

DEVELOPING MANAGEMENT ZONES FOR SITE SPECIFIC NUTRIENT MANAGEMENT IN POTATO PRODUCTION



PEI Potato Conference
February, 2019

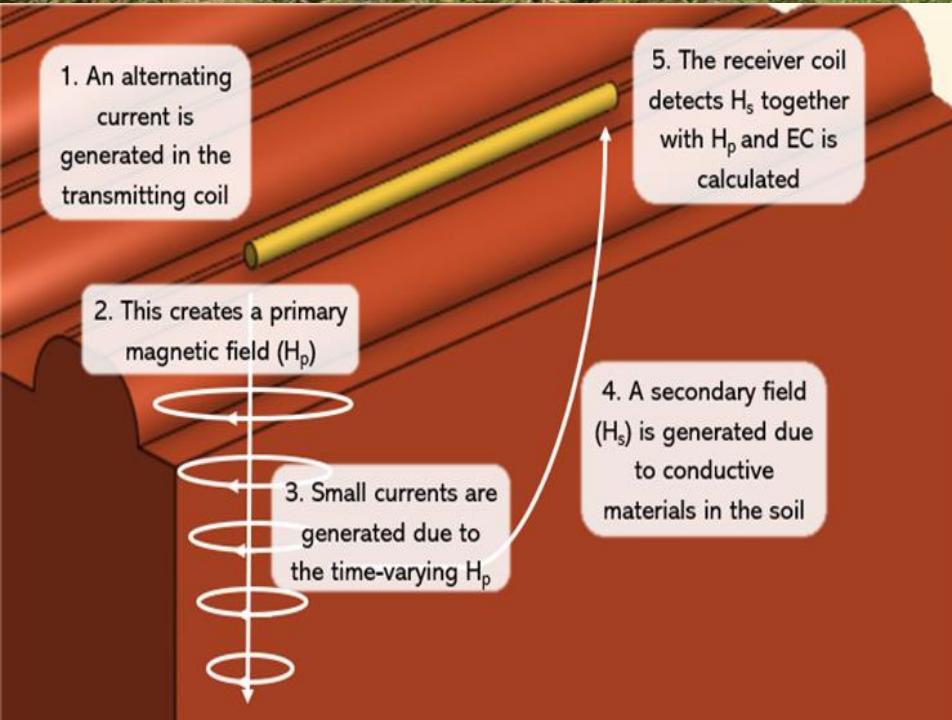
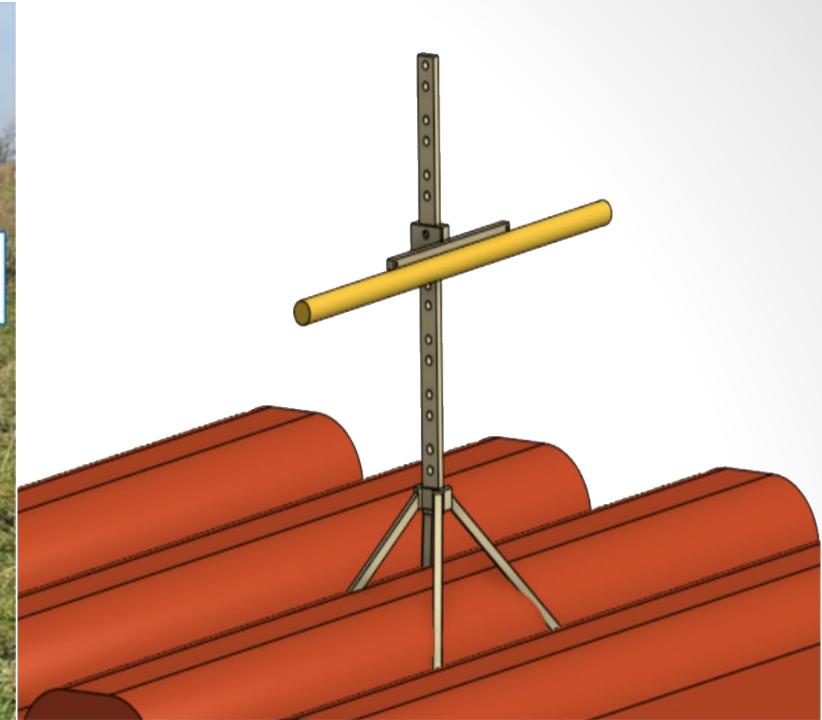
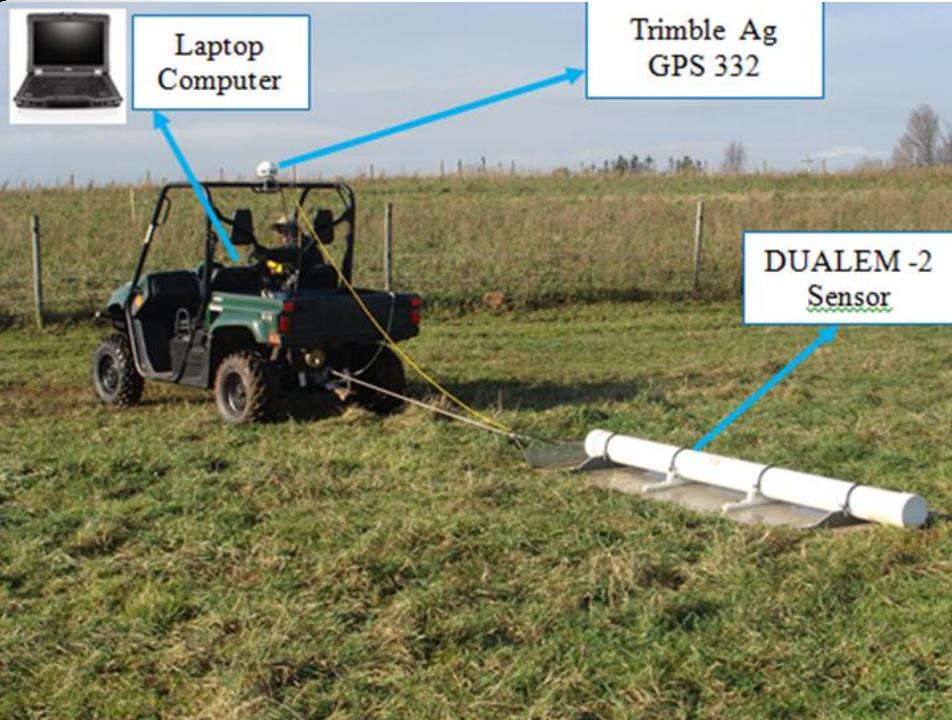
Aitazaz A. Farooque, PhD, P.Eng
E-mail: afarooque@upei.ca



UNIVERSITY
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Introduction

- An increase in yield requires precise agricultural inputs
 - NOT UNIFORM
- Complex interactions among soil, topography, climate, cultivation, crop, and agricultural inputs
- Substantial variability in soil and crop - **YIELD VARIABILITY**
- Management of agricultural inputs based on soil and crop variability - **FARM PROFITABILITY** and **ENVIRONMENTAL PROTECTION**



Objectives

- ✓ Characterize and quantify variability - soil, crop, topography and yield,
- ✓ Identify the significant factors affecting potato productivity,
- ✓ Calibrate yield monitoring system testify its potential to be used as factor to develop MZs,
- ✓ Sensors for an accurate prediction of the attributes of interest explaining significant variability
- ✓ Develop MZs for site-specific application of agricultural input – Ensure economic and environmental sustainability.

PARAMETERS - DETERMINED

Soil Sampling/Analysis

Ph
EC
Lime Index
Moisture Content
Soil Chemical Properties
SOM
(P, K, Ca, Mg, Cu, B, Zn, Al, Mn, Na, CEC, Fe,...)

Sensors Data

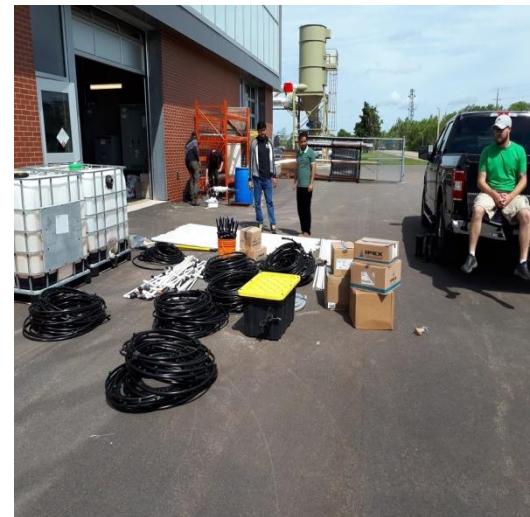
HCP
PRP
Slope Sensor
NDVI
TDR

Potato Yield

Calibration of yield monitor
Geo-referenced yield collection

4 Samplings over the growing season

Data Collection



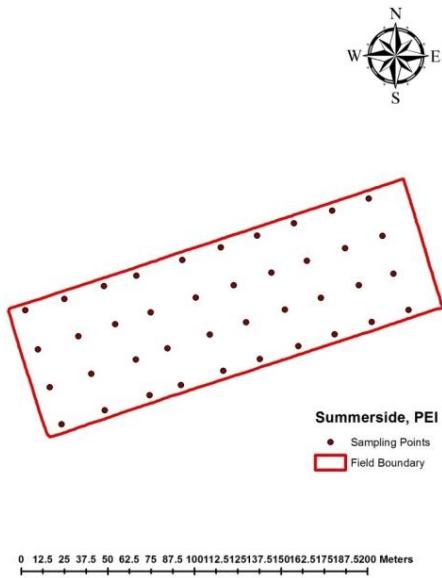
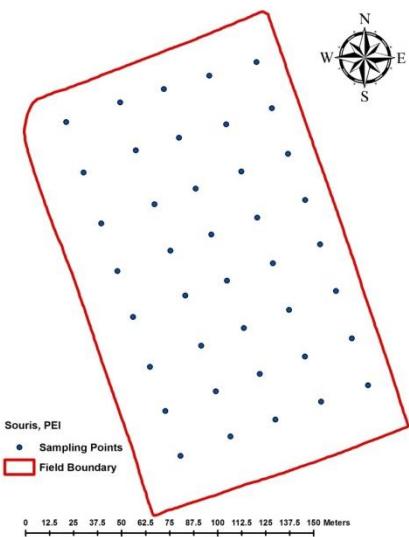
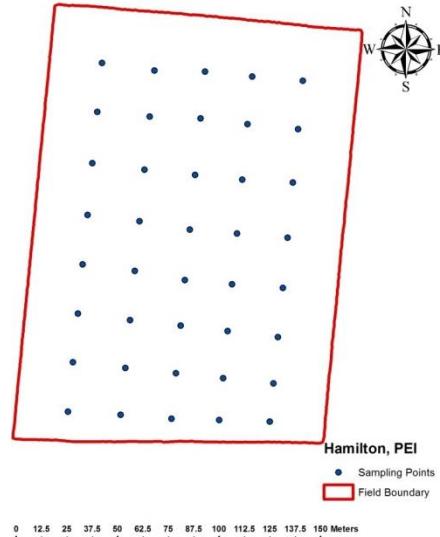
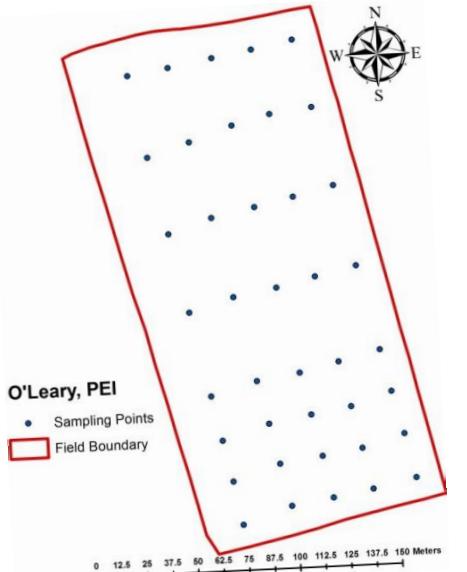
Data Collection



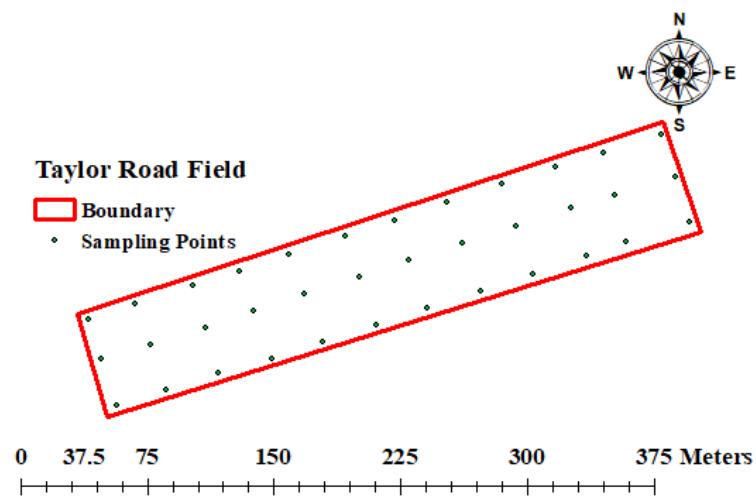
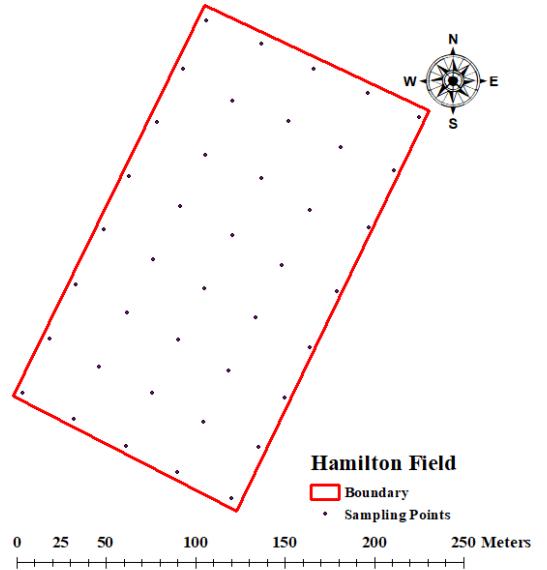
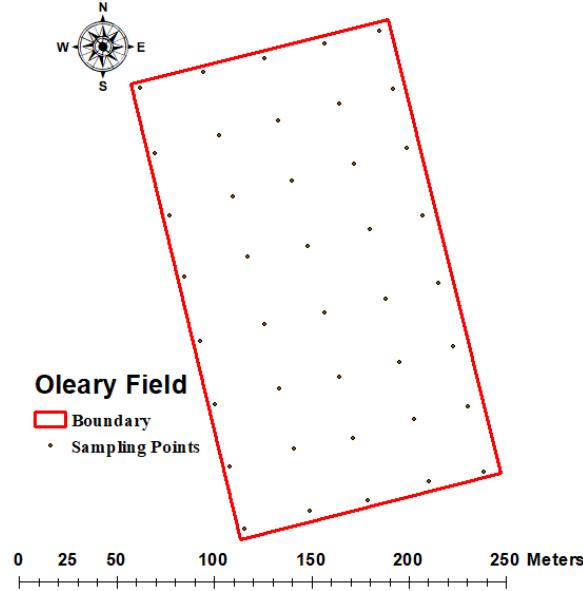
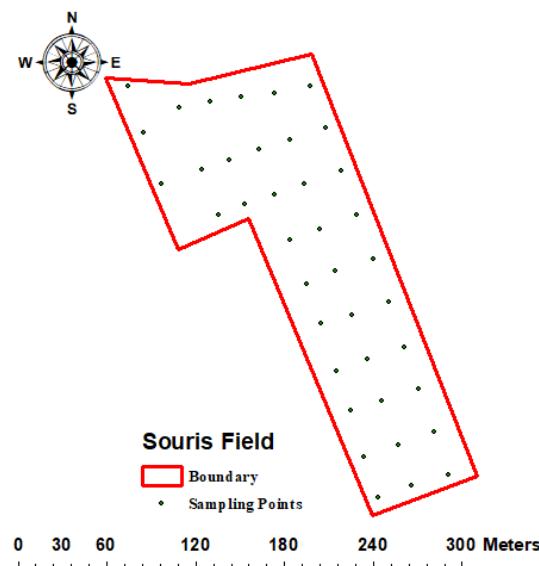
Data Collection



Site Selection 2017

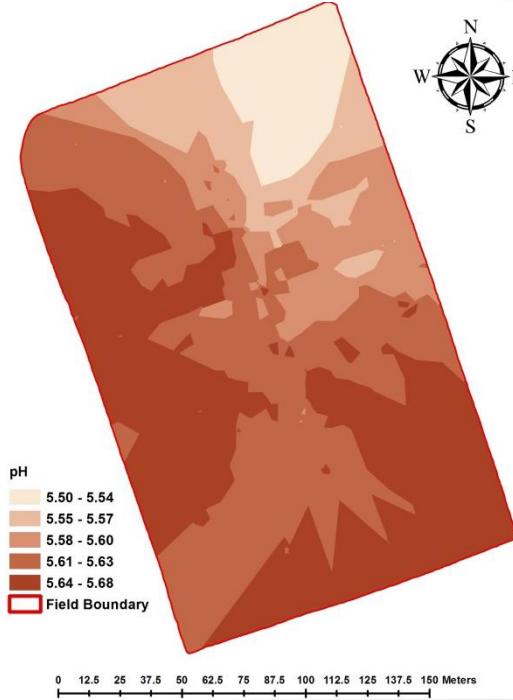
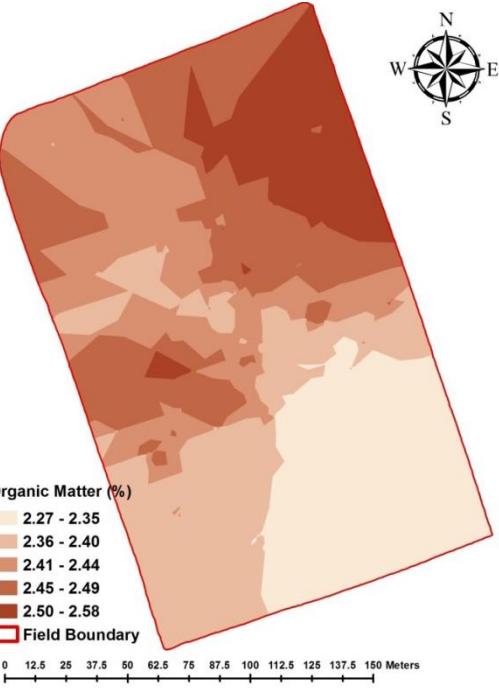
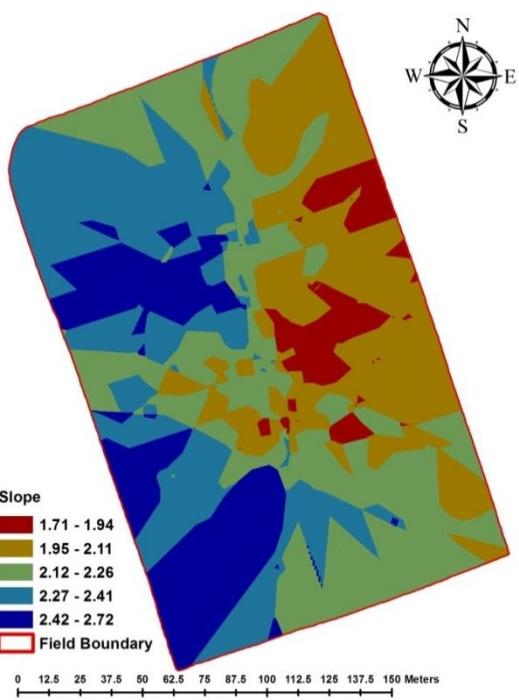
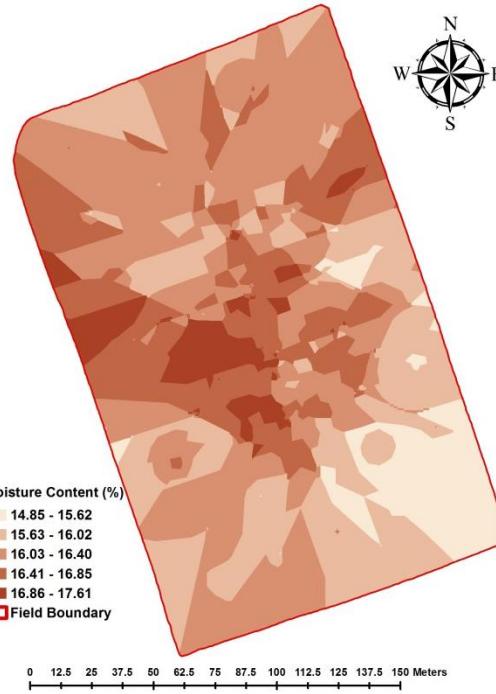
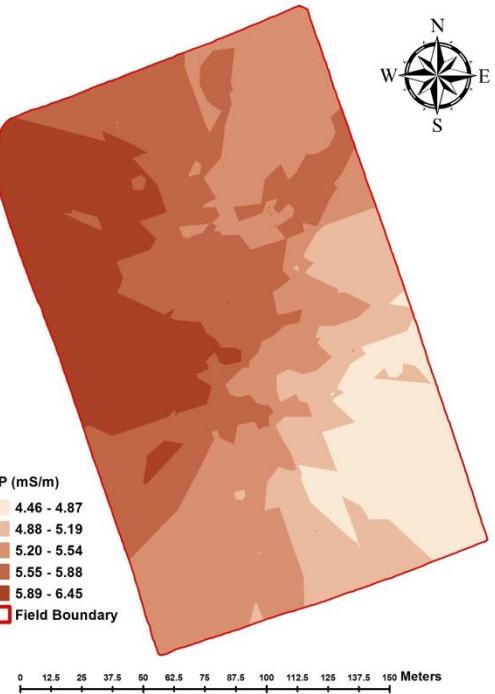
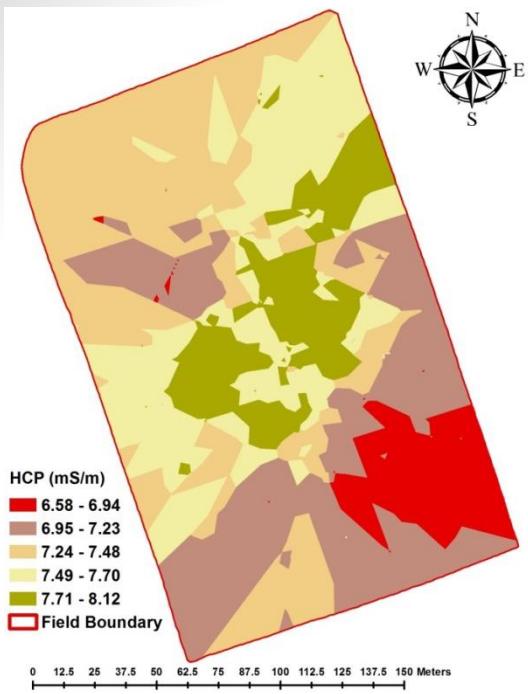


Site Selection 2018

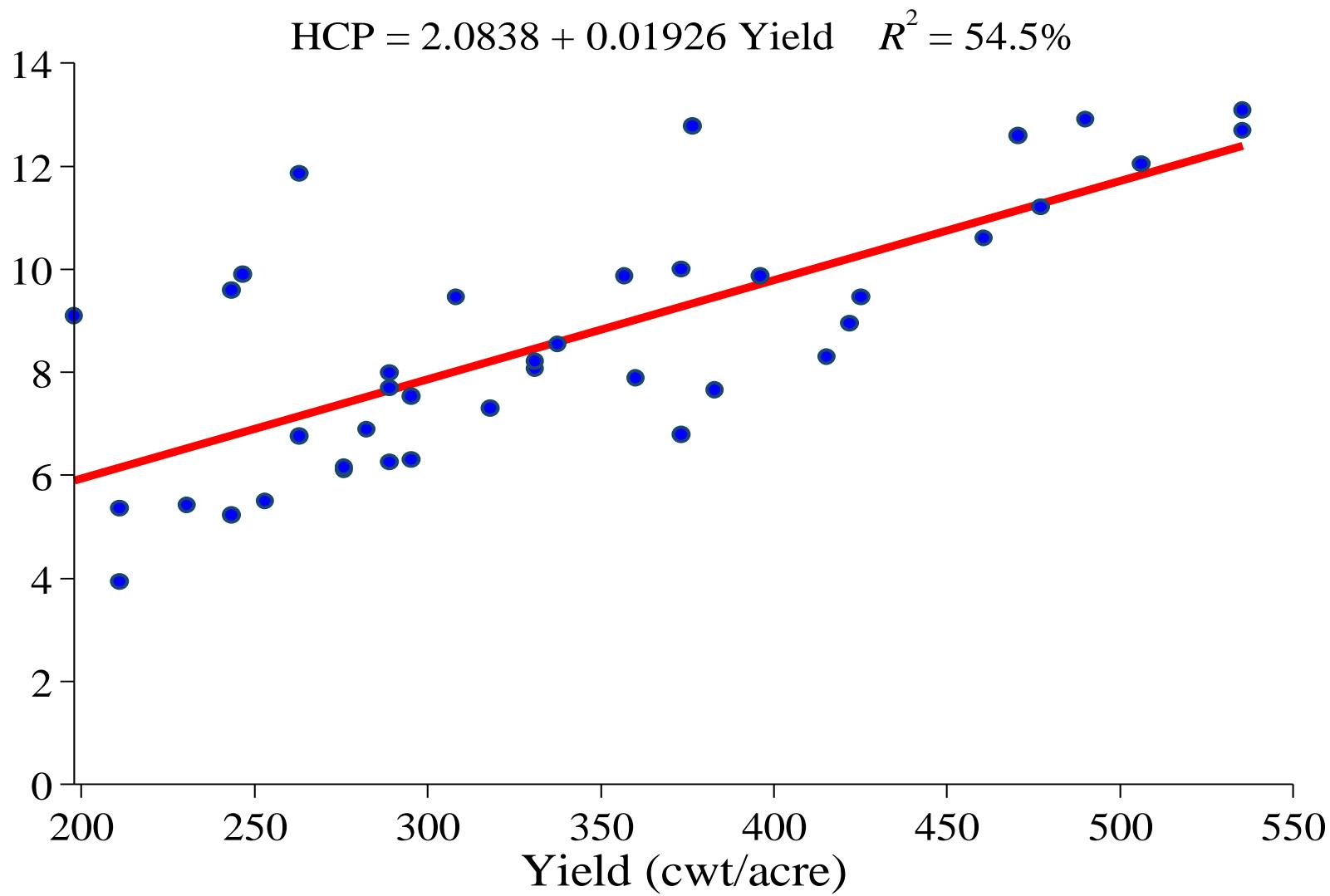


Results 2017

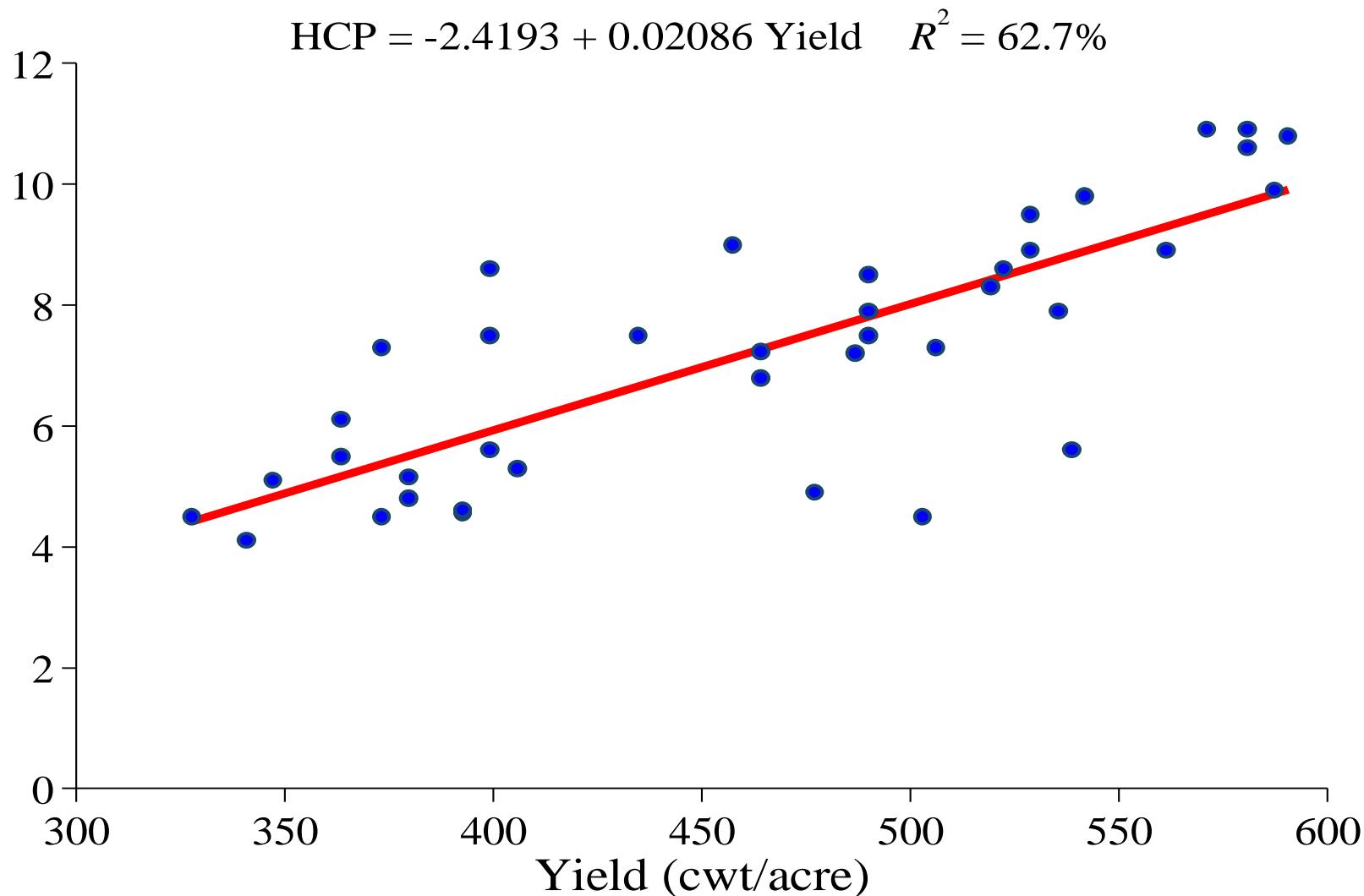
Interpolation and Mapping – Souris PEI



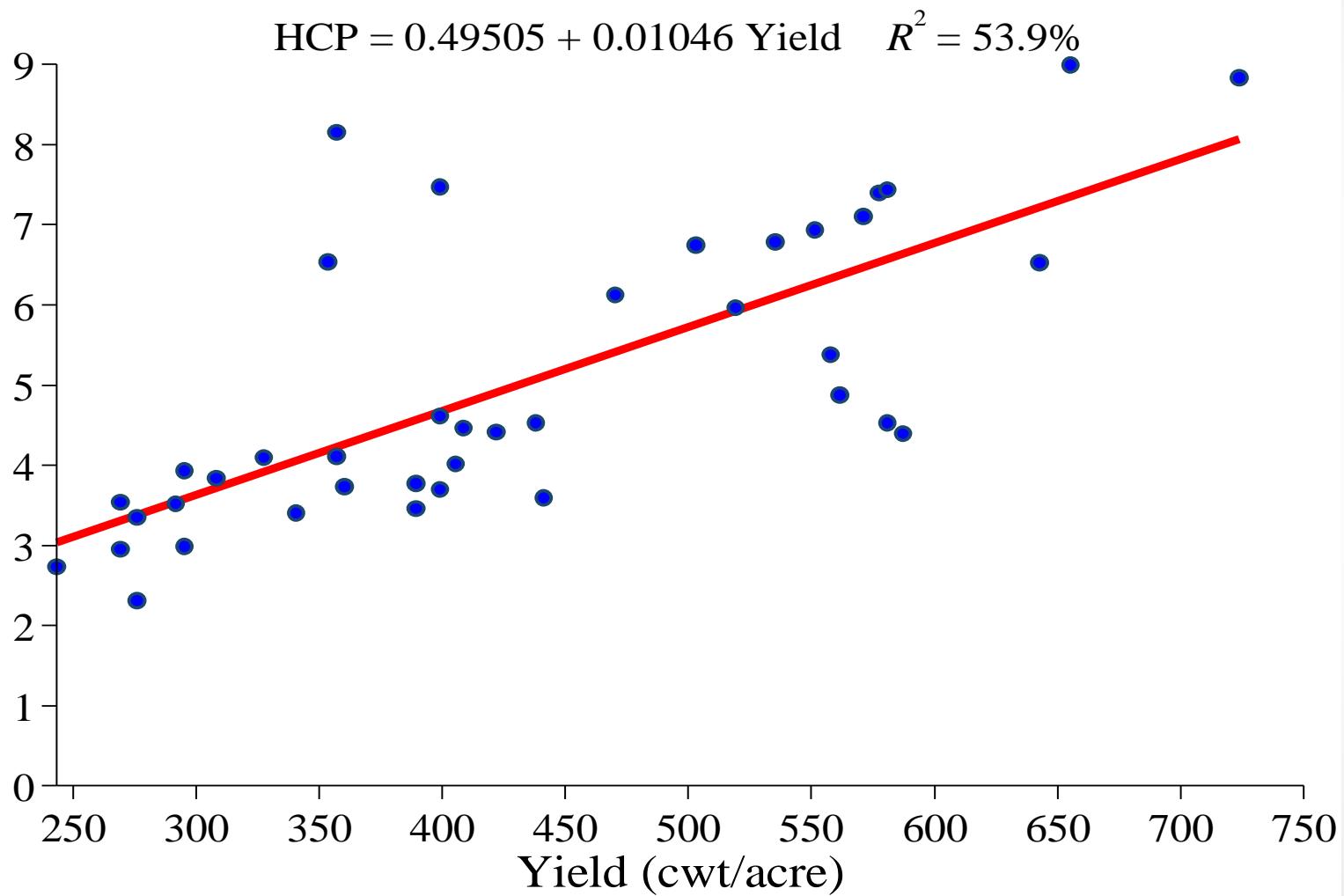
Multiple Regression – Summerside PEI



Multiple Regression – Souris PEI

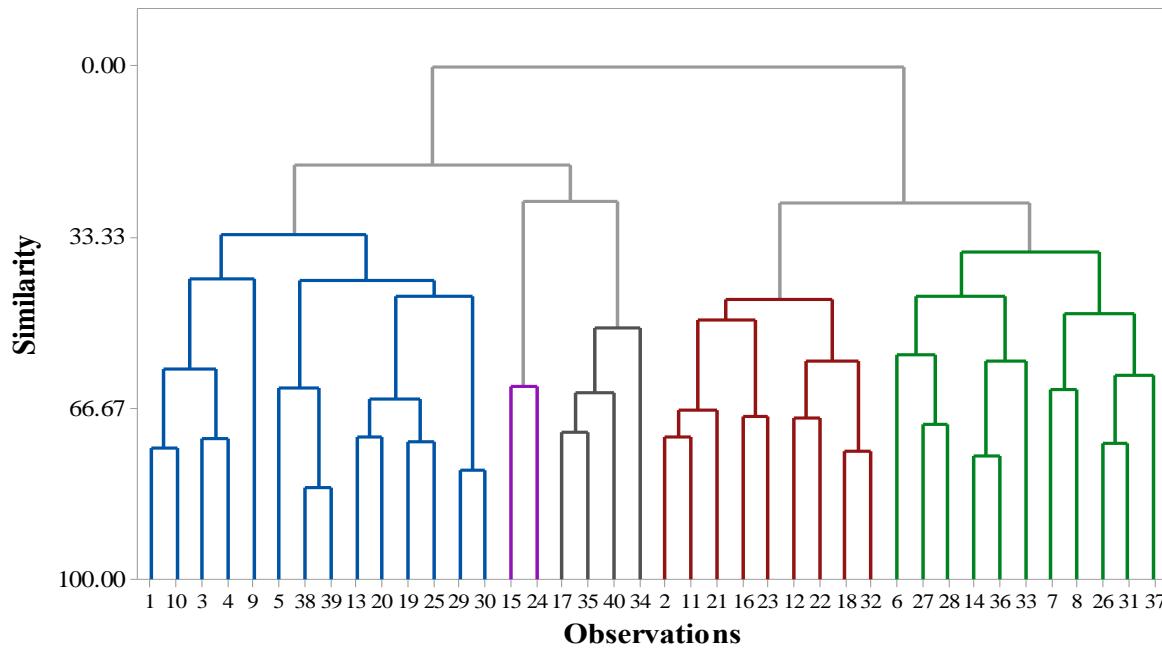


Multiple Regression - O'Leary PEI



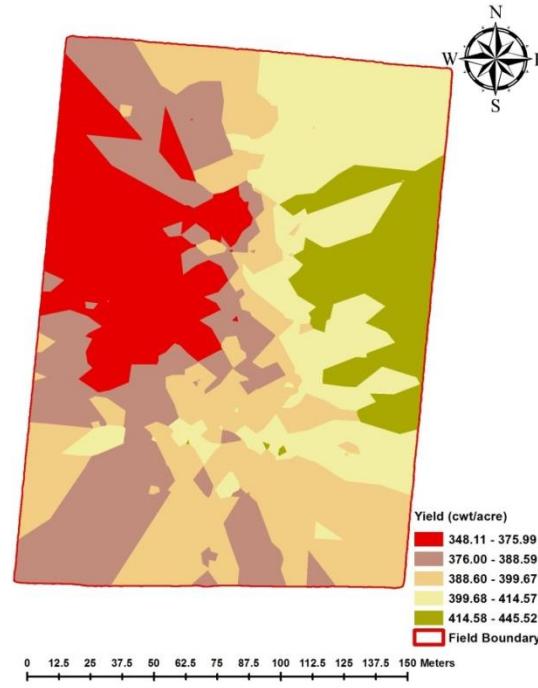
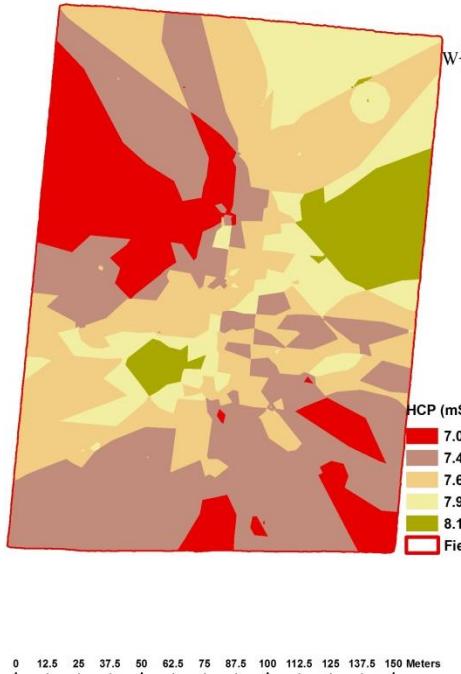
Cluster Analysis – Souris PEI

Cluster Observation Dendrogram

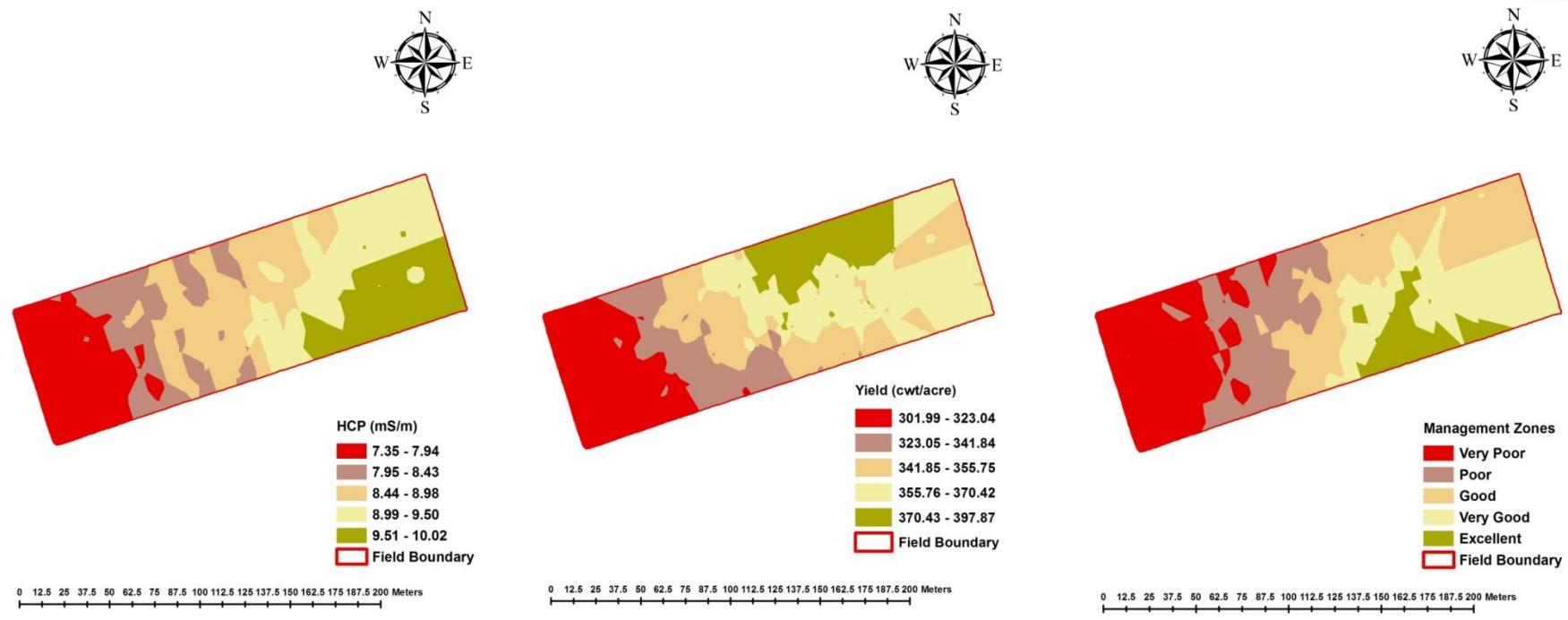


Excellent: Blue 539.50
Very Good: Purple 535.43
Good: Gray 507.00
Poor: Green 426.00
Very Poor: 365.25 Red

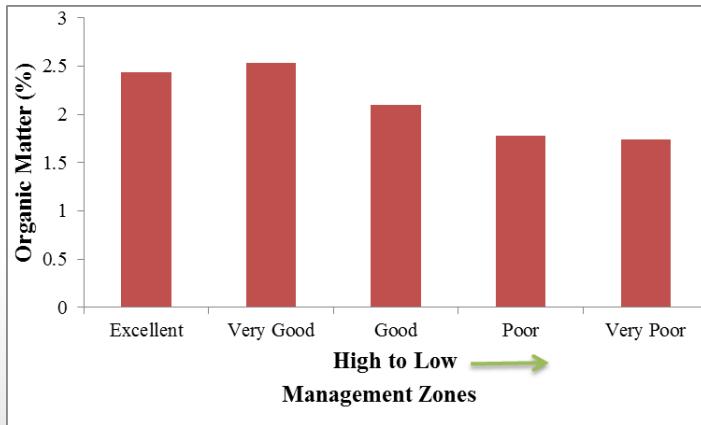
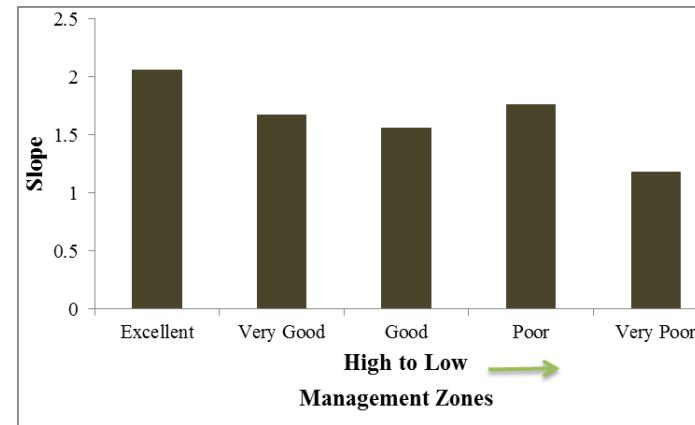
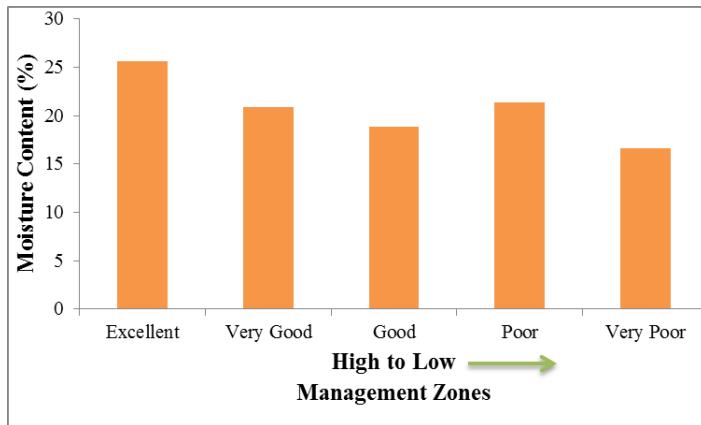
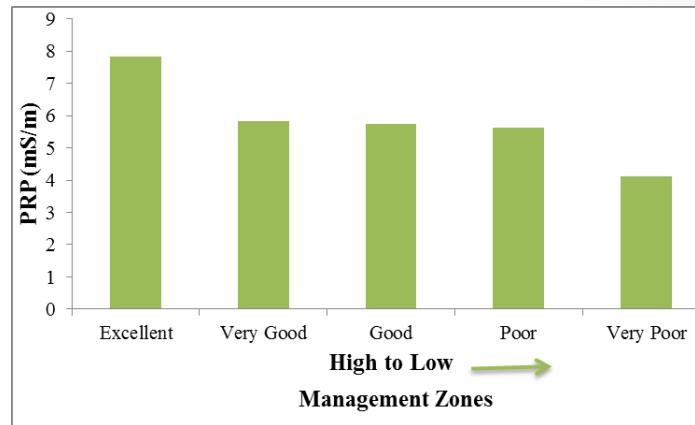
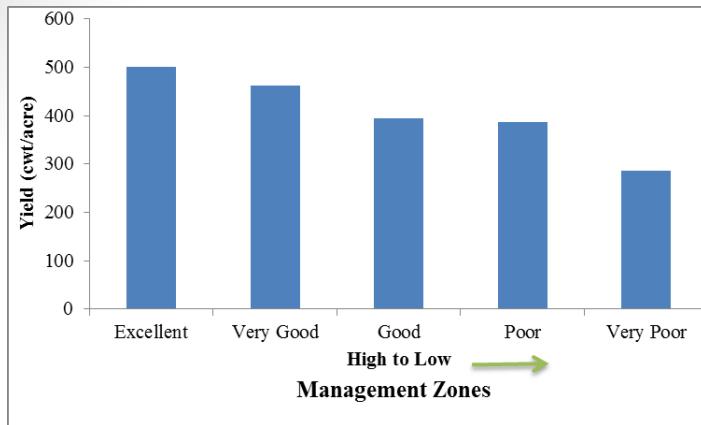
Management Zones – Hamilton PEI



Management Zones – Summerside PEI

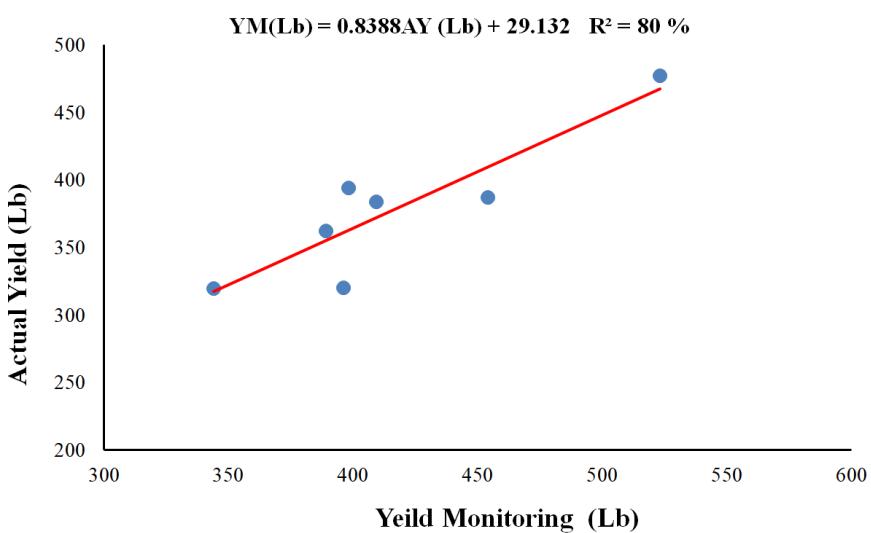


Zonal Analysis – PEI

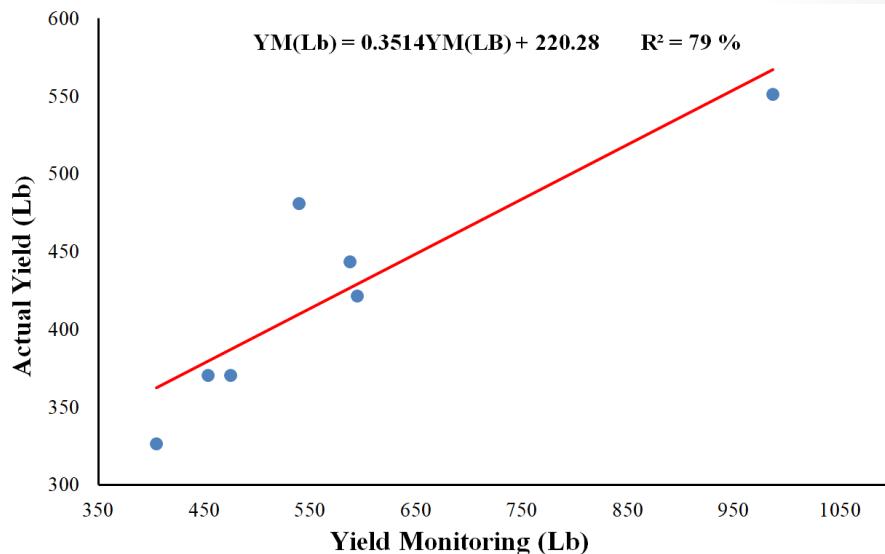


Results 2018

Yield Monitoring



Summerside PEI
 $R^2 = 0.80$



Taylor Road
 $R^2 = 0.79$

Summary Statistics

Descriptive Statistics, Hamilton, PEI				
Variable	Minimum	Maximum	Mean	CV
Yield (cwt/ac)	237.87	532.72	379.88	31.23
HCP	3.70	7.90	5.71	34.21
PRP	2.40	4.30	3.36	22.12
MC	6.04	11.40	8.62	23.66
Slope	0.34	3.10	1.62	41.26

CVs < 15% - Least Variable

CVs 15 – 35% - Moderately Variable

CV > 35% Highly Variable

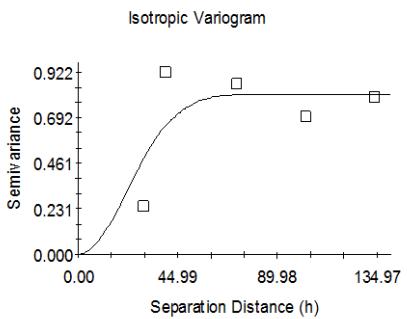
Total N	78.00	520.00	104.40	29.77
Calcium	560.00	1044.00	790.80	17.82
Magnesium	50.00	100.00	80.00	16.00

The field showed moderate to high variability in collected data

Sulfur	13.00	20.00	16.00	10.69
Manganese	21.00	53.00	34.13	23.19
Iron	107.00	204.00	139.25	14.21
Sodium	21.00	42.00	30.05	15.99
Aluminum	1511.00	1833.00	1627.50	4.57
Lime Index	6.60	7.10	6.80	1.91
% P/Al	7.75	14.10	10.39	16.38
CEC	5.00	10.00	7.88	17.77
Total % Base Sat	41.20	99.00	68.50	23.99

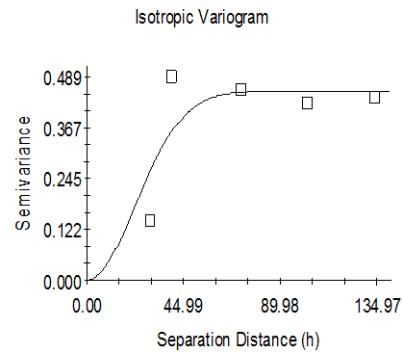
Geostatistical Analysis

HCP



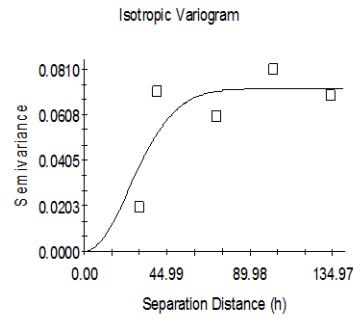
Gaussian model (Co = 0.00100; Co + C = 0.81100; Ao = 31.10; $r^2 = 0.539$; RSS = 0.147)

Slope



Gaussian model (Co = 0.00100; Co + C = 0.45400; Ao = 31.80; $r^2 = 0.624$; RSS = 0.0321)

OM



Gaussian model (Co = 0.00010; Co + C = 0.07210; Ao = 35.00; $r^2 = 0.639$; RSS = 8.540E-04)

Calculates spatial variability in terms of distance (in meters).

Geostatistical Analysis

Souris PEI

Parameters	Range (m)
HCP (mS m^{-1})	18.31
PRP (mS m^{-1})	18.83
Moisture Content (%)	30.80
Slope	12.10
Organic Matter (%)	30.80
pH	33.30

Spatial variability is 1/3 of the range of variability.

Magnesium (ppm)	26.40
Boron (ppm)	53.40
Copper(ppm)	223.80
Zinc (ppm)	41.60
Sulfur (ppm)	30.80
Manganese (ppm)	190.87
Iron (ppm)	45.55
Sodium (ppm)	103.69
Aluminium (ppm)	66.60
Lime Index	23.56
% PAI	77.94
CEC (meq/100g)	30.90
Total % Base Saturation	103.69

Correlation Analysis - Hamilton PEI

	HCP	PRP	Organic Matter	pH	K ₂ O
PRP		0.565***			
Organic Matter	0.024 ^{NS}	0.10 ^{NS}			
pH	-0.133 ^{NS}	0.24 ^{NS}	0.015 ^{NS}		
K ₂ O	0.521*	0.28*	0.192 ^{NS}	0.126 ^{NS}	
CEC	-0.311*	-0.338*	0.274*	0.043 ^{NS}	0.175 ^{NS}

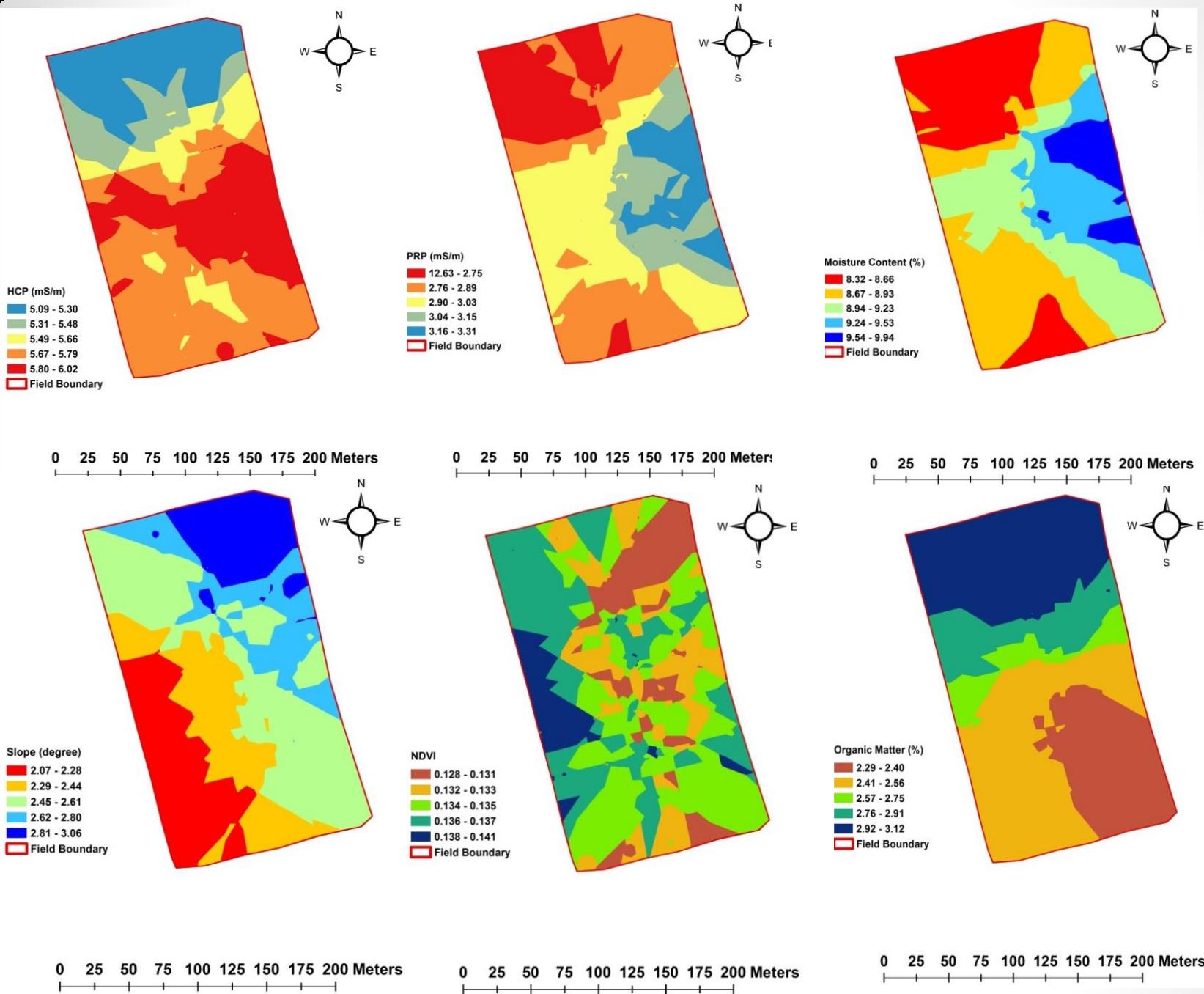
Significance of correlation indicated by *, ** and ***, are equivalent to p=0.05, p= 0.01 and p=0.001. Where NS is non -significant at p=0.05

Correlation Analysis – Souris PEI

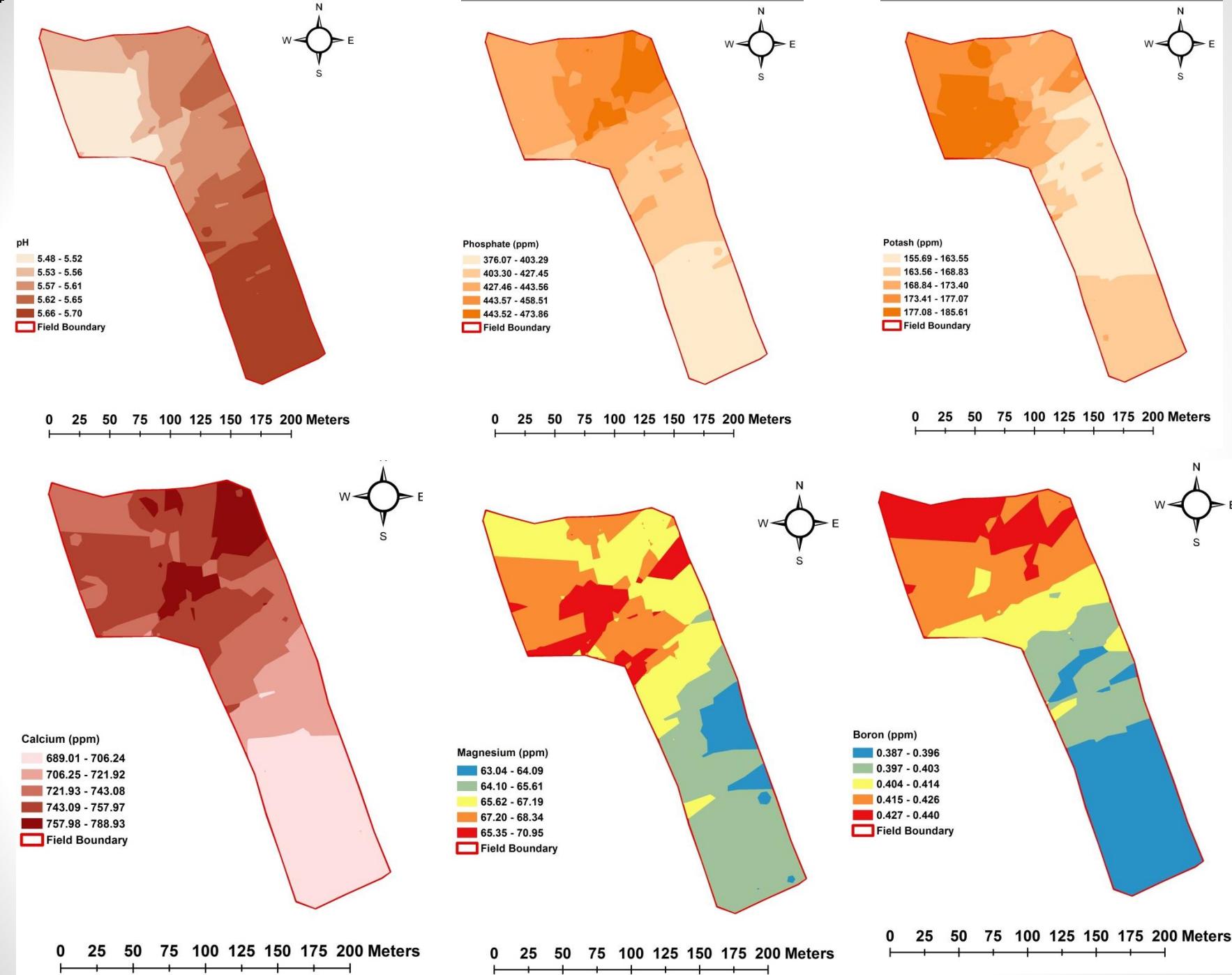
	HCP	PRP	Organic Matter	pH	K ₂ O
PRP		0.687***			
Organic Matter	-0.149 ^{NS}		0.057 ^{NS}		
pH	-0.347*	-0.197 ^{NS}		0.091 ^{NS}	
K ₂ O	0.433**	0.463**		0.136 ^{NS}	0.119 ^{NS}
CEC	0.25*	0.153 ^{NS}		0.113 ^{NS}	-0.324*
					0.222 ^{NS}

Significance of correlation indicated by *, ** and ***, are equivalent to p=0.05, p= 0.01 and p=0.001. Where NS is non-significant at p=0.05

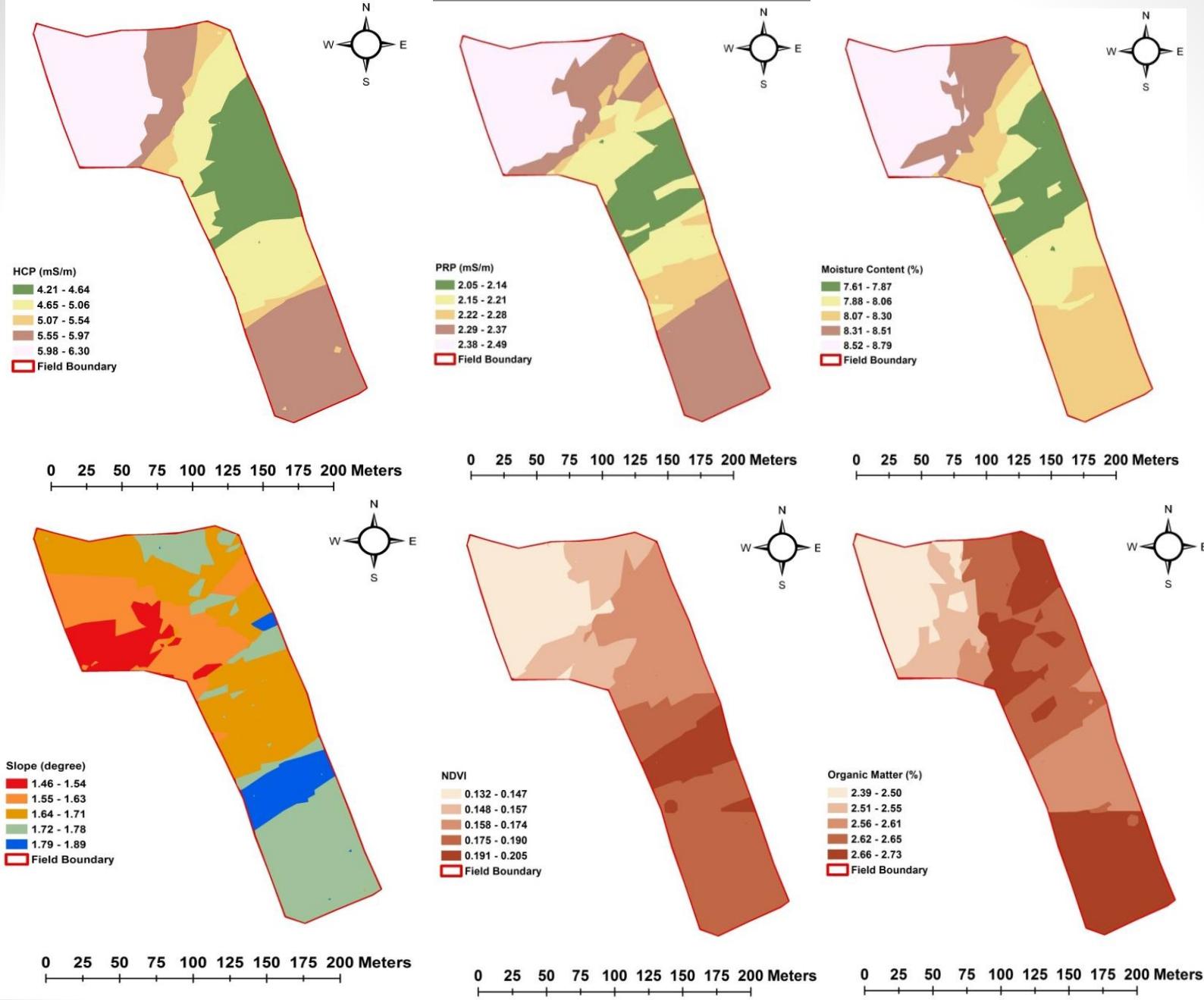
Interpolation and Mapping – O'leary, PEI



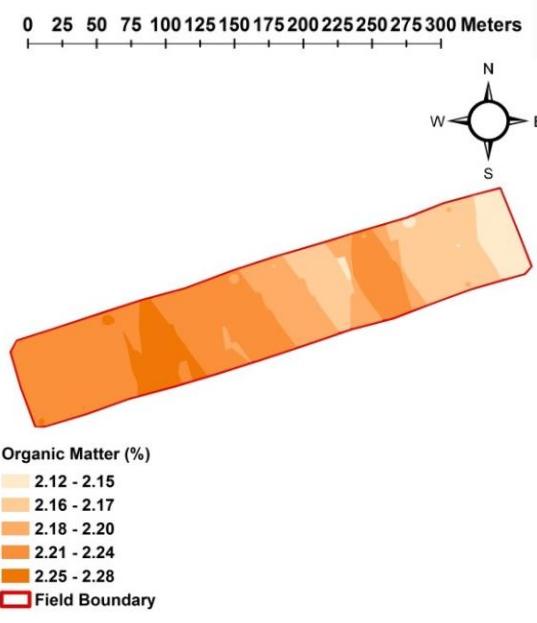
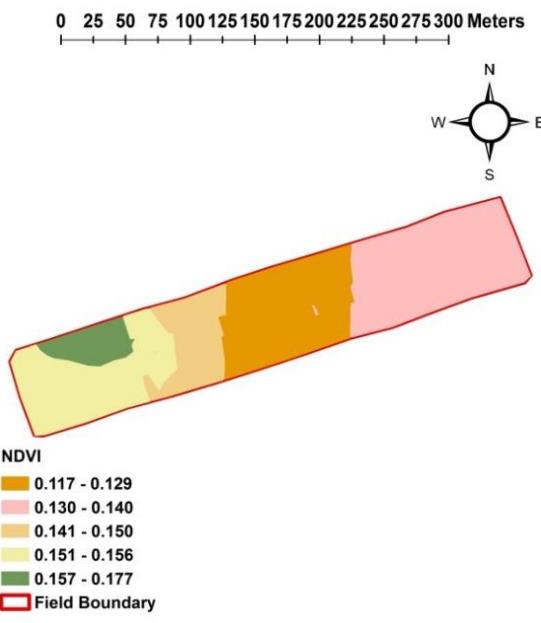
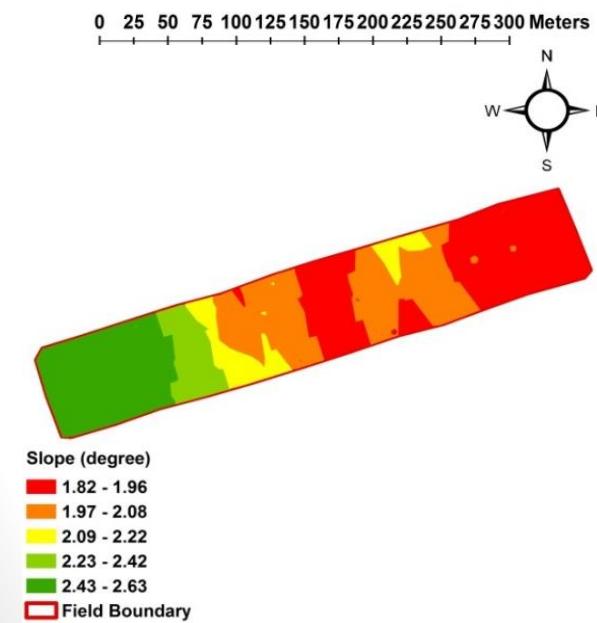
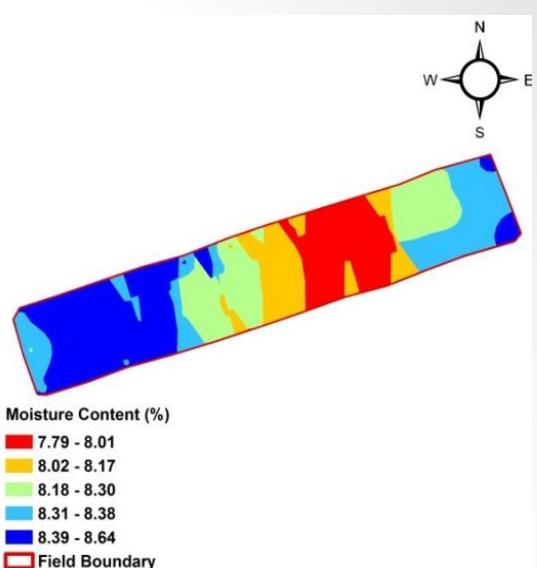
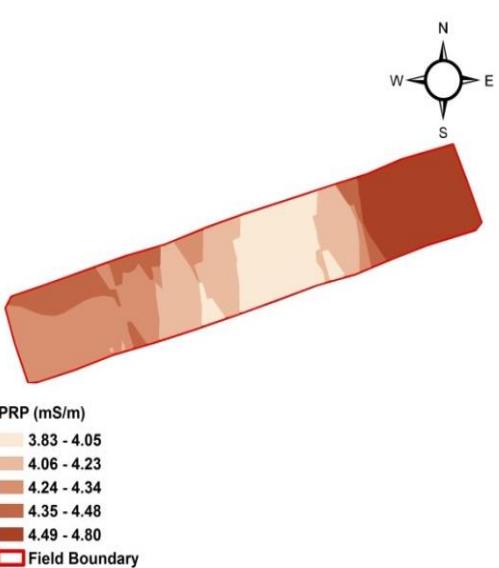
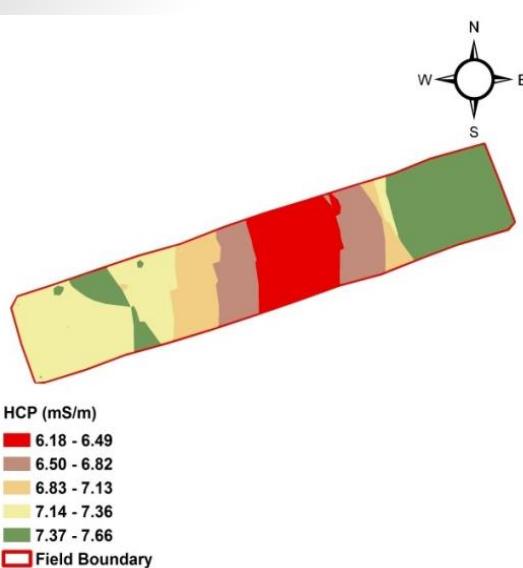
Interpolation and Mapping – Souris PEI



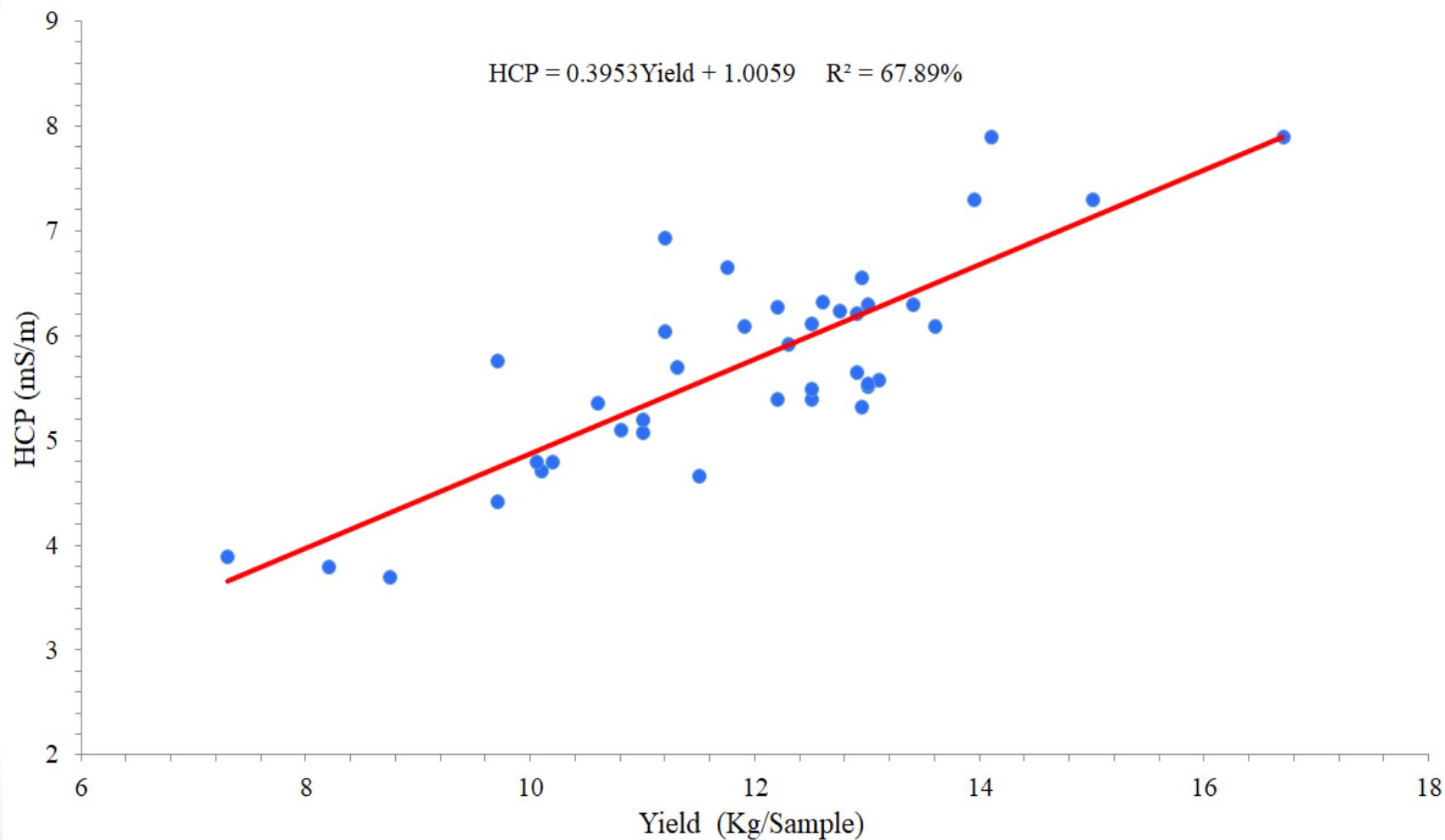
Interpolation and Mapping – Souris, PEI



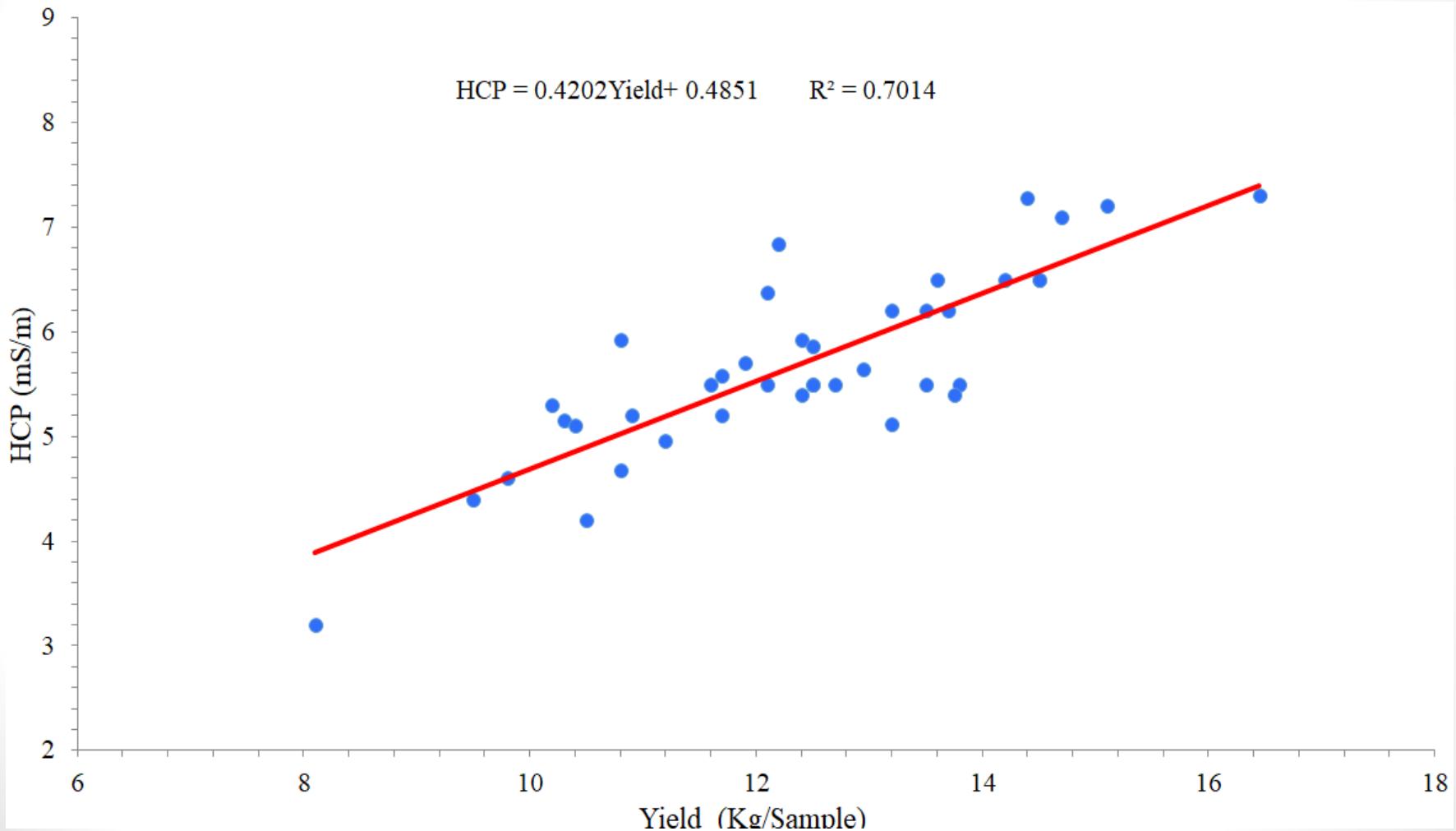
Interpolation and Mapping – Taylor Rd PEI



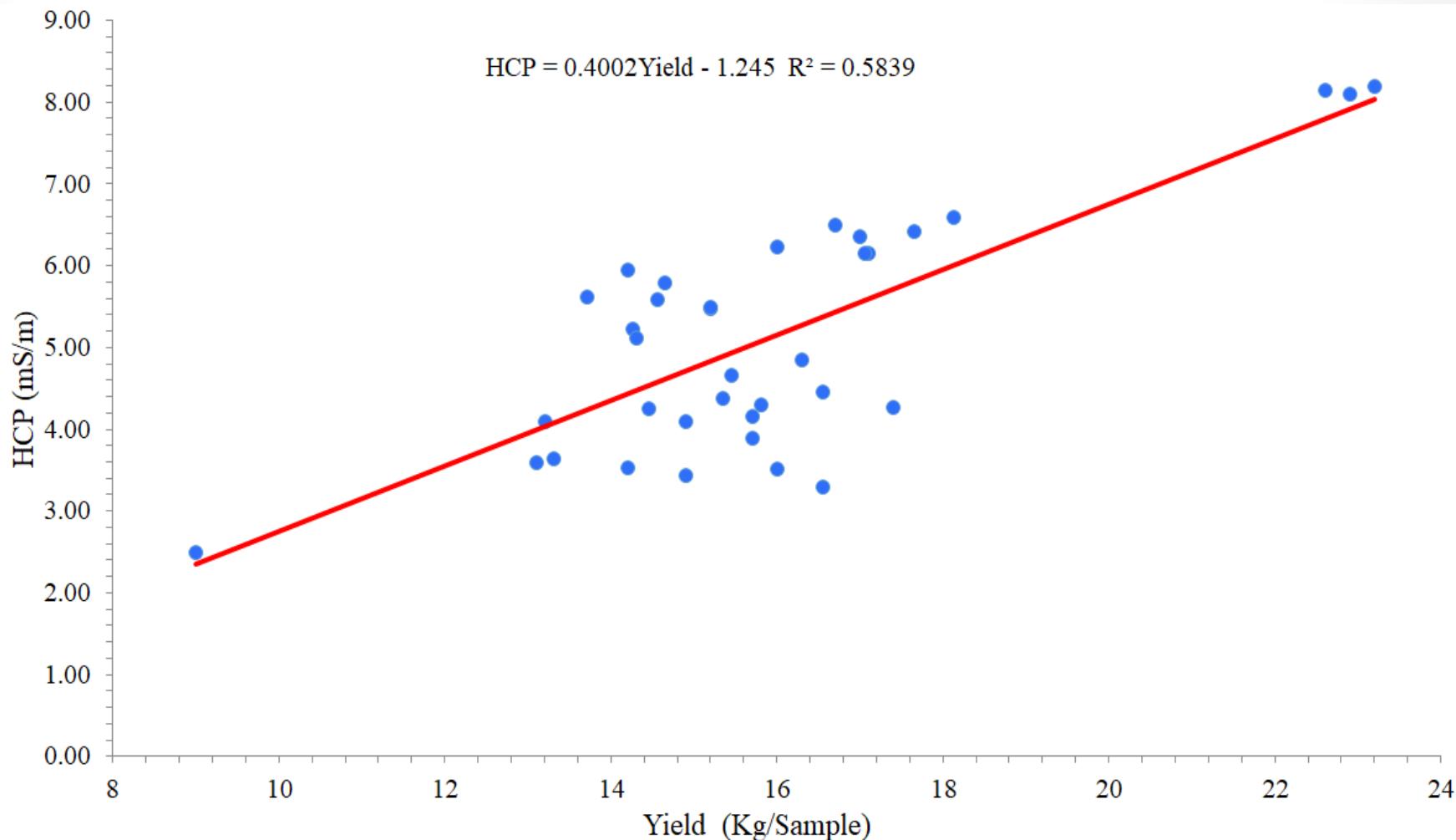
Regression Analysis - Hamilton PEI



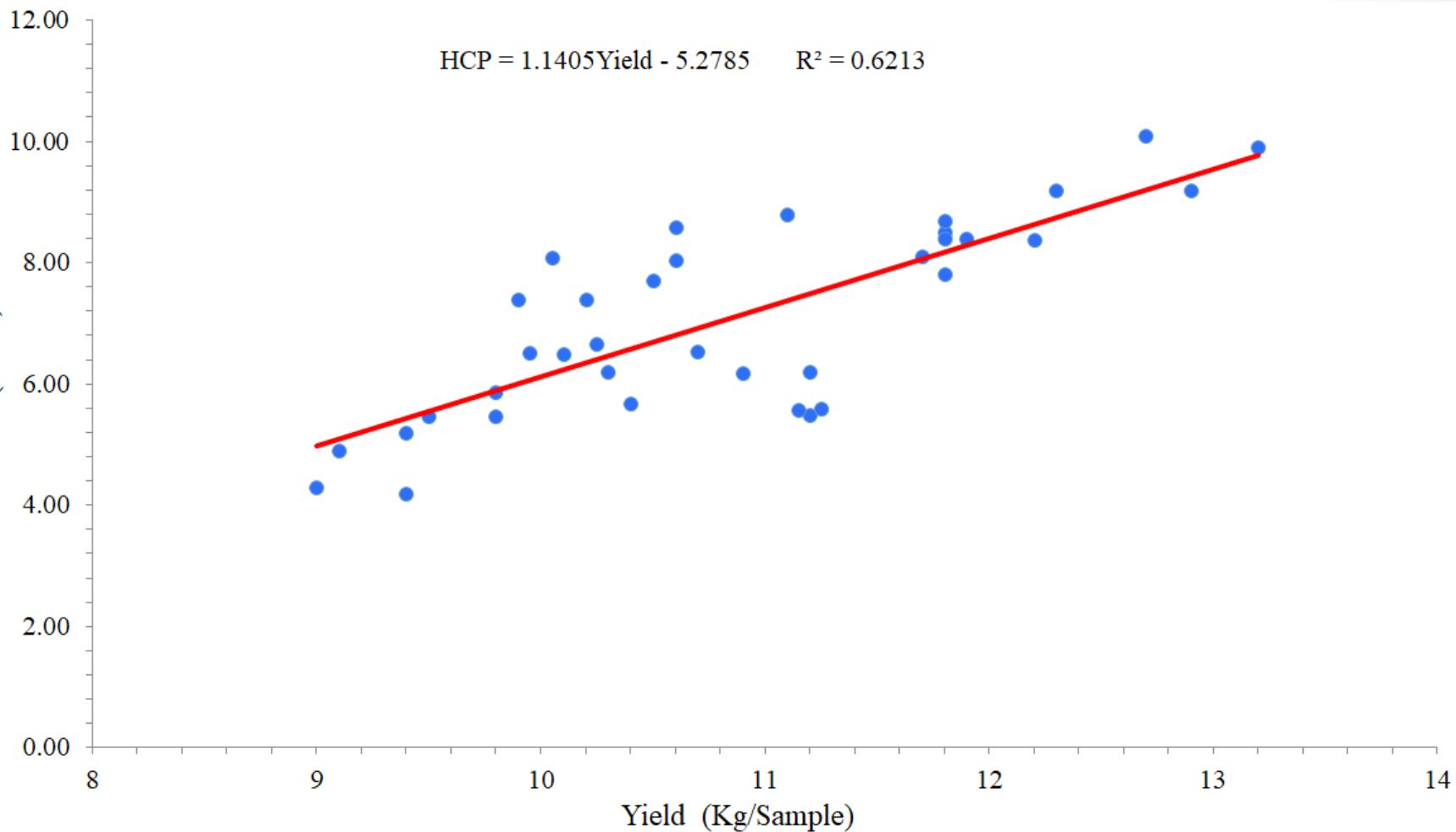
Regression Analysis - O'Leary PEI



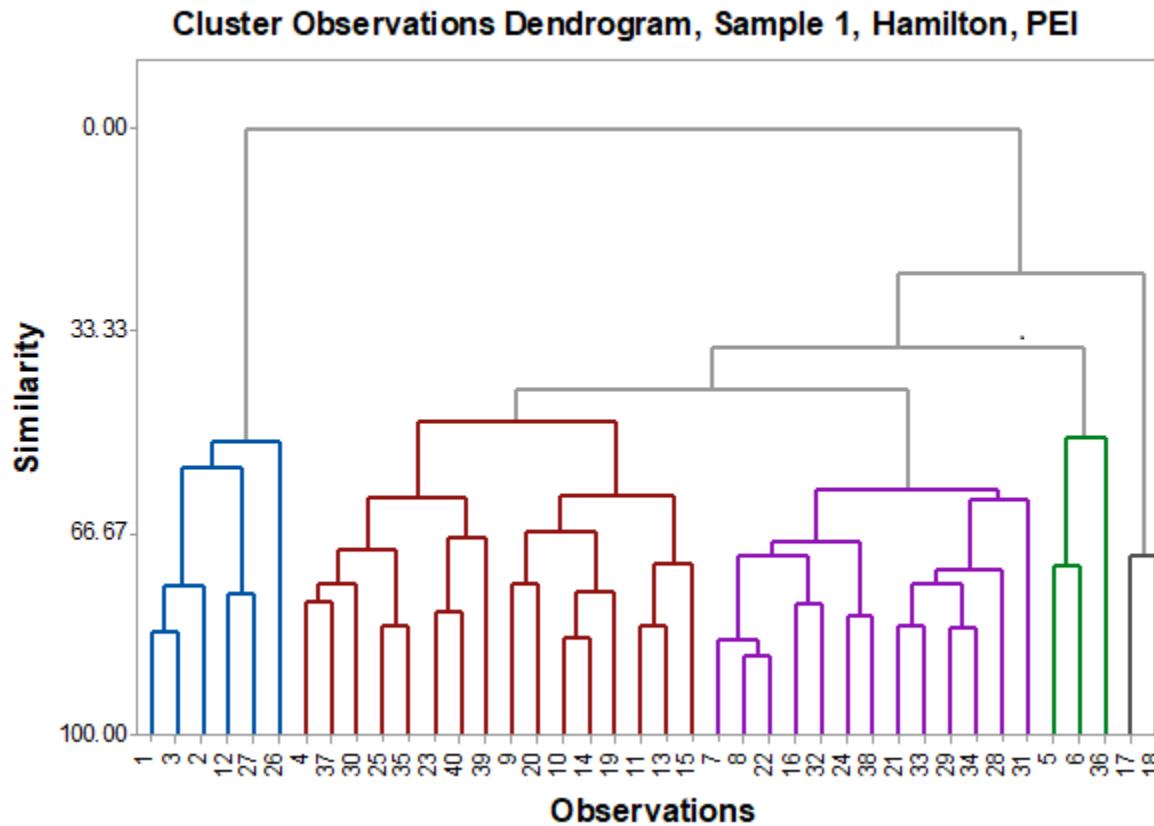
Regression Analysis - Souris PEI



Regression Analysis - Taylor Road PEI

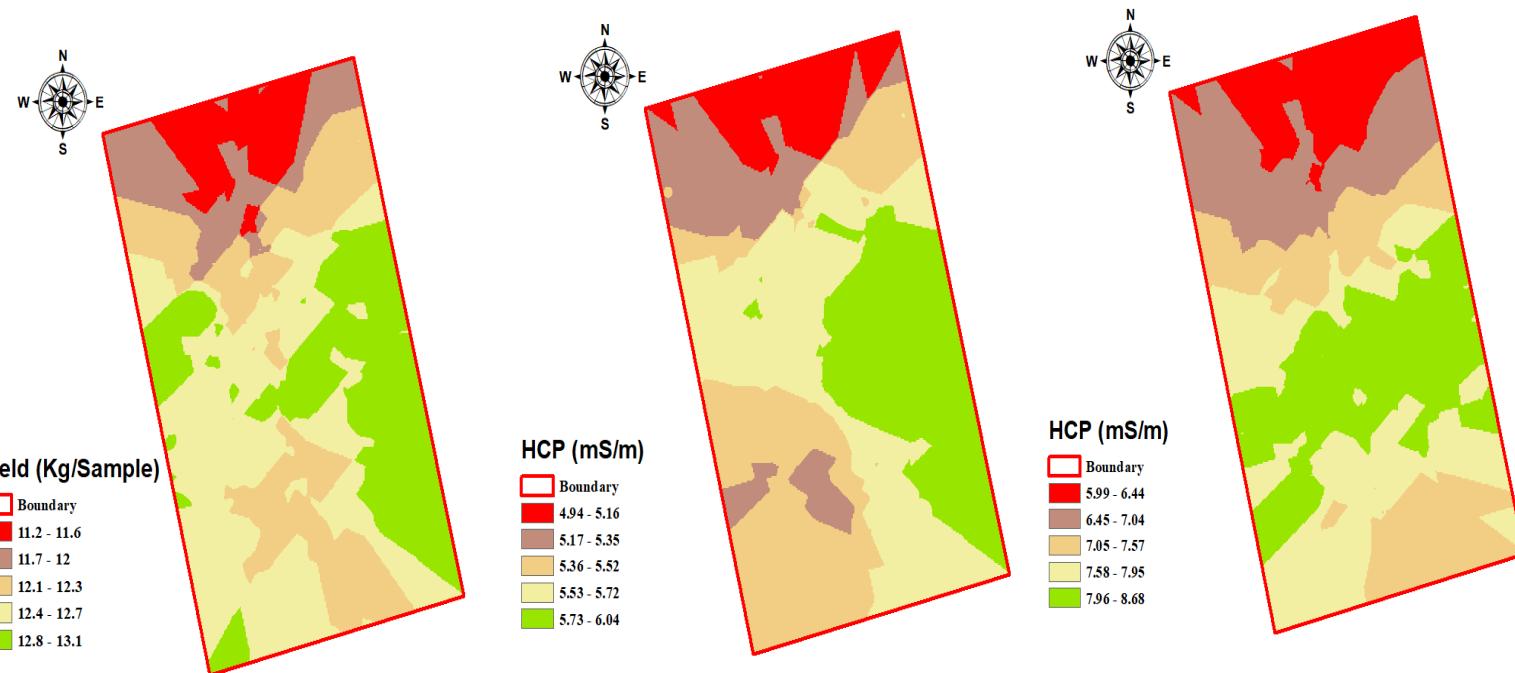


Cluster Analysis, Hamilton, PEI

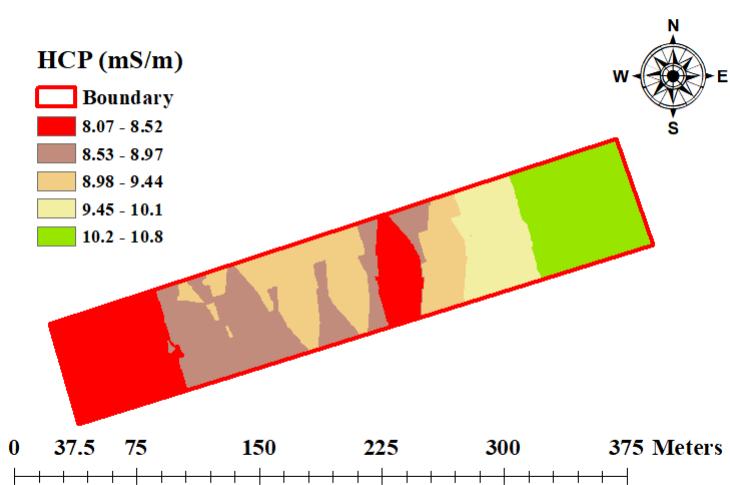
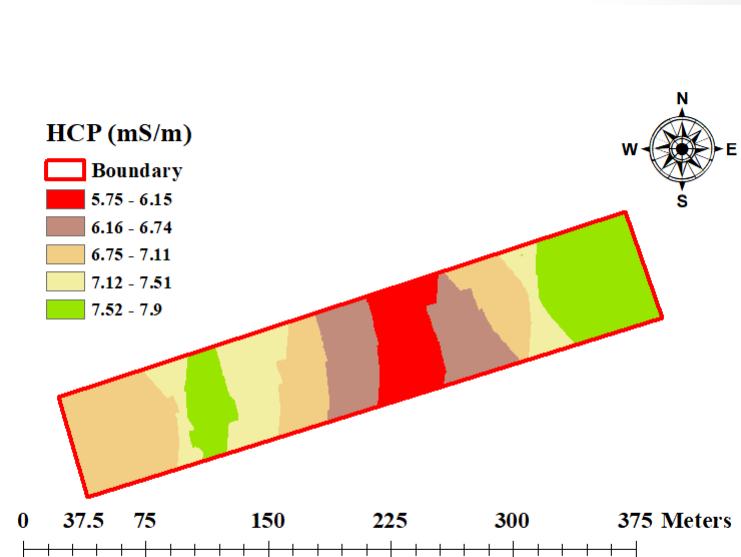
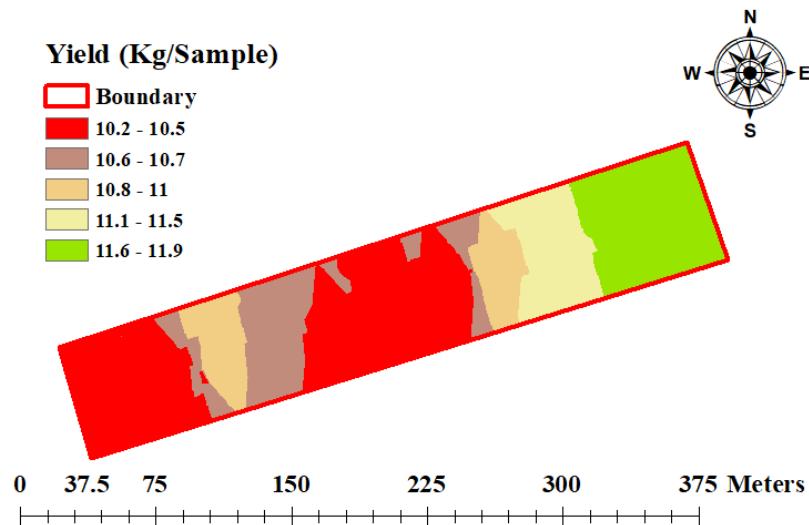


Yield (cwt/ac) Mean
Excellent: Gray 491.30
Very good: Green 437.60
Good: Purple 395.43
Poor: Red 377.81
Very poor: Blue 285.80

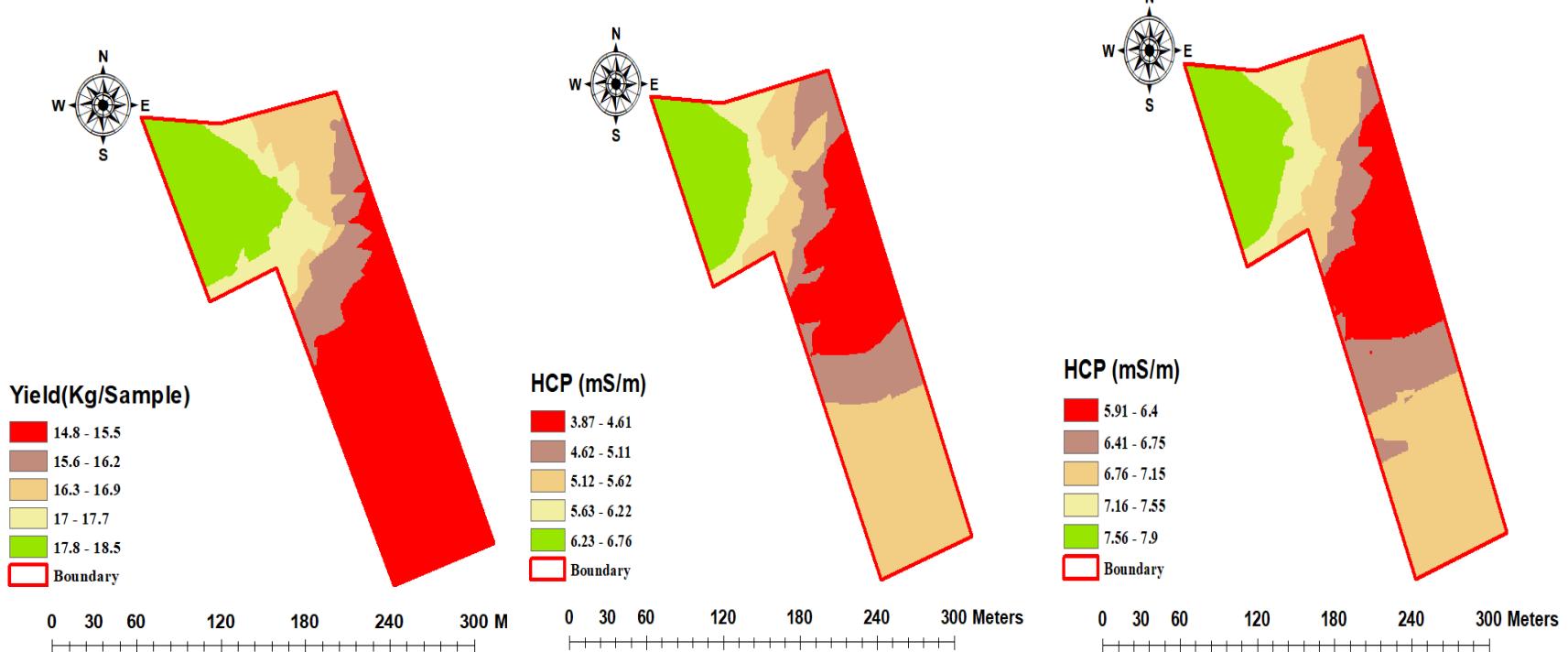
Management Zones – O’Leary, PEI



Management Zones – Tayler Road, PEI



Management Zones - Souris, PEI



Yield Comparison With thermal Imagery

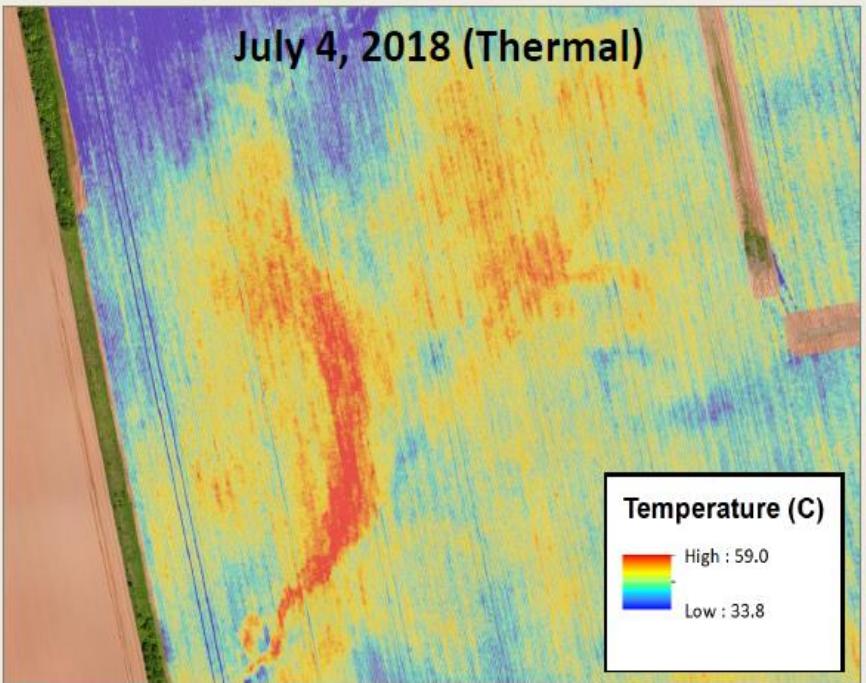
May 18, 2018 (before planting)



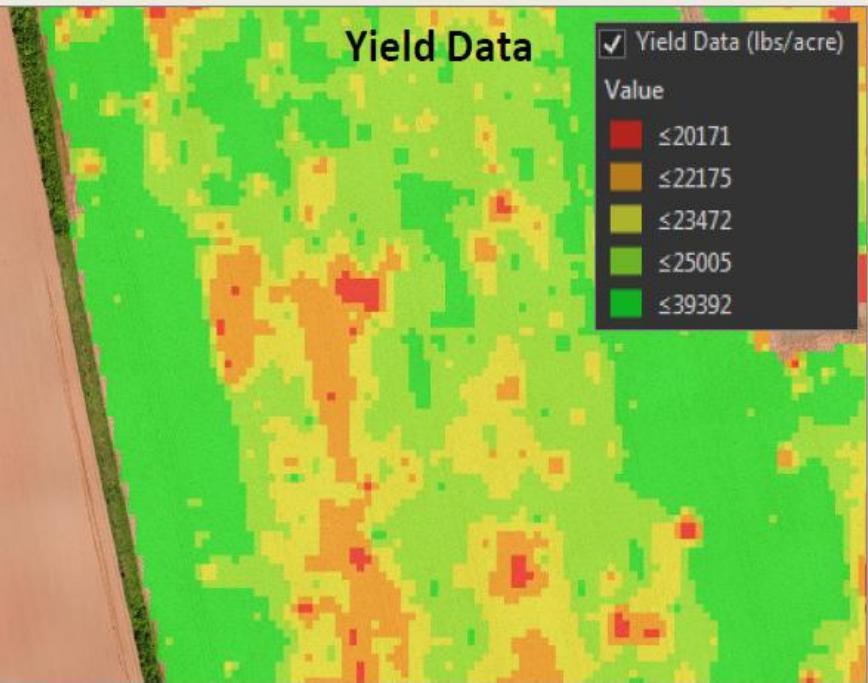
July 4, 2018 (after emergence)



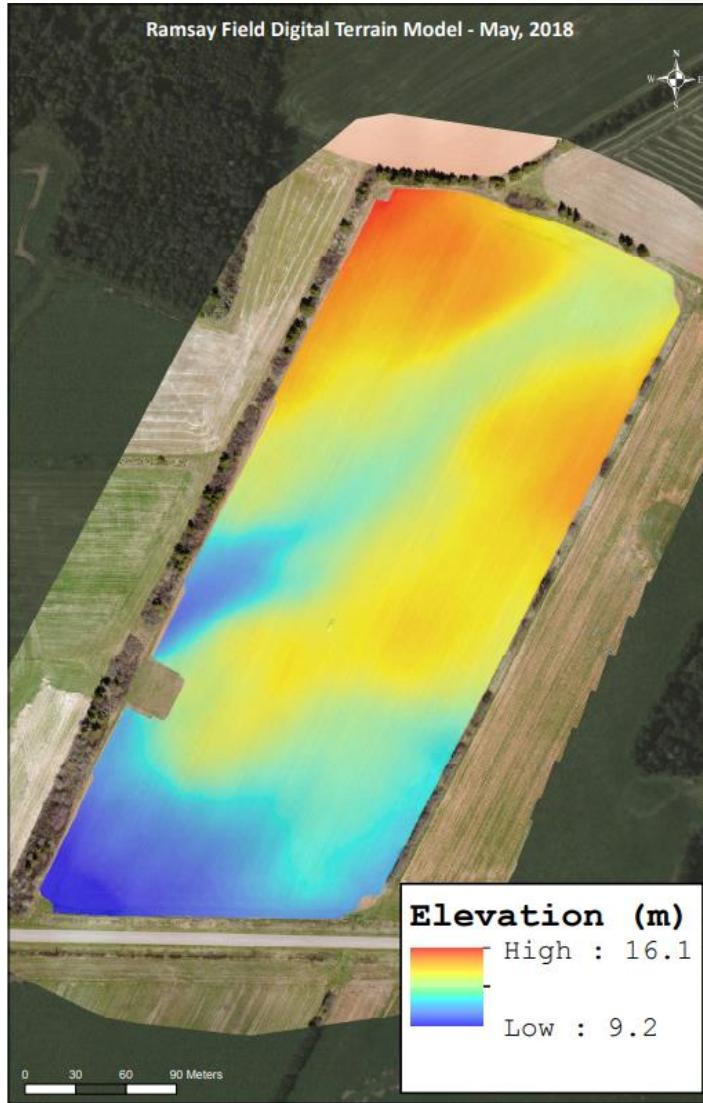
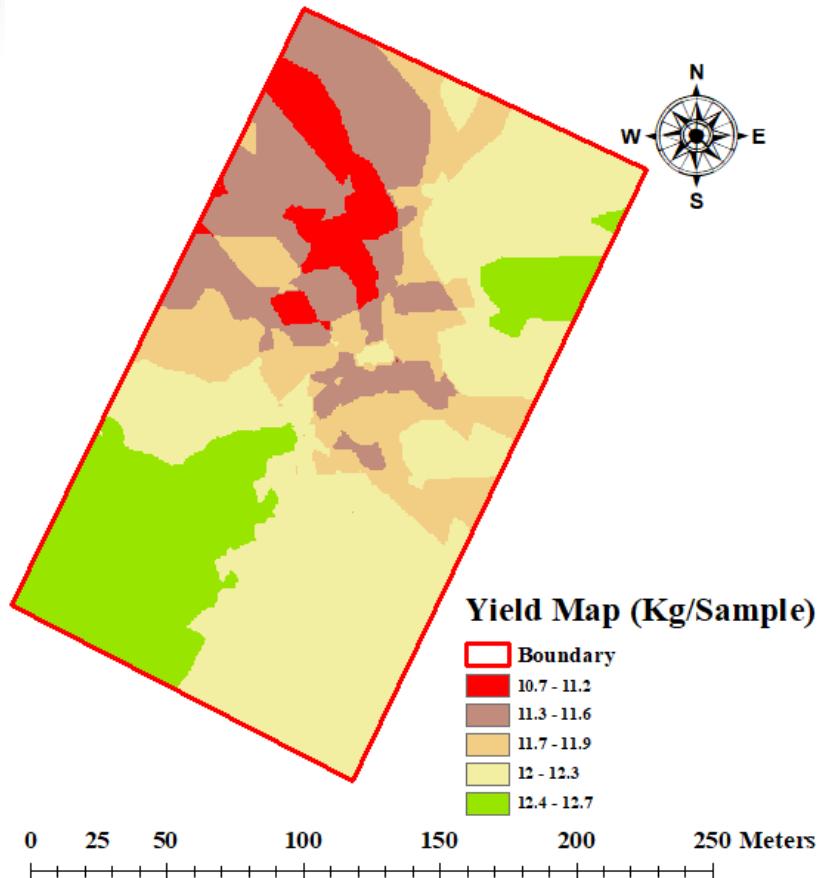
July 4, 2018 (Thermal)

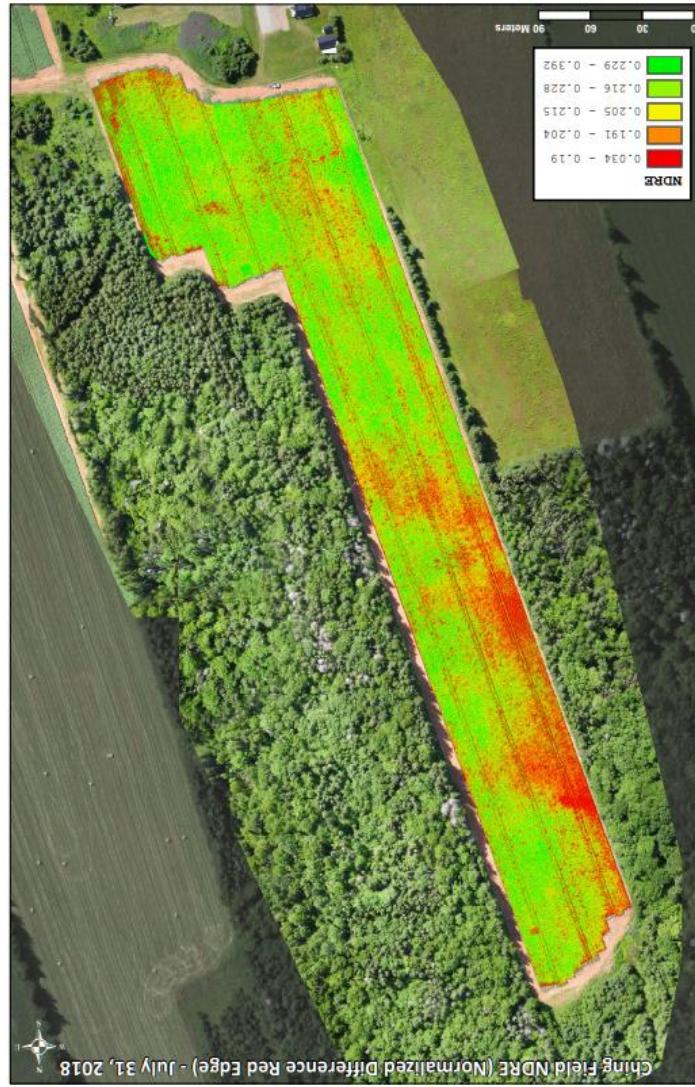
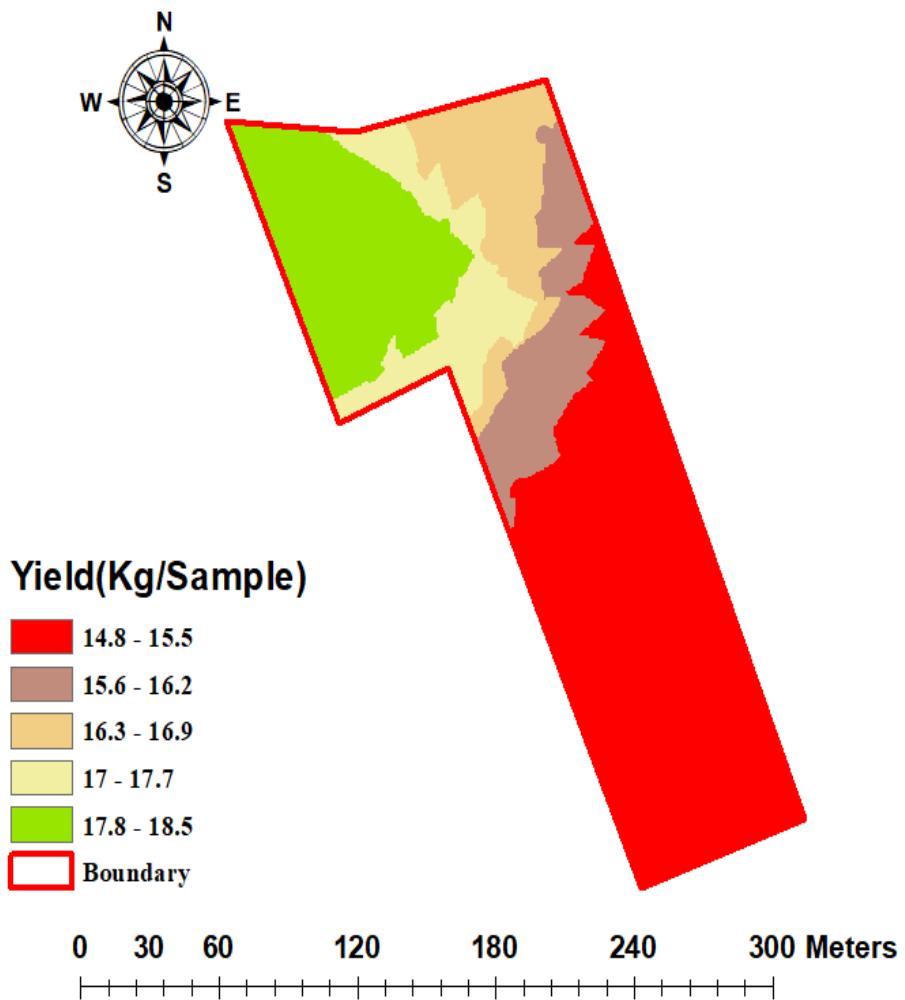


Yield Data

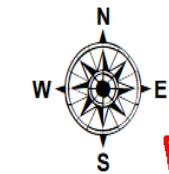


Yield Comparison With thermal Imagery, Hamilton



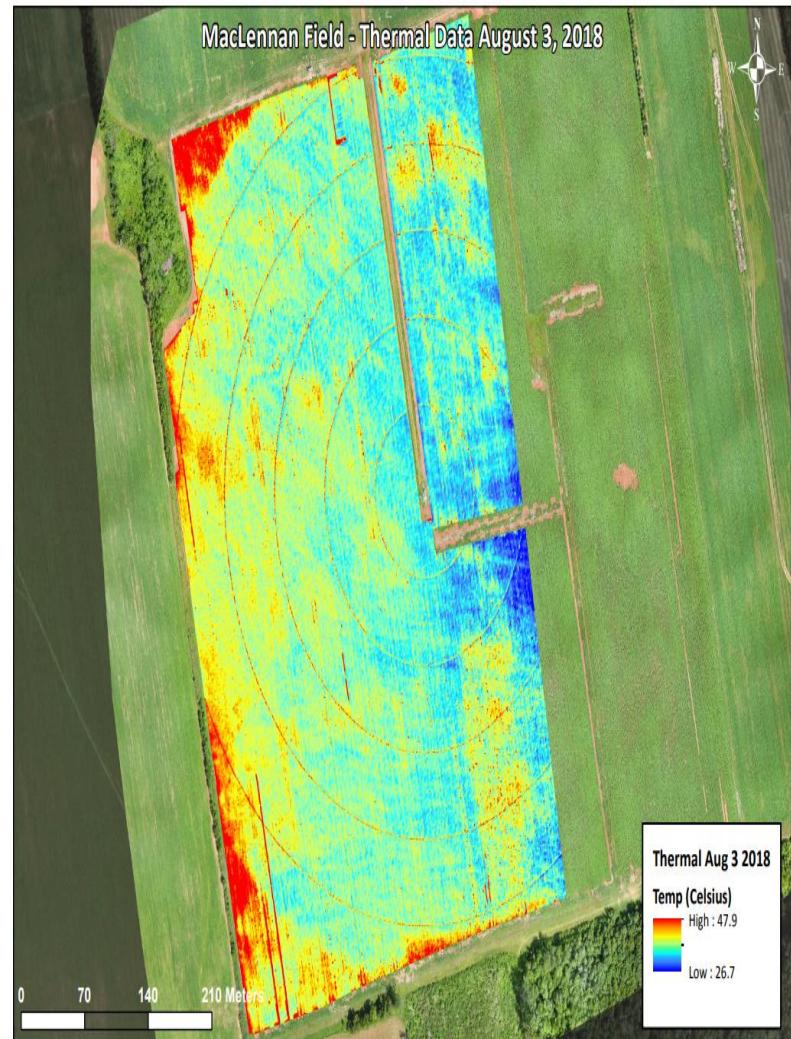


Yield Comparison With NDVI Map, Souris



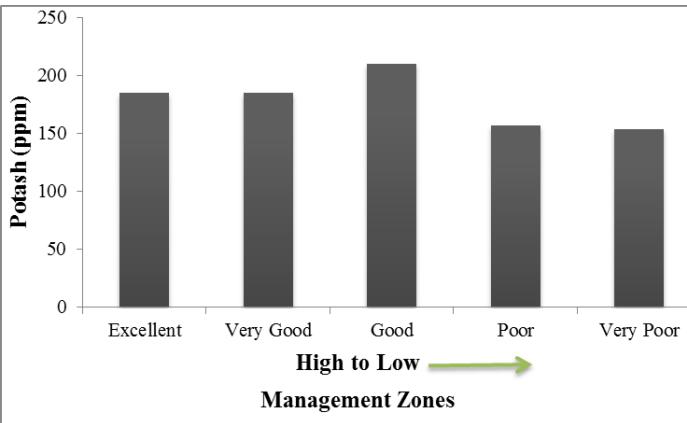
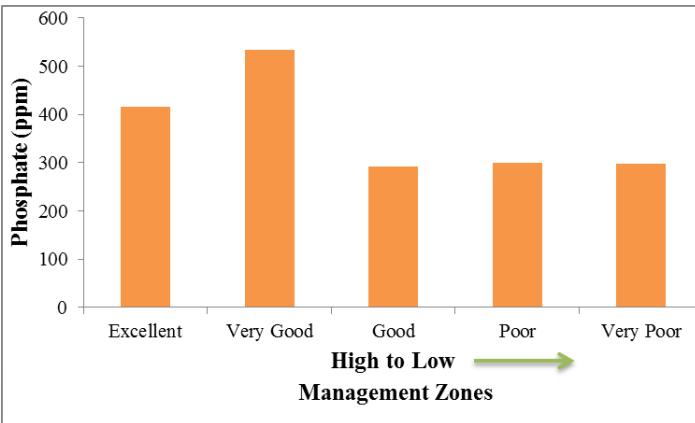
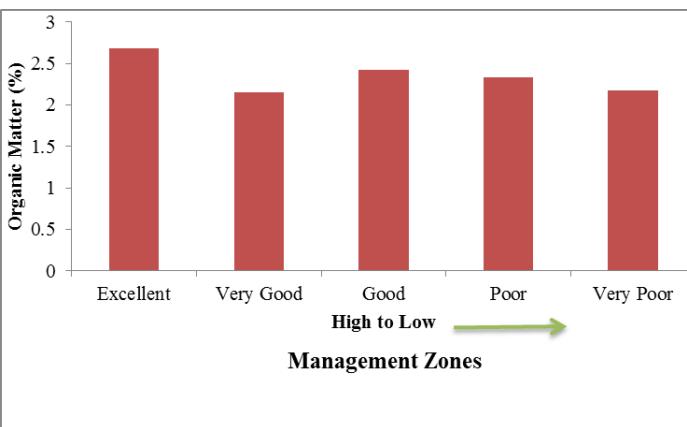
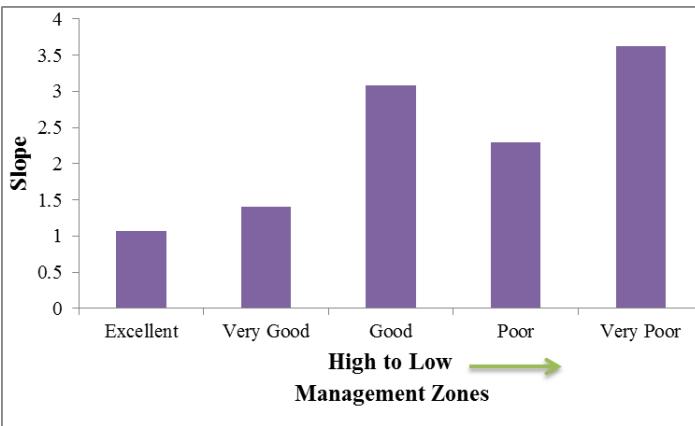
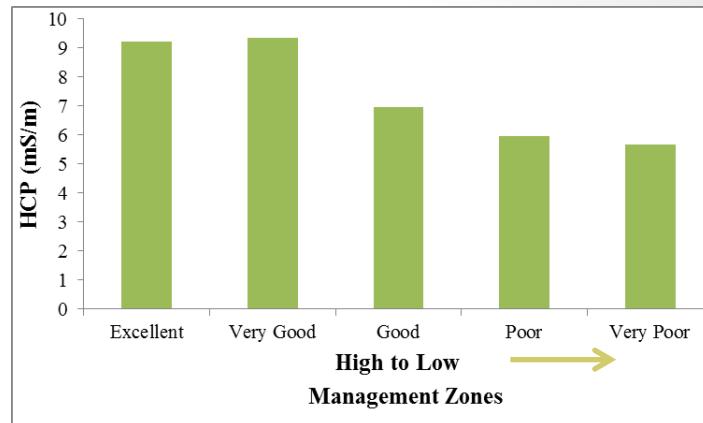
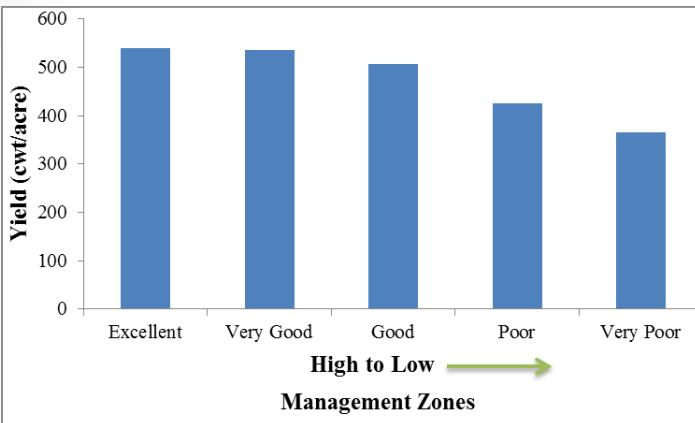
Yield (Kg/Sample)

- Boundary
- 11.2 - 11.6
- 11.7 - 12
- 12.1 - 12.3
- 12.4 - 12.7
- 12.8 - 13.1



Yield Comparison With thermal Imagery, Oleary

Zonal Analysis – Souris, PEI



Conclusions

- ❖ The CVs showed moderate to high variability
- ❖ Range of influence and geo-referenced mapping in GIS showed substantial spatial variability.
- ❖ The HCP was found to explain > 60% of variability in tuber yield within selected fields
- ❖ The DualEM showed significant potential to be used for delineation of MZs

Future Steps

- Repeat experiments (2 fields for calibrations and 2 for mapping)
- Apply nutrient based on developed MZs using map based VR spreader to evaluate the productivity benefits.
- Include fall sampling prior to potato production to examine the impact of rotation on developing MZs.
- Evaluate environmental benefits of the variable rate nutrient management based on prescription maps
- Develop user friendly protocols for farmers/industry use
- Train HQP and industry personnel

Ongoing Research Projects

- ✓ An autonomous robotic system for precision agriculture and environmental protection.
- ✓ Enhancement of Canadian potato production through precision agriculture technologies.
- ✓ SpudNik-1: A CubeSat-based high resolution imaging system for precision agriculture.
- ✓ Development of precision agriculture (PA) technologies to improve crop productivity and mitigate environmental risks: A pathway to sustainable agriculture production.
- ✓ Intelligent nutrient management practices: A pathway to environmental sustainability.
- ✓ Evaluating the water balance in Prince Edward Island: Sustainability prospective.

Ongoing Research Projects

- ✓ Development of map based variable rate technology for site-specific nutrient management in potato cropping system.
- ✓ Development of sensor based management zones to improve farm profitability and lower environmental risks in potato cropping systems.
- ✓ Delineating management zones for site-specific application of agrochemicals in potato cropping system.
- ✓ Improving wild blueberry crop productivity using precision agriculture technology.
- ✓ Development of VR sprayer for integrated weed management in soybean.
- ✓ Automation of commercial wild blueberry harvester to improve harvestable berry yield and minimize operator stress.
- ✓ Integrated harvesting technologies to improve berry recovery and quality.

Collaborators/ Funding Agencies



Black Pond Farms
Oyster Cove Farms
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NB Growers



Precision Agriculture Research Group – UPEI
Ryan Barrett
Khalil Al Mughrabi



THANK YOU FOR YOUR ATTENTION

E-mail: afarooque@upei.ca