Evaluation of Cost-Effective Real-Time Slope Sensing System for Wild Blueberry

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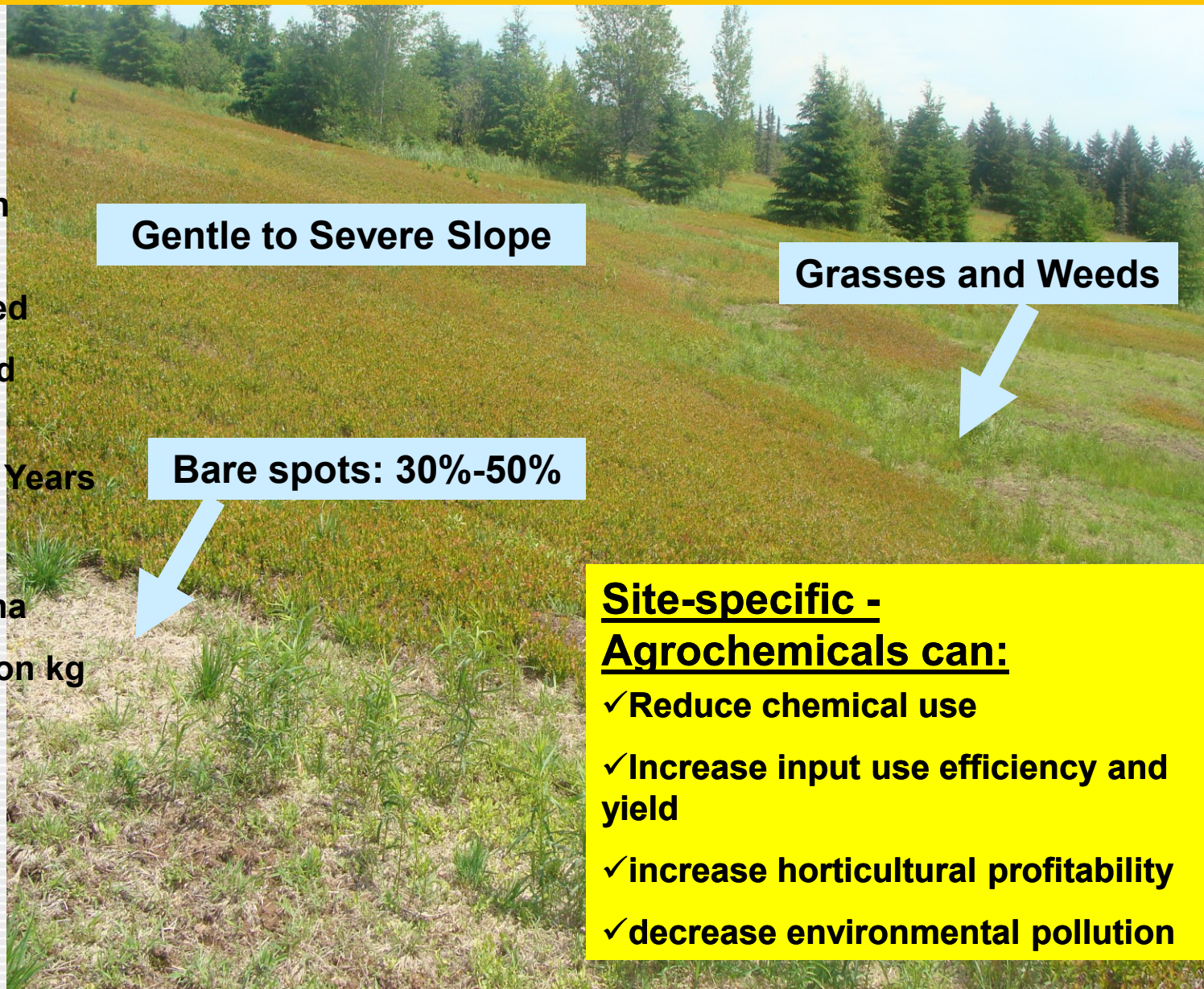
Wild Blueberry fields need to be managed site-specifically using VRT, Sensors, DGPS, Digital photography, Aerial images, GIS…..

- WBB- Unique Crop
- Native- Northeastern North America
- Crop-Never cultivated
- Deforested Farmland

- Production cycle = 2 Years

- Total area = 79,000 ha
- Fruit yield = 82 million kg
- Value = $352 million



Site-specific - Agrochemicals can:

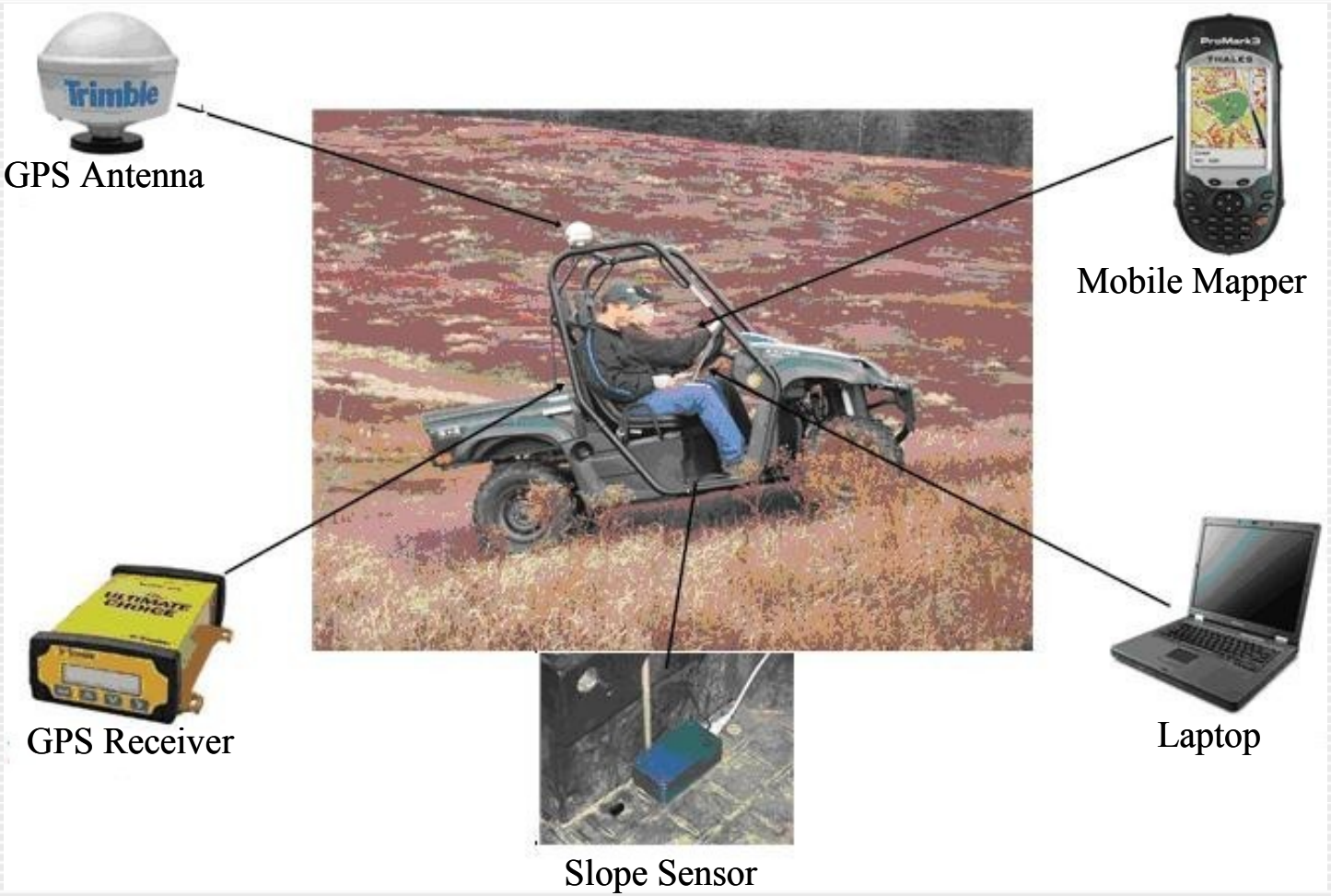
- ✓Reduce chemical use
- ✓Increase input use efficiency and yield
- ✓increase horticultural profitability
- ✓decrease environmental pollution

OBJECTIVES

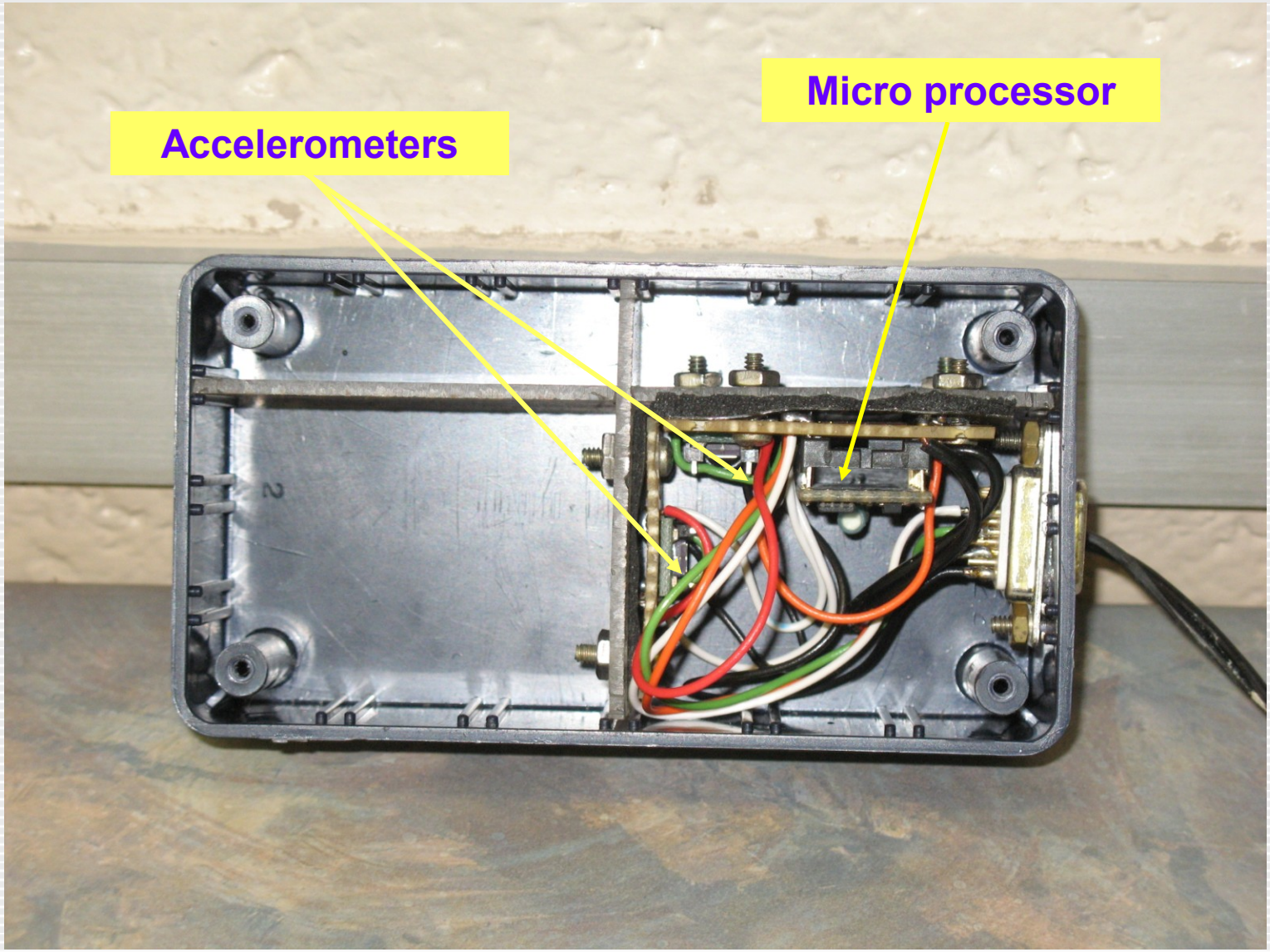
- To develop cost-effective automated slope measurement and mapping system
- To evaluate performance of slope system in commercial wild blueberry fields

Low-cost Slope Measurement and Mapping System

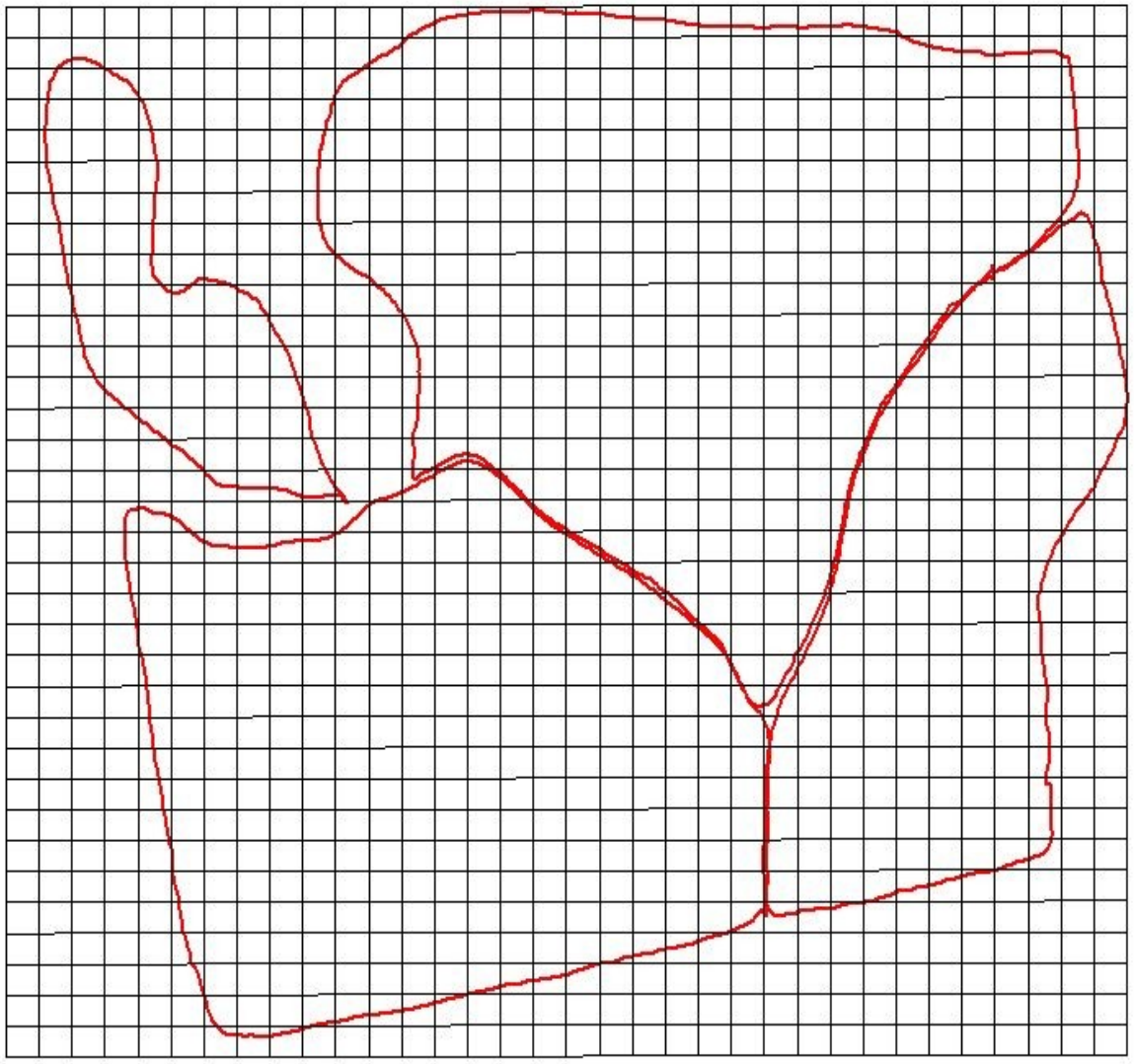
SMMS-Integration



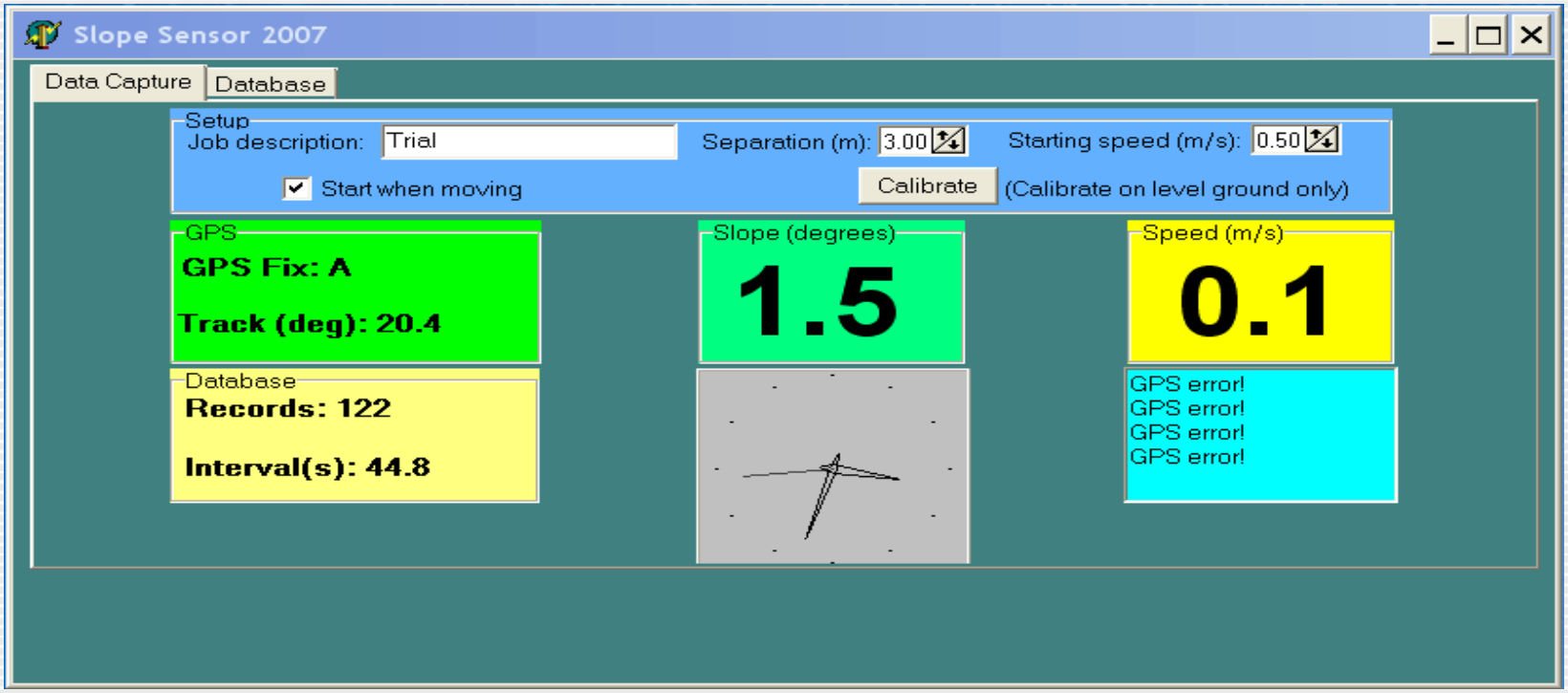
Accelerometers Configuration



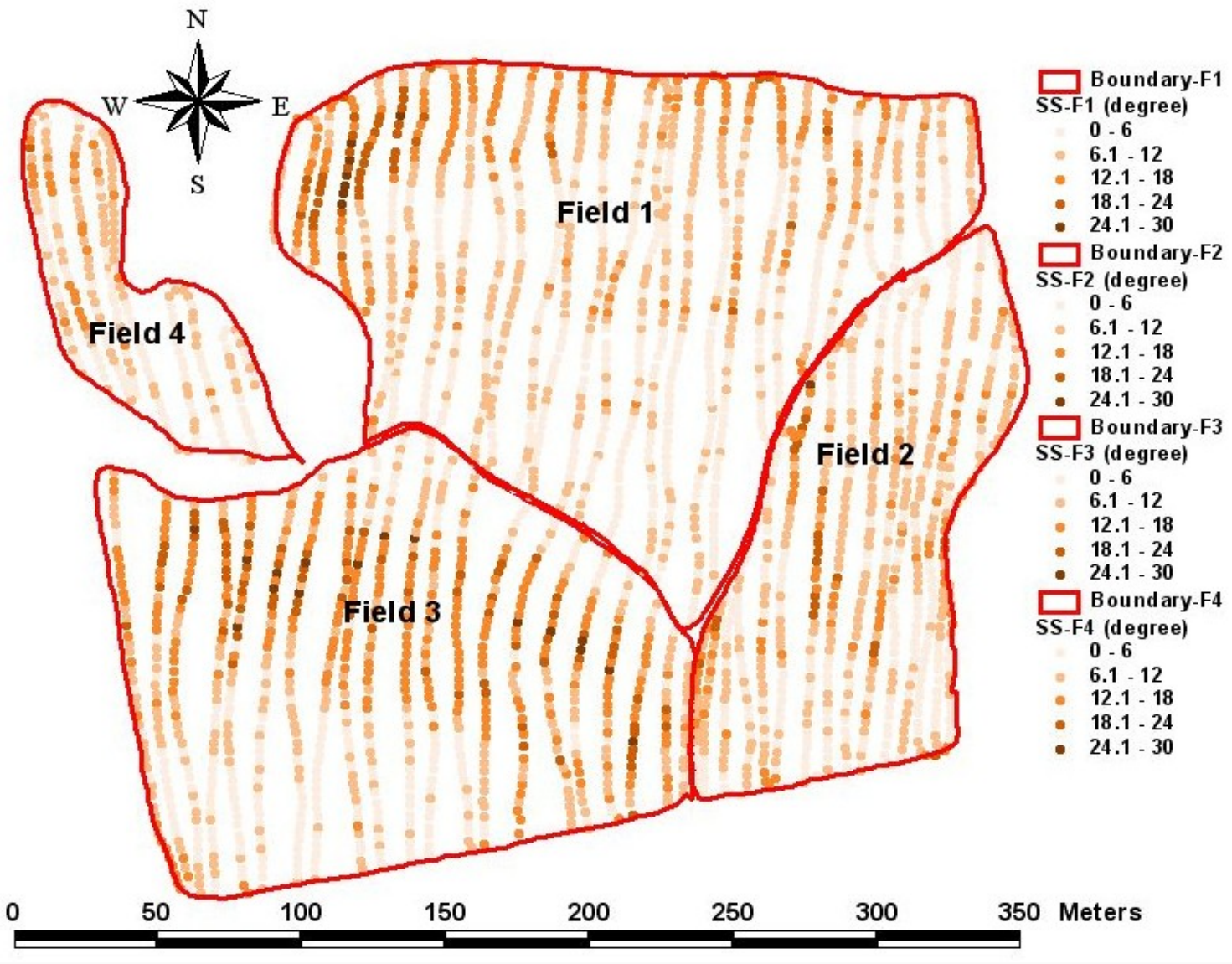
Gridlines for Field Tracking



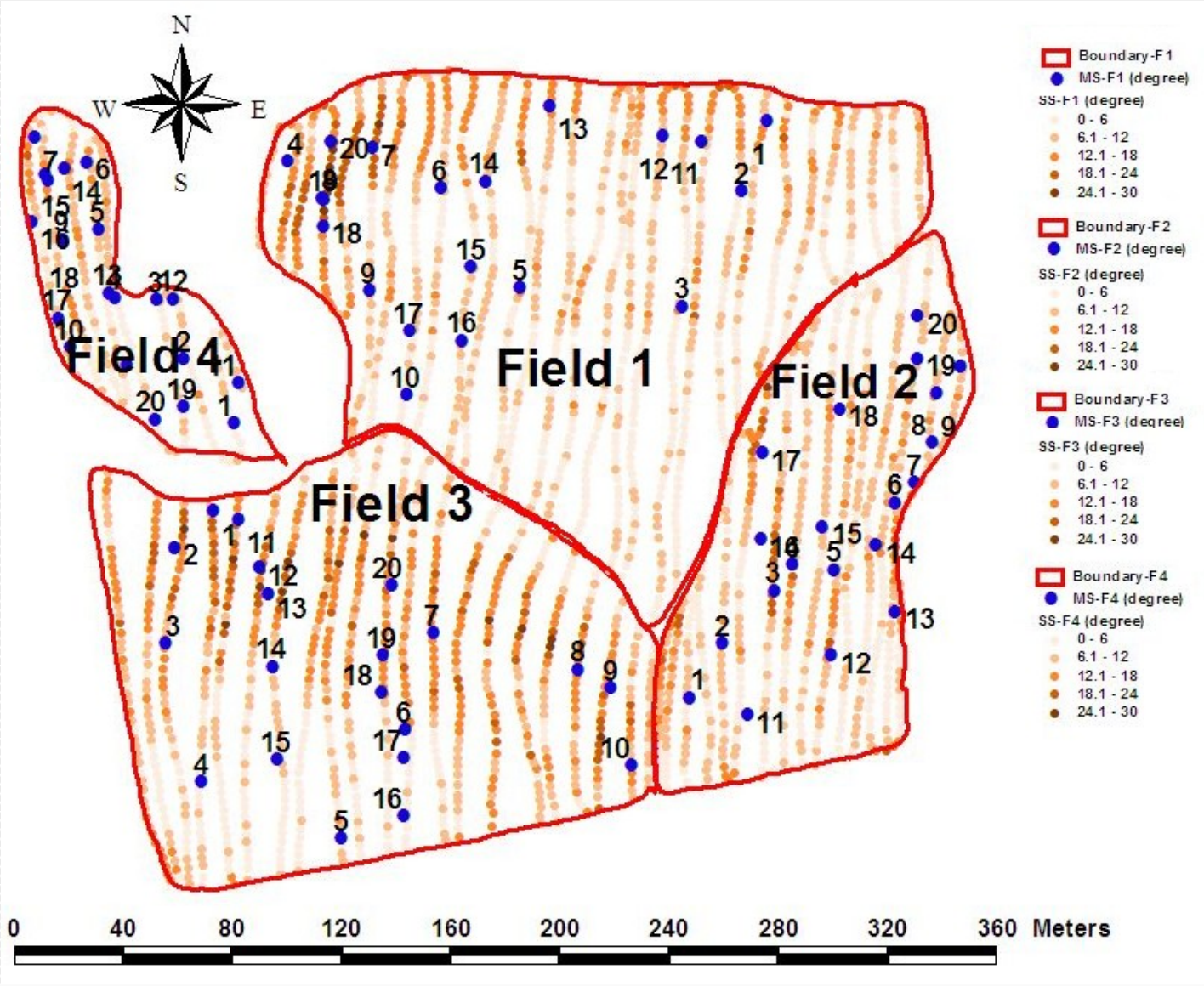
Software Development



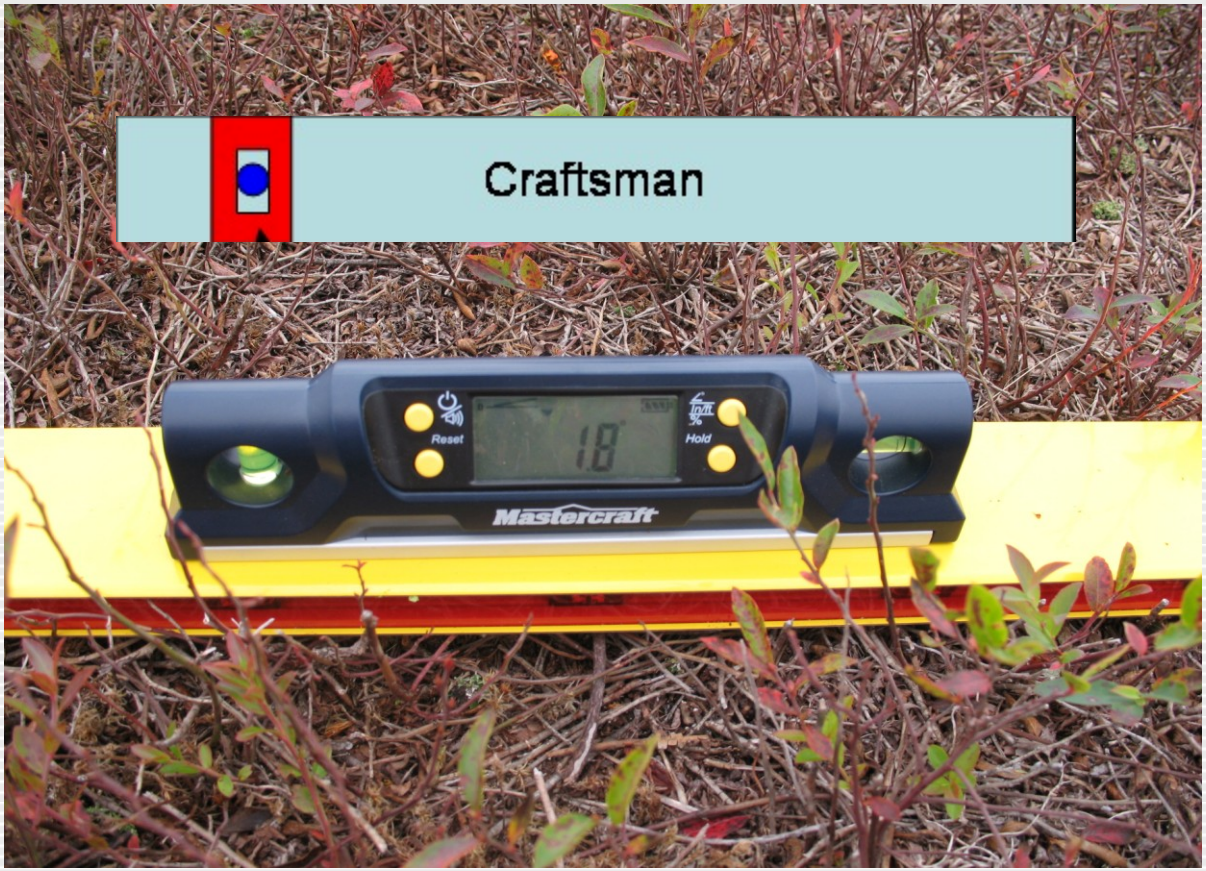
GIS map of slope angle raw data measured with SMMS



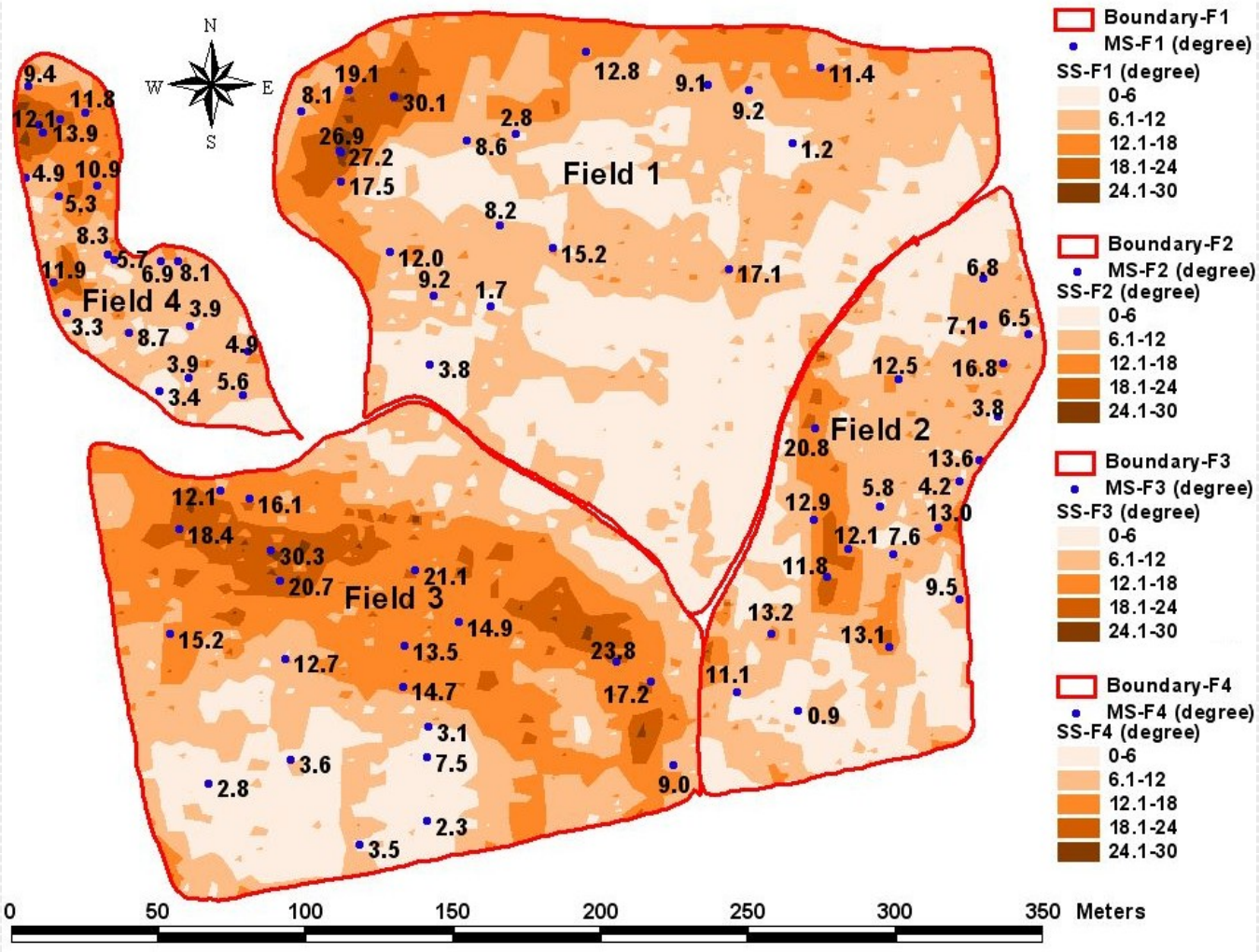
Points for Manual Slope Measurements



Craftsman SmartTool Plus digital level



Interpolated maps of slope measured with SMMS and manually at selected points

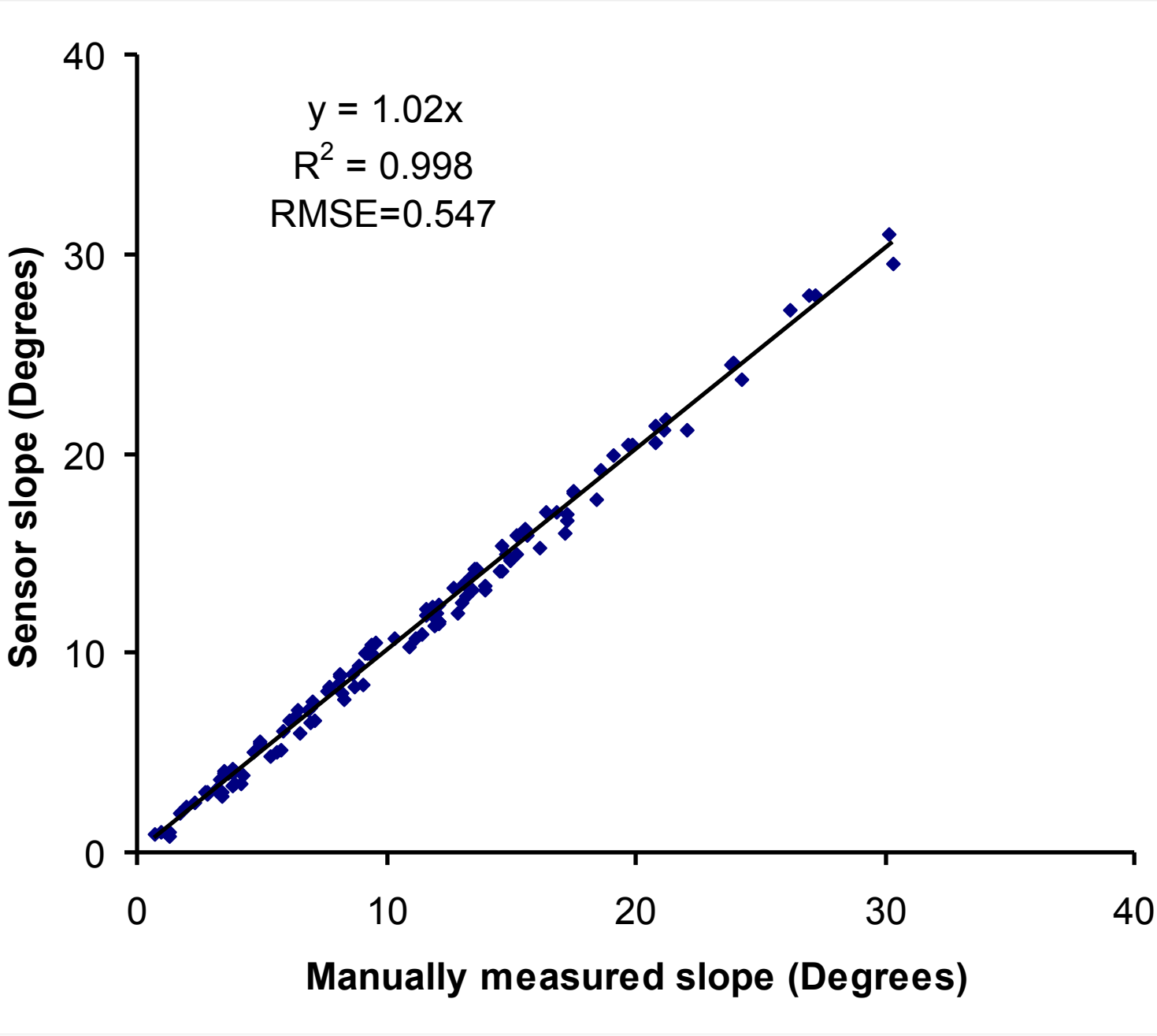


Relationship between Sensor Data and Manual Data

Field 1 (n)	Mean	Max.	Min.	R^2	RMSE	t(d.f.) F-probability
MSF1 (20)	12.56	30.1	1.2	0.995	0.57	-0.108(38) 0.914
SSF1(20)	12.85	31.0	1.0			
MSF2 (20)	10.12	20.8	0.9	0.990	0.135	-0.059(38) 0.953
SSF2 (20)	10.21	21.4	1.1			
MSF3 (20)	12.81	30.3	1.3	0.995	0.111	-0.005(38) 0.996
SSF3 (20)	12.83	29.5	0.8			
MSF4 (20)	7.82	13.9	3.3	0.981	0.165	0.072(38)
SSF4 (20)	7.98	13.4	3.5			0.942

Relationship between Sensor Data and Manual Data

Field 2 (n)	Mean (degree)	Max. (degree)	Min. (degree)	R^2	RMSE
MSF5 (20)	11.97	26.2	1.3	0.994	0.207
SSF5 (20)	12.15	27.2	1.1		
MSF6 (20)	11.24	23.9	0.7	0.996	0.456
SSF6 (20)	11.66	24.6	1.0		


y = 1.02x
R2 = 0.998
RMSE=0.547
Sensor slope (Degrees)
Manually measured slope (Degrees)
0
10
20
30
40

Percentage of field area under different slopes

Field	Total area (ha)	Percentage of area in different slope classes				
		very low	low	moderate	steep	very steep
F1	2.97	32.6	43.4	15.5	7.2	1.3
F2	1.40	40.3	44.5	12.3	2.9	0
F3	2.54	26.1	32.3	30.3	9.4	1.9
F4	0.53	45.9	42.7	11.3	0	0
F5	3.09	25.0	45.5	22.5	1.0	0
F6	1.08	36.0	43.0	17.5	3.5	0

Sampling points in low, moderate and steep slope areas

Comparison of mean fruit yield, soil properties/leaf nutrients for different slope zones

Soil properties/ Leaf nutrients/ Fruit yield	Site 1 Slope (degrees) Zones			Site 2 Slope (degrees) Zones		
	0-12	12-18	18-24	0-12	12-18	18-24
Yield (Mg ha^{-1})	6.1^{a}	4.9^{b}	2.6^{b}	8.6^{a}	5.6^{b}	3.15^{b}
Soil Properties						
SOM (g kg^{-1})	55.4^{a}	45.1^{b}	41.7^{b}	82.2^{a}	70.2^{b}	57.2^{b}
Soil pH	4.54^{a}	4.6^{a}	4.62^{a}	4.65^{a}	4.65^{a}	4.68^{a}
Leaf Nutrients						
N (g kg^{-1})	16.3^{a}	16^{a}	13.2^{b}	18.1^{ab}	18.3^{a}	16.2^{b}
P (g kg^{-1})	1.3^{a}	1.2^{ab}	1.0^{b}	1.4^{a}	1.2^{ab}	1.0^{b}
K (g kg^{-1})	4.1^{a}	4.2^{a}	3.8^{a}	4.4^{a}	4.3^{a}	4.1^{a}

Means followed by similar letter(s) in each row not significantly different from each other at the 5 % confidence level

Ranges for Wild Blueberry Leaf Nutrient in Nova Scotia

Leaf Nutrient	Minimum	Maximum
N ($g\ kg^{-1}$)	16	20
P ($g\ kg^{-1}$)	1.1	1.44
K ($g\ kg^{-1}$)	4.1	5.2

Eaton et al. 2009. International Journal of Fruit Science

Conclusions

- ✓ The cheap, accurate, reliable, smaller size and light weight accelerometers could be used as tilt sensor to develop SMMS.
- ✓ The SMMS was sufficiently accurate to measure and map slope rapidly and reliably in selected wild blueberry fields.
- ✓ The soil organic matter, leaf nutrients (N, P) and fruit yield were significantly different in steep slopes and low lying areas of each field
- ✓ This information could be used to generate prescription maps for site-specific application of agrochemicals to improve horticultural profitability and environmental protection.
- ✓ The slope maps can also be used for safety reasons during field operations by adjusting the vehicle's speed at particular slopes.
- ✓ The operator can use slope maps as a guide for accurate application of agrochemicals by changing spray rates at particular slopes.

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Nova Scotia's Provincial Berry
the Wild Blueberry

THANKS

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