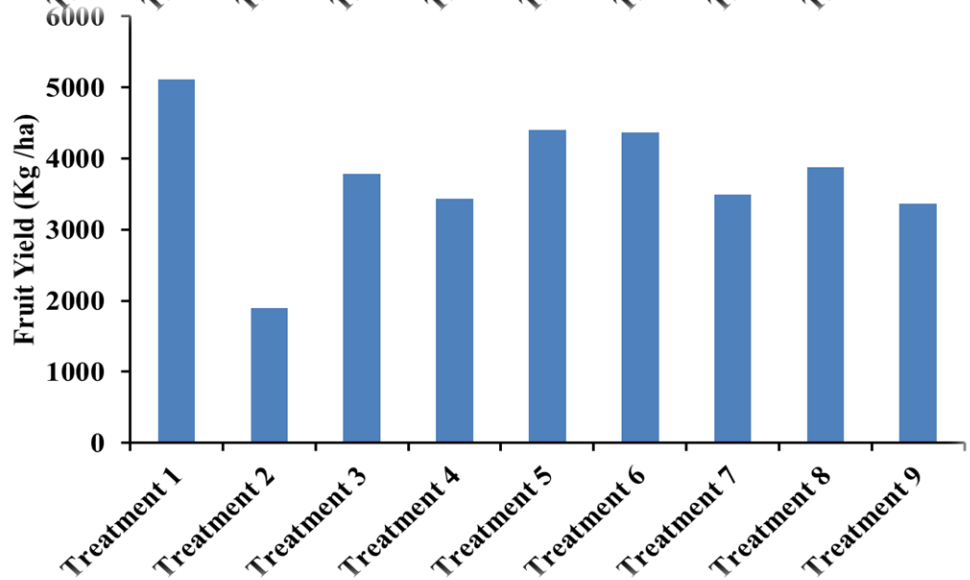


Treatment 7 @ Speed 1.25 mph and 26 rpm
Treatment 8 @ Speed 1.25 mph and 28 rpm
Treatment 9 @ Speed 1.25 mph and 30 rpm

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)

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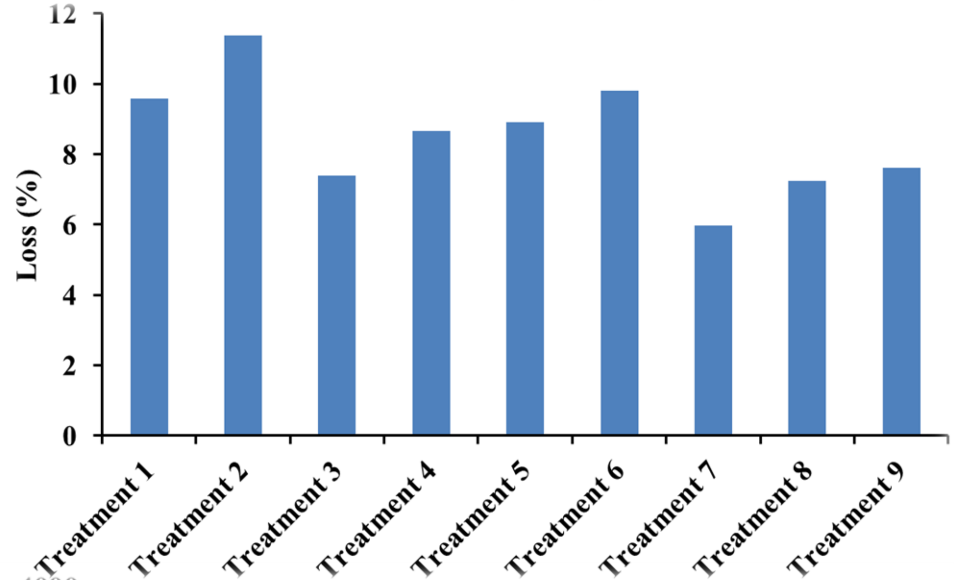
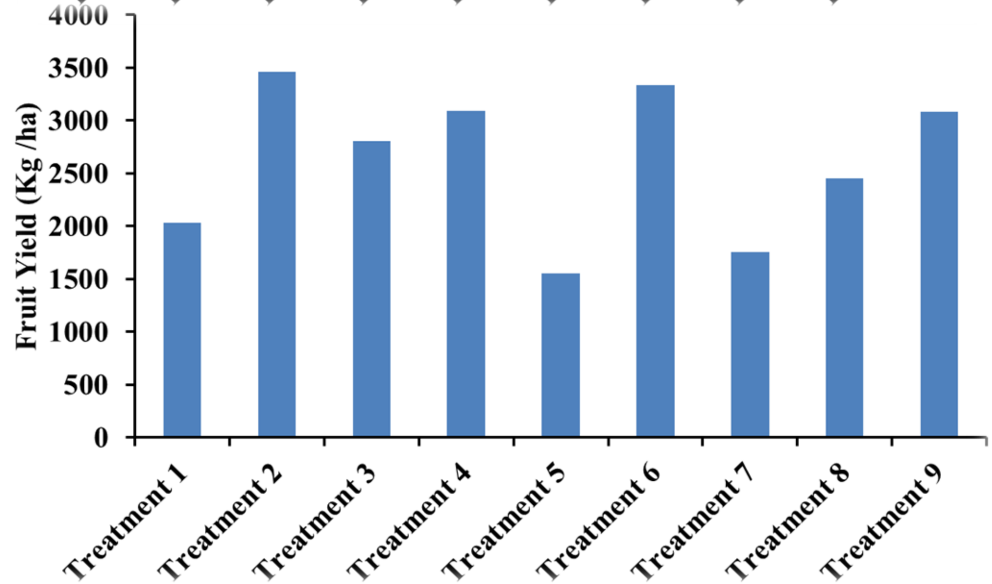
Quantification of Losses – Small Scott

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

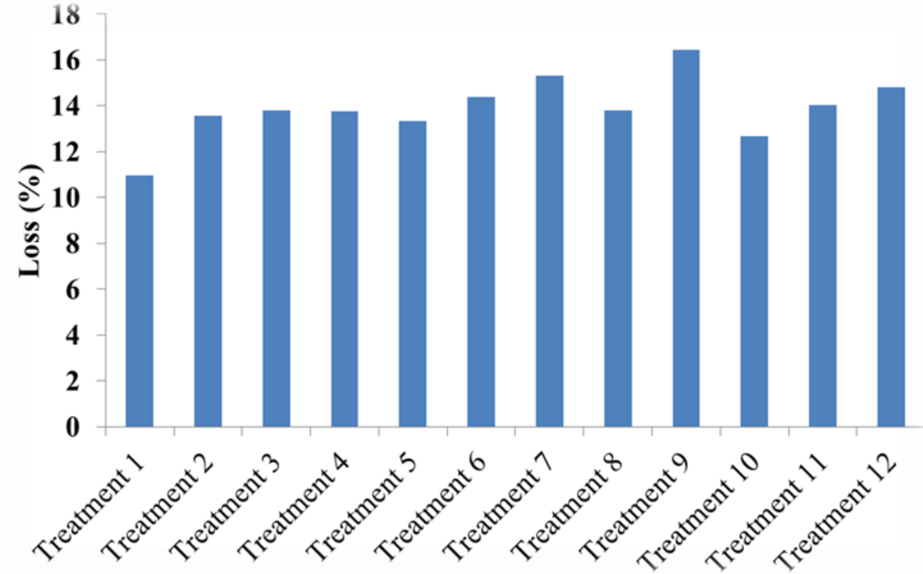
Fruit Yield: 2600 Kg/ha



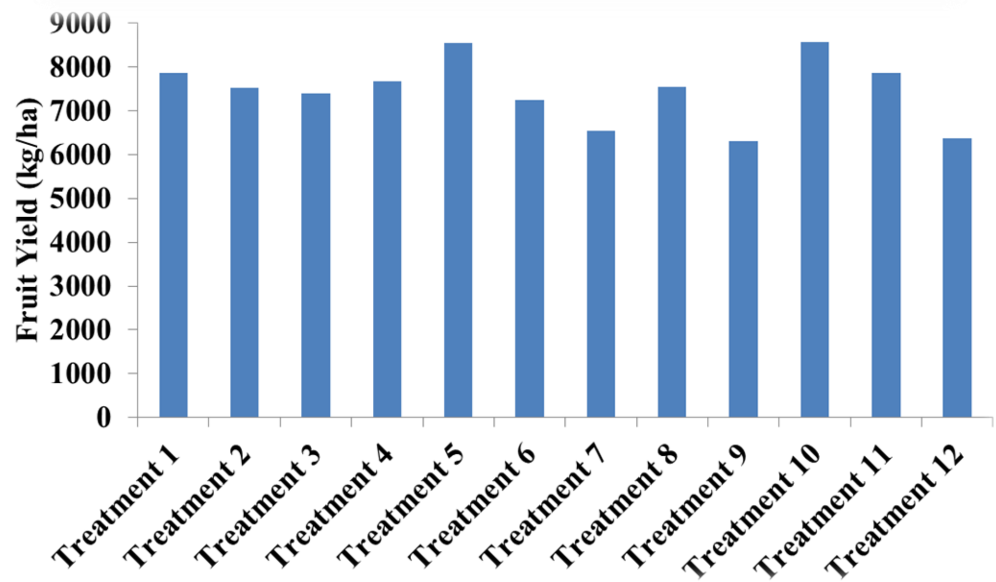


Quantification of Losses – Tracdie site

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



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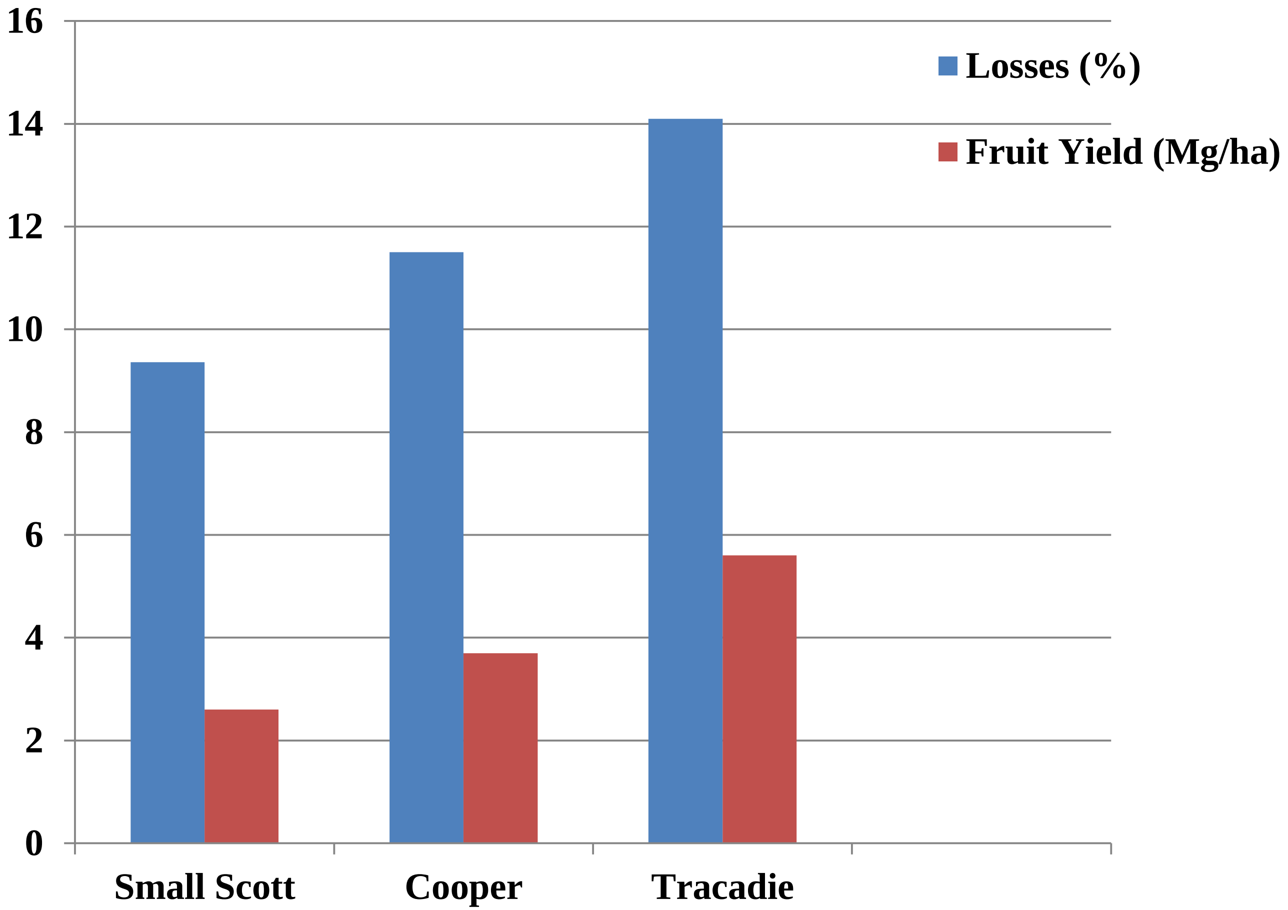
Overall Losses



Outcome and Future Research

- 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

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Questions