

# Precision Agriculture Research Program

## Low-Cost Yield Monitoring System for Wild Blueberry Fruit Yield Mapping

**Nova Scotia Agricultural College**

**\*University of Florida**



Wild Blueberry Research  
Program



Nova Scotia  
Agricultural College

**2008 International Symposium:  
Application of Precision Agriculture for Fruit and Vegetables  
6-9 January, Orlando, FL**

# Wild Blueberry fields need to be managed site-specifically using VRT, Sensors, DGPS, Digital photography, Aerial images, GIS.....

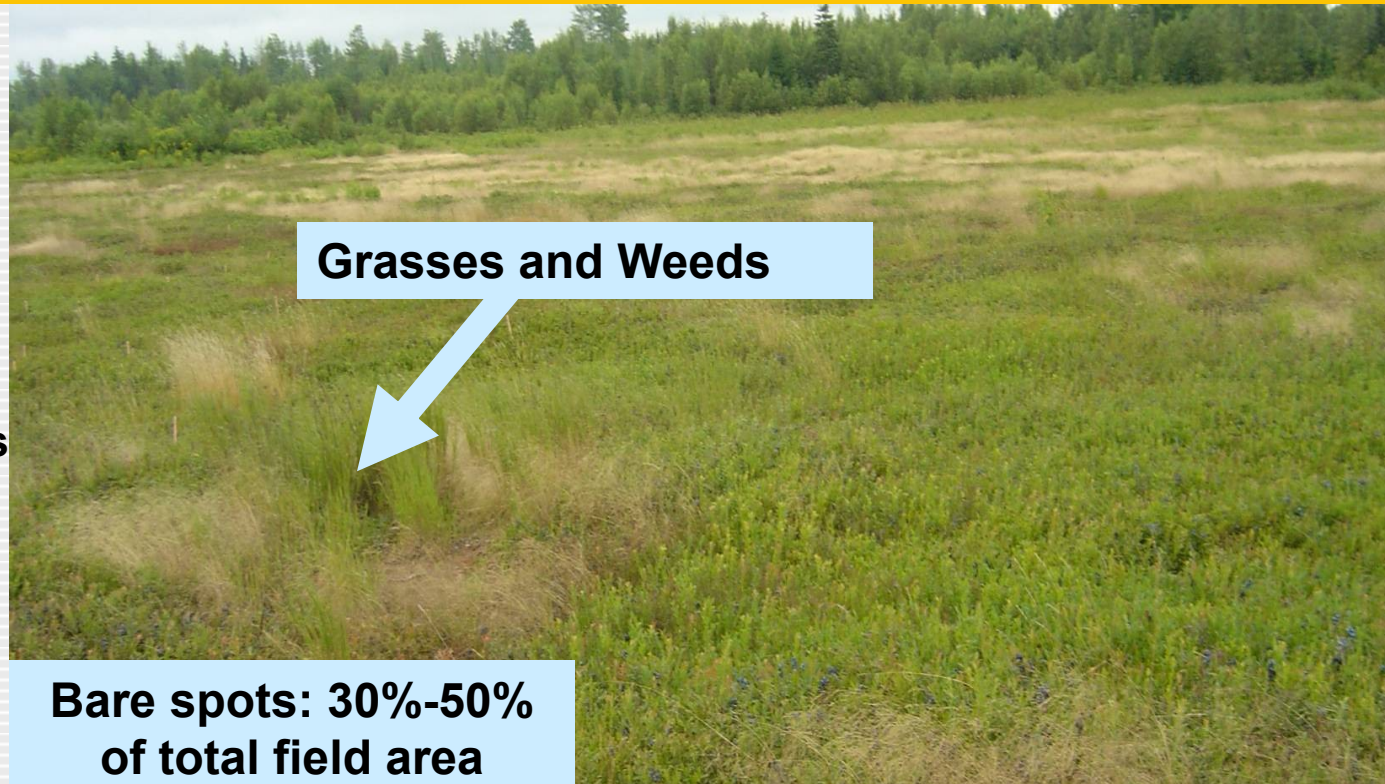
**WBB- Unique crop**  
**Native- North America**  
**Never cultivated**  
**Deforested Farmland**

**Production cycle = 2 Years**

**Total area = 79,000 ha**

**Fruit yield = 82 million kg**

**Value = \$352 million**



**Grasses and Weeds**

**Bare spots: 30%-50%  
of total field area**

**Site-specific - Agrochemicals**  
**can:**

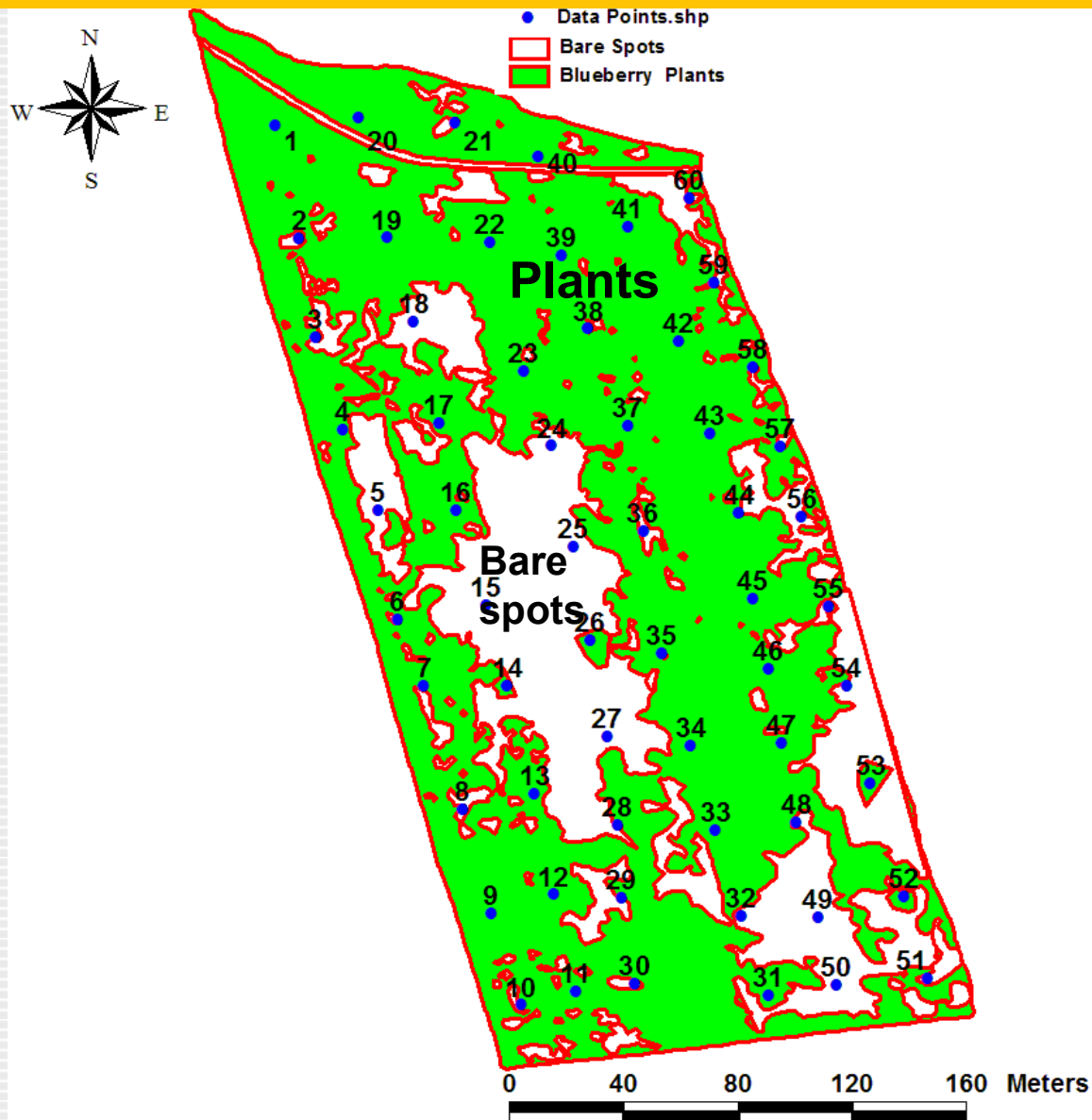
- ✓ **Increase input use efficiency and yield**
- ✓ **increase horticultural profitability**
- ✓ **decrease environmental pollution**

# Objectives

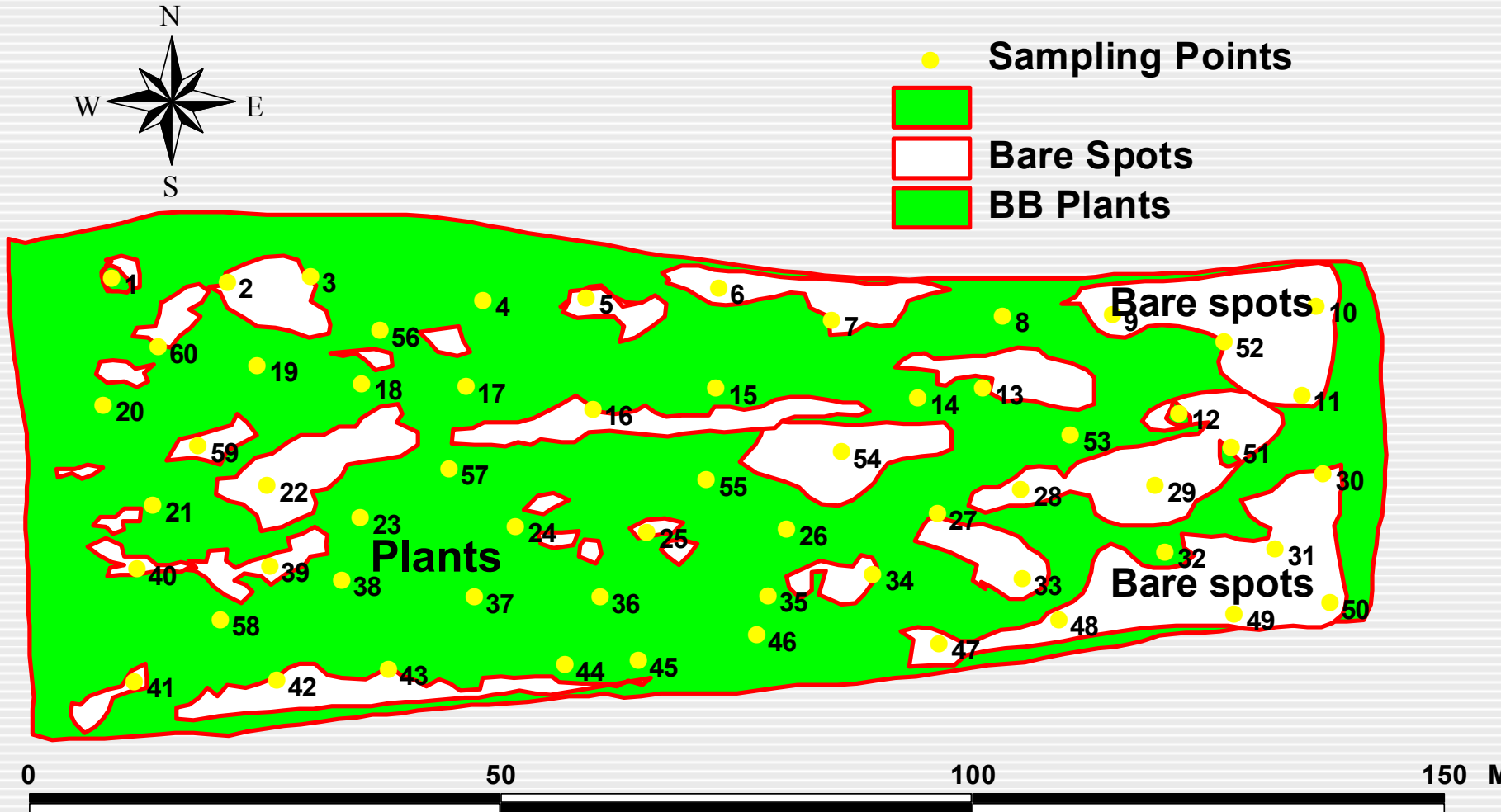
- **Knowing where the wild blueberry plants are in a field would make production more environmentally safe and efficient: agrochemical additions only where needed**
- **- feasibility testing of mapping wild blueberry yield with digital color photography**



# Adams Field-1



# Debert Field-2



# Yield Mapping with Image Processing



# Hand Harvesting-Raking



Blueberry image processing

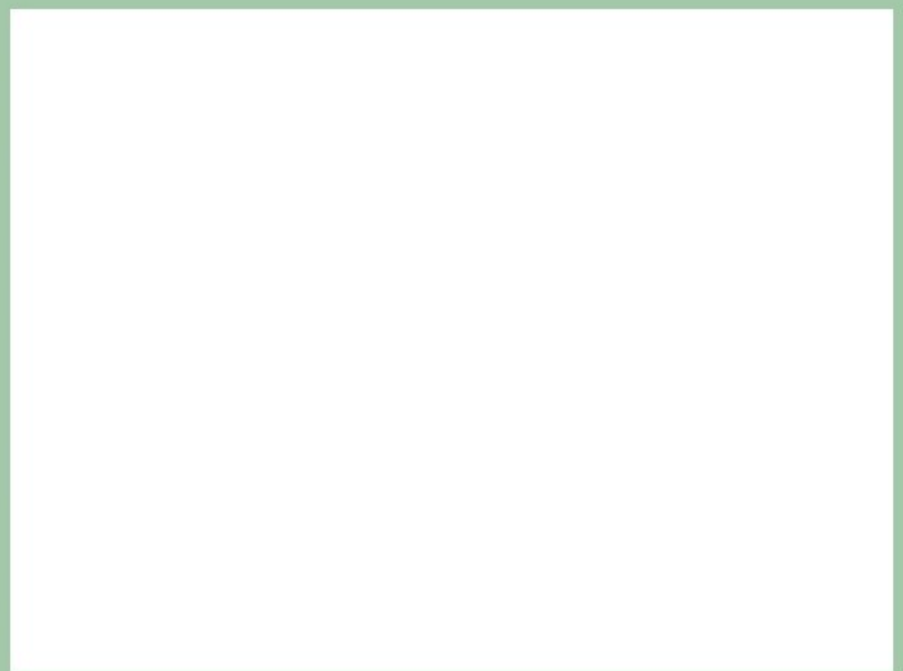
ID	Recnumber	Comment	GPSstatus	Date	TimeGMT	RowFt	Image name	Northing	Easting	GPSTrack	Speed	TcameraC	Distance_cm	Orange%	Masked
28084	0	blueberry14Aug07				0	3.JPG	0.00	0.00	0.00	0.00	0	0.0	0.029	1
28085	0	blueberry14Aug07				0	4.JPG	0.00	0.00	0.00	0.00	0	0.0	2.873	1
28086	0	blueberry14Aug07				0	5.JPG	0.00	0.00	0.00	0.00	0	0.0	0.016	1
28087	0	blueberry14Aug07				0	6.JPG	0.00	0.00	0.00	0.00	0	0.0	0.101	1
28088	0	blueberry14Aug07				0	7.JPG	0.00	0.00	0.00	0.00	0	0.0	4.928	1
28089	0	blueberry14Aug07				0	8.JPG	0.00	0.00	0.00	0.00	0	0.0	3.827	1
28090	0	blueberry14Aug07				0	9.JPG	0.00	0.00	0.00	0.00	0	0.0	6.326	1
28091	0	blueberry14Aug07				0	10.JPG	0.00	0.00	0.00	0.00	0	0.0	0.170	1
28092	0	blueberry14Aug07				0	11.JPG	0.00	0.00	0.00	0.00	0	0.0	3.919	1
28093	0	blueberry14Aug07				0	12.JPG	0.00	0.00	0.00	0.00	0	0.0	6.132	1
28094	0	blueberry14Aug07				0	13.JPG	0.00	0.00	0.00	0.00	0	0.0	5.852	1
28095	0	blueberry14Aug07				0	14.JPG	0.00	0.00	0.00	0.00	0	0.0	5.720	1
28096	0	blueberry14Aug07				0	15.JPG	0.00	0.00	0.00	0.00	0	0.0	0.066	1

Copy to Clipboard

Blue  Green  Tolerance:   Process image

Navigation icons: back, forward, home, search, refresh, etc.

Total records: 60



Find image

Process all

End ID#:

Blue pixels: 317565 =5.7% Erode/Dilate iterations:  Erode/Dilate

Green pixels: 5932 =0.1%

Blue as percentage of blue+green: 98.3%



# Blueberry image processing

ID	Recnumber	Comment	GPSstatus	Date	TimeGMT	RowFt	Image name	Northing	Easting	GPSTrack	Speed	TcameraC	Distance_cm	Orange%	Masked
28084	0	blueberry14Aug07				0	3.JPG	0.00	0.00	0.00	0.00	0	0.0	0.029	1
28085	0	blueberry14Aug07				0	4.JPG	0.00	0.00	0.00	0.00	0	0.0	2.873	1
28086	0	blueberry14Aug07				0	5.JPG	0.00	0.00	0.00	0.00	0	0.0	0.016	1
28087	0	blueberry14Aug07				0	6.JPG	0.00	0.00	0.00	0.00	0	0.0	0.101	1
28088	0	blueberry14Aug07				0	7.JPG	0.00	0.00	0.00	0.00	0	0.0	4.928	1
28089	0	blueberry14Aug07				0	8.JPG	0.00	0.00	0.00	0.00	0	0.0	3.827	1
28090	0	blueberry14Aug07				0	9.JPG	0.00	0.00	0.00	0.00	0	0.0	6.326	1
28091	0	blueberry14Aug07				0	10.JPG	0.00	0.00	0.00	0.00	0	0.0	0.170	1
28092	0	blueberry14Aug07				0	11.JPG	0.00	0.00	0.00	0.00	0	0.0	3.919	1
28093	0	blueberry14Aug07				0	12.JPG	0.00	0.00	0.00	0.00	0	0.0	6.132	1
28094	0	blueberry14Aug07					15.JPG	0.00	0.00	0.00	0.00	0	0.0	852	1
28095	0	blueberry14Aug07						0.00	0.00	0.00	0.00	0	0.0	298	1
28096	0	blueberry14Aug07						0.00	0.00	0.00	0.00	0	0.0	066	1

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Blueberry fruit pixels

Noise pixels

Blue 75

Green 250

Tolerance: 5

Process image

Navigation icons: back, forward, zoom in, zoom out, refresh, etc.

blueberry14Aug07

Total records: 60

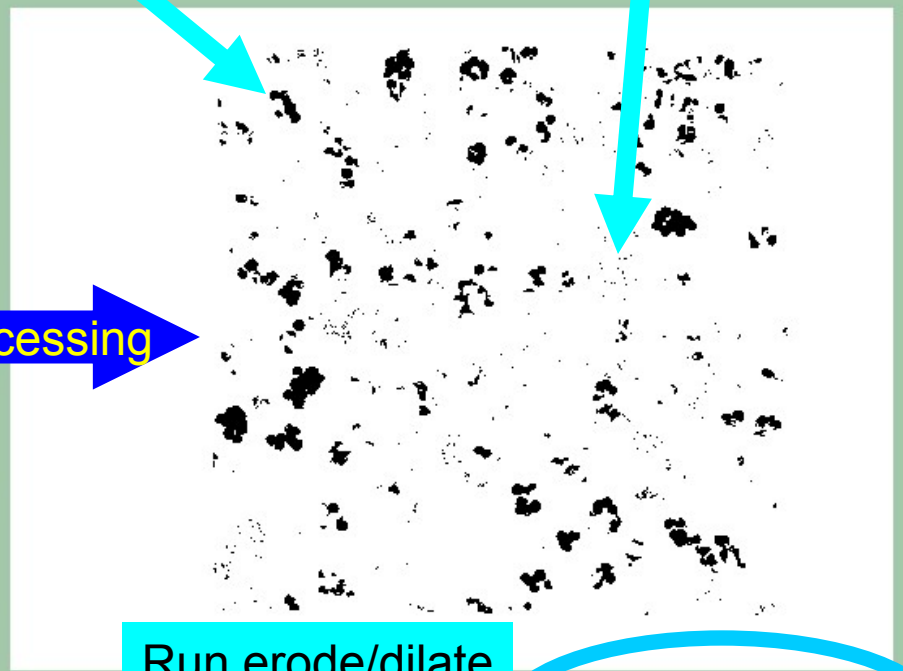


Image processing

Run erode/dilate

Erode/Dilate iterations: 3  Erode/Dilate

Blue pixels: 349663 =6.3%

Green pixels: 5932 =0.1%

Blue as percentage of blue+green: 98.3%

Find image

Process all

End ID#: 290

Blueberry image processing

ID	Recnumber	Comment	GPSstatus	Date	TimeGMT	RowFt	Image name	Northing	Easting	GPSTrack	Speed	TcameraC	Distance_cm	Orange%	Masked
28084	0	blueberry14Aug07				0	3.JPG	0.00	0.00	0.00	0.00	0	0.0	0.029	1
28085	0	blueberry14Aug07				0	4.JPG	0.00	0.00	0.00	0.00	0	0.0	2.873	1
28086	0	blueberry14Aug07				0	5.JPG	0.00	0.00	0.00	0.00	0	0.0	0.016	1
28087	0	blueberry14Aug07				0	6.JPG	0.00	0.00	0.00	0.00	0	0.0	0.101	1
28088	0	blueberry14Aug07				0	7.JPG	0.00	0.00	0.00	0.00	0	0.0	4.928	1
28089	0	blueberry14Aug07				0	8.JPG	0.00	0.00	0.00	0.00	0	0.0	3.827	1
28090	0	blueberry14Aug07				0	9.JPG	0.00	0.00	0.00	0.00	0	0.0	6.326	1
28091	0	blueberry14Aug07				0	10.JPG	0.00	0.00	0.00	0.00	0	0.0	0.170	1
28092	0	blueberry14Aug07				0	11.JPG	0.00	0.00	0.00	0.00	0	0.0	3.919	1
28093	0	blueberry14Aug07				0	12.JPG	0.00	0.00	0.00	0.00	0	0.0	6.132	1
28094	0	blueberry14Aug07				0	13.JPG	0.00	0.00	0.00	0.00	0	0.0	852	1
28095	0	blueberry14Aug07				0	14.JPG	0.00	0.00	0.00	0.00	0	0.0	720	1
28096	0	blueberry14Aug07				0	15.JPG	0.00	0.00	0.00	0.00	0	0.0	066	1

Copy to Clipboard

Noise pixels removed

Blue 75 Green 250 Tolerance: 5  Process image

Navigation icons: back, forward, zoom in, zoom out, refresh, and a dropdown menu showing 'blueberry14Aug07'.



% fruit pixels only

Blue pixels: 317565 = 5.7%

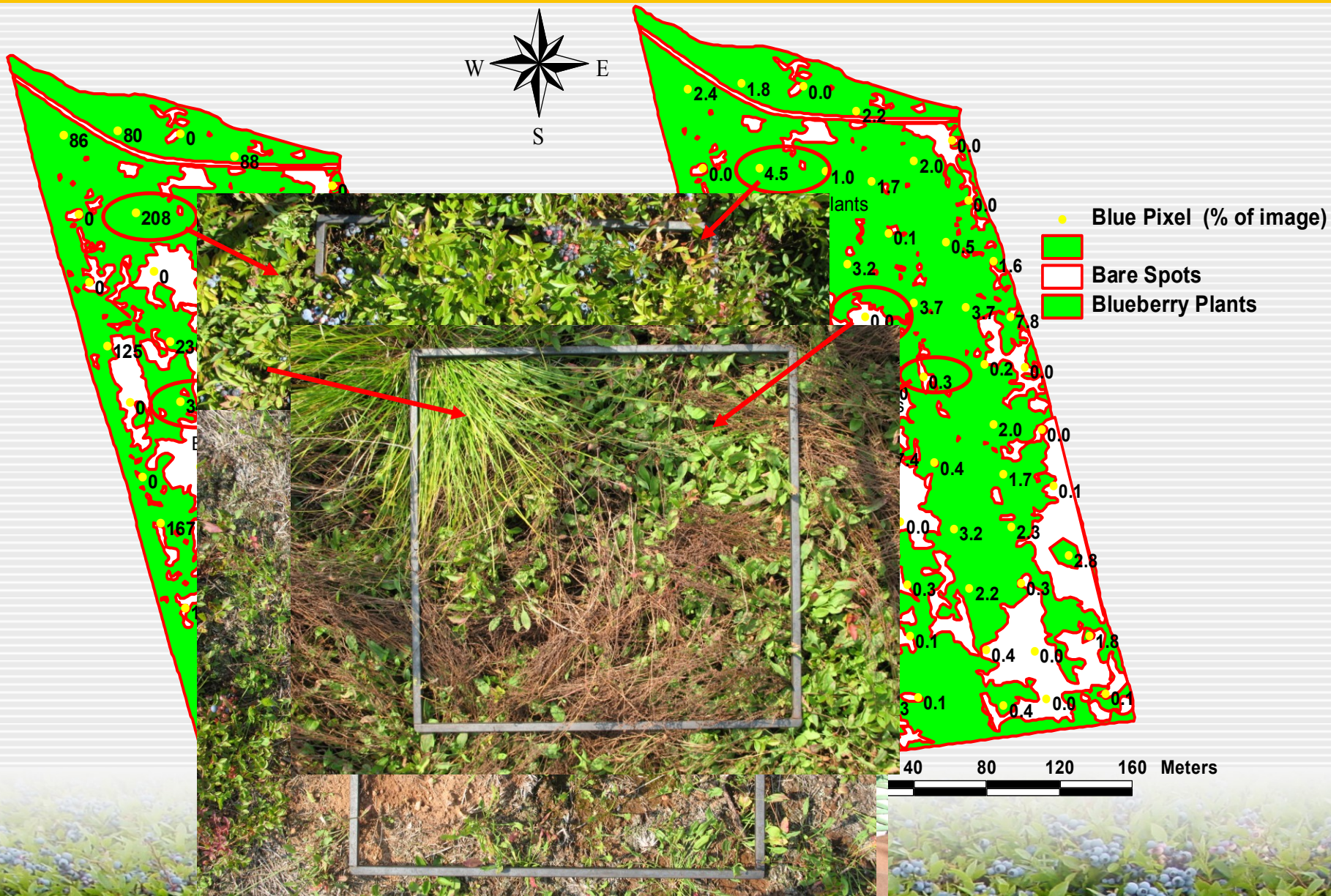
Green pixels: 5932 = 0.1%

Blue as percentage of blue+green: 98.3%

Erode/Dilate iterations: 3  Erode/Dilate

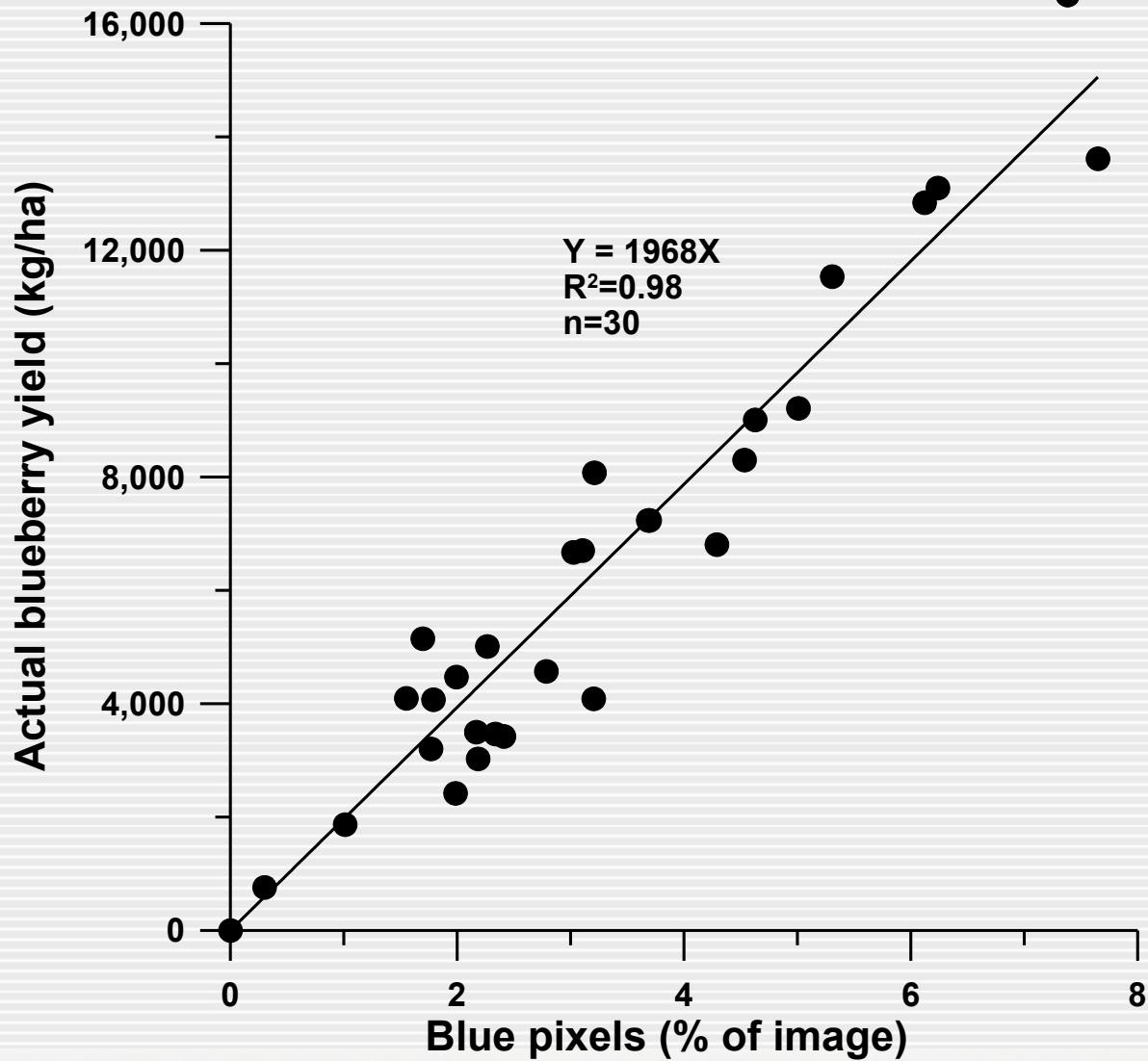
End ID#: 290

# Adams Field: Blue Pixels (% of image) vs Fruit Yield (g/0.25<sup>2</sup>)

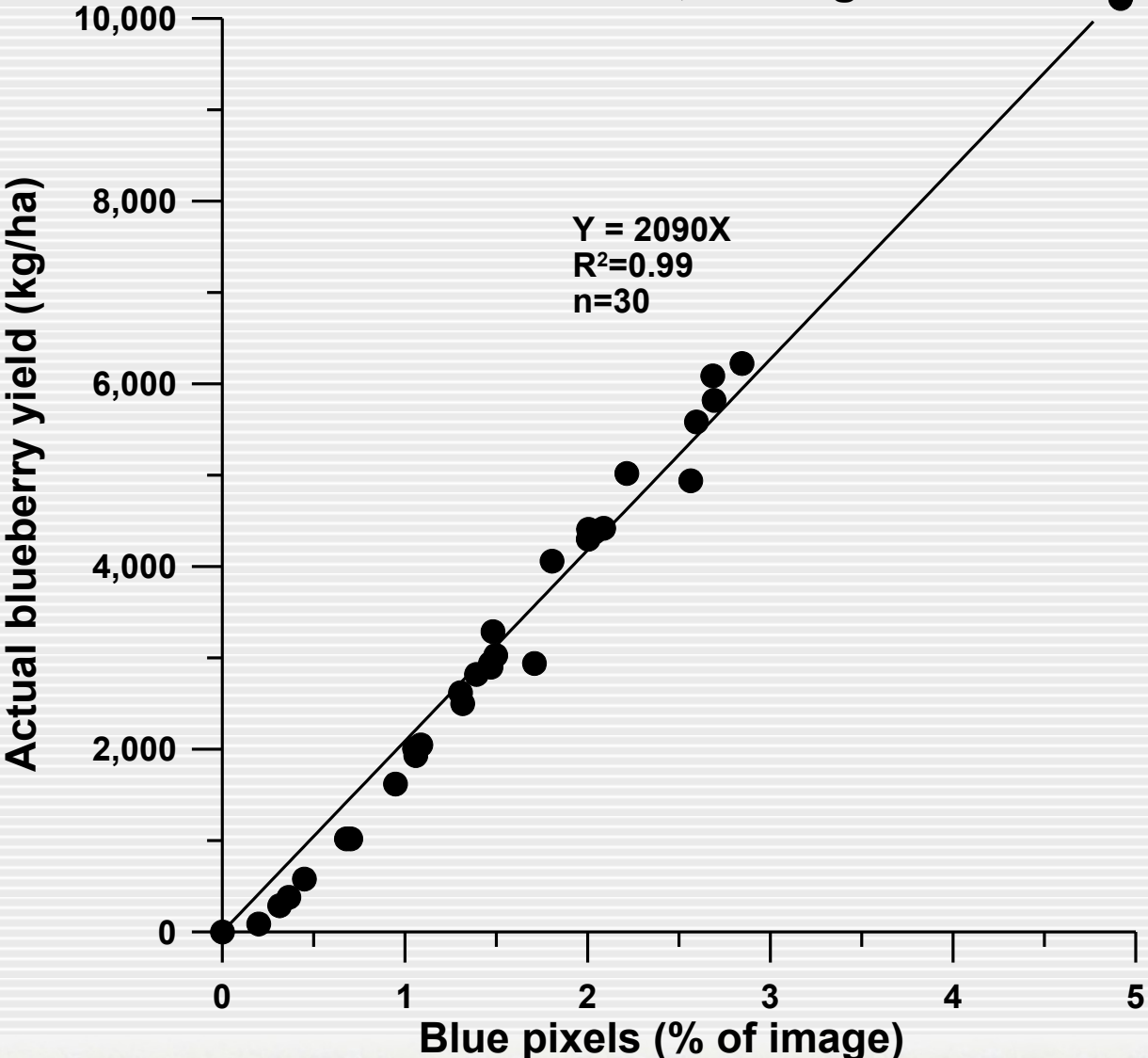




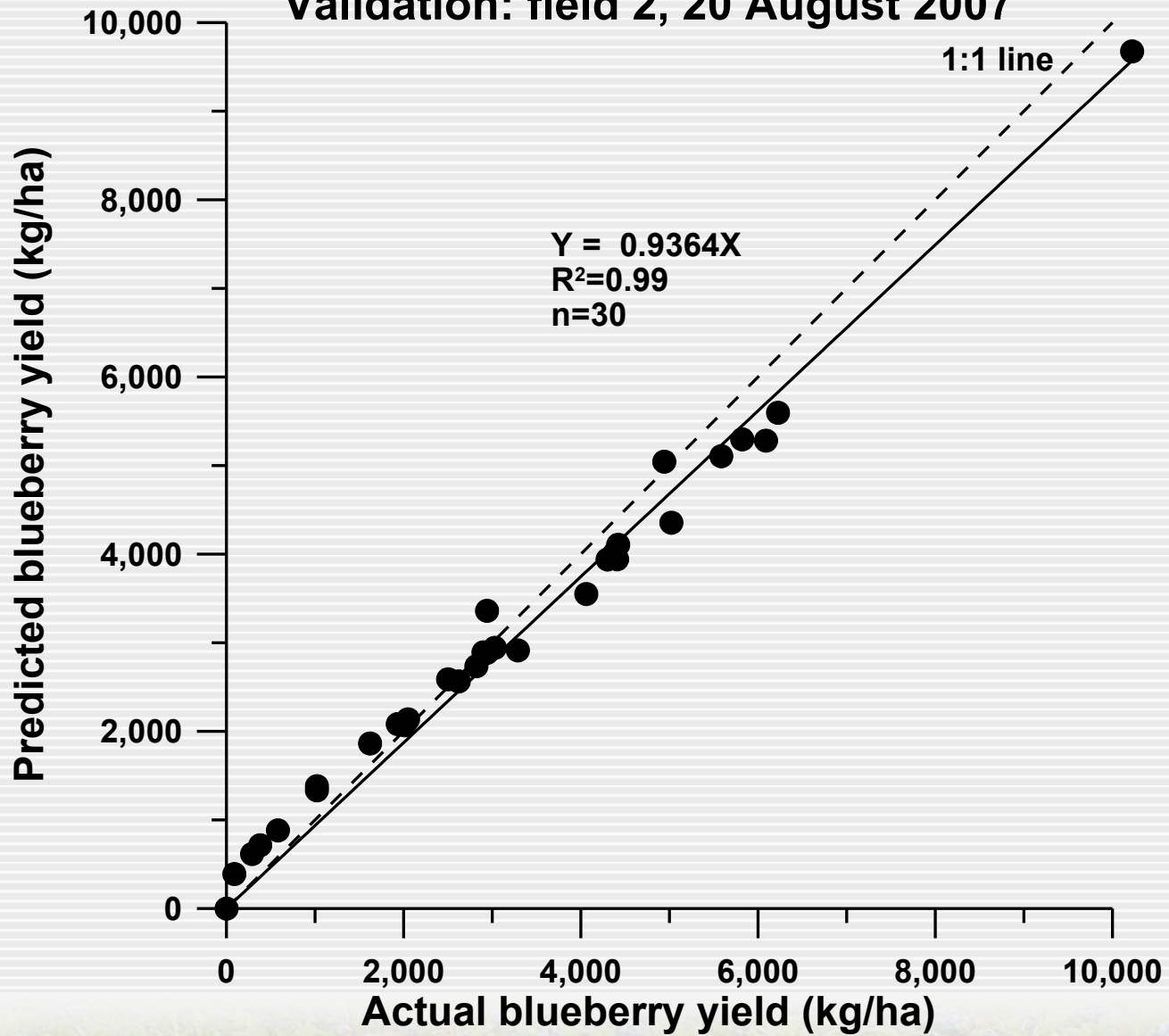
# Calibration: field 1, 16 August 2007



**Calibration: field 2, 20 August 2007**



# Validation: field 2, 20 August 2007



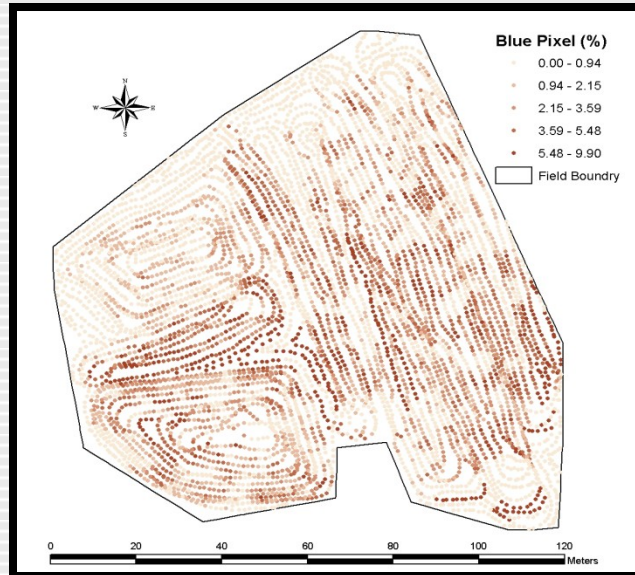
# Automated Real-Time Yield Monitoring System



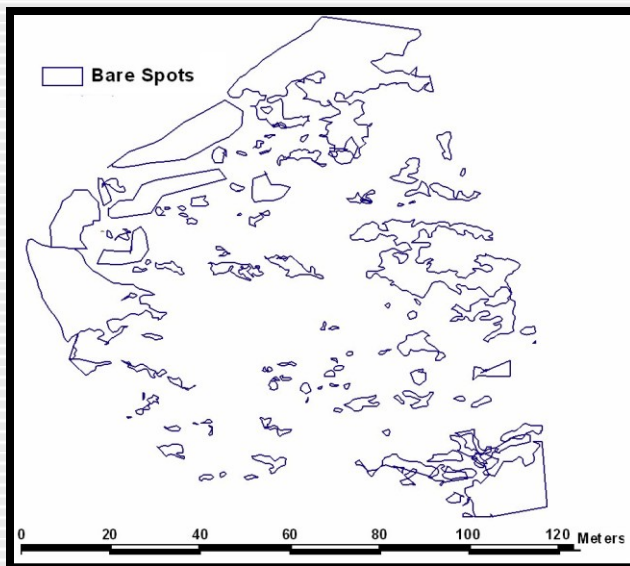


# Fruit Yield and Bare Spot Map

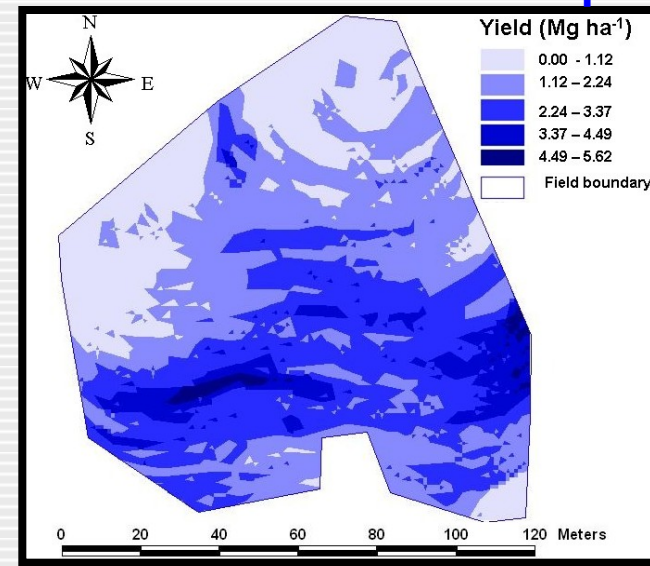
## Raw Data



## Bare Spot Map



## Smooth Fruit Yield Map



# Yield Monitoring System $\mu$ Eye for Double Head Harvester

## Custom Software

The screenshot displays the 'WBB yield monitoring program' interface. It features two camera views (CAM 1 and CAM 2) showing real-time images of a field and their corresponding processed images where blue pixels are highlighted. The interface includes various control panels and data fields:

- File:** Field\_Image\_ (Scan\_Save), Folder to save (Browse), Camera selection (Camera 1, Camera 2).
- Parameter BDX:** Processing Time(ms), Exposure Time(ms) (2), GAIN value (0), Velocity(km/hour) (4.61), PORT (COM1), BAUD RATE (09600), Connected button.
- Selection:** Save Image, Enable simulation.
- Error Report:** Enable Report.
- Info:** Number of  $\mu$ Eyes (2), Driver version (3.50.0010), Operating System (Windows XP).
- Location Data:** Latitude (4521.9162897), Longitude (06312.7406146), Total Blue pixel Ratio(%) (2.816551).
- Application:** Application, Exit buttons.

**CAM 1 Data:**  
UI12265E-C  
ID: 1  
SN4002670878  
No. of Blue: 9368

**CAM 2 Data:**  
UI12265E-C  
ID: 2  
SN4002668211  
No. of Blue: 10100



# Conclusions

- Automated yield monitoring system comprising of Digital Colour Camera, DGPS and Laptop computer will be developed
- System will be incorporated into harvester to monitor and map real-time blueberry fruit yield
- System will also be capable to detect/map bare spots/weed patches



- Information will be used for variable rate application of agrochemicals to improve fruit yield and quality, increase profitability, reduce environmental risks

# ACKNOWLEDGEMENTS



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Agricultural College**



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# THANKS

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