# Variable Rate Seed Spacing in Potatoes –

# Does it pay?

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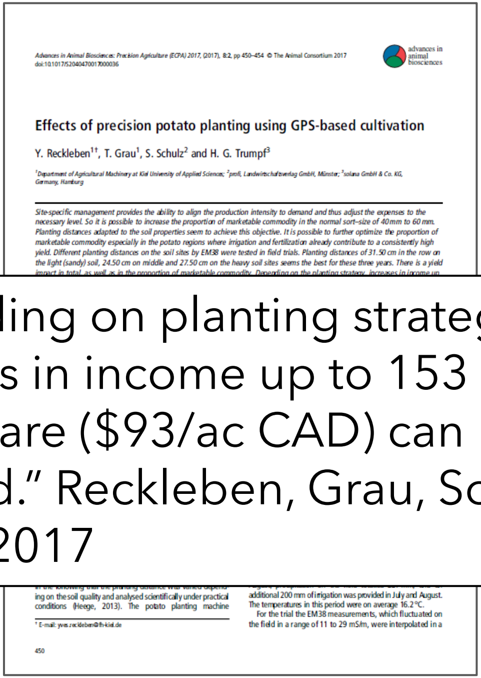
University of Prince Edward Island
Feb 13, 2023

# Why Variable Rate Planting?


We now have planting equipment that can address in field variability.

Shapefiles can be loaded onto controllers which will automatically adjust seed spacing based on defined zones within the field.

# Existing Research



Advances in Animal Biosciences: Precision Agriculture (ECPA) 2017, (2017), 8:2, pp 450–454 © The Animal Consortium 2017
doi:10.1017/S2040470017000036

advances in animal biosciences

### Effects of precision potato planting using GPS-based cultivation

Y. Reckleben[1†], T. Grau[1], S. Schulz[2] and H. G. Trumpf[3]

[1]Department of Agricultural Machinery at Kiel University of Applied Sciences; [2]profi, Landwirtschaftsverlag GmbH, Münster; [3]solana GmbH & Co. KG, Germany, Hamburg

*Site-specific management provides the ability to align the production intensity to demand and thus adjust the expenses to the necessary level. So it is possible to increase the proportion of marketable commodity in the normal sort–size of 40 mm to 60 mm. Planting distances adapted to the soil properties seem to achieve this objective. It is possible to further optimize the proportion of marketable commodity especially in the potato regions where irrigation and fertilization already contribute to a consistently high yield. Different planting distances on the soil sites by EM38 were tested in field trials. Planting distances of 31.50 cm in the row on the light (sandy) soil, 24.50 cm on middle and 27.50 cm on the heavy soil sites seems the best for these three years. There is a yield*

ing on the soil quality and analysed scientifically under practical conditions (Heege, 2013). The potato planting machine

additional 200 mm of irrigation was provided in July and August. The temperatures in this period were on average 16.2 °C.

For the trial the EM38 measurements, which fluctuated on the field in a range of 11 to 29 mS/m, were interpolated in a

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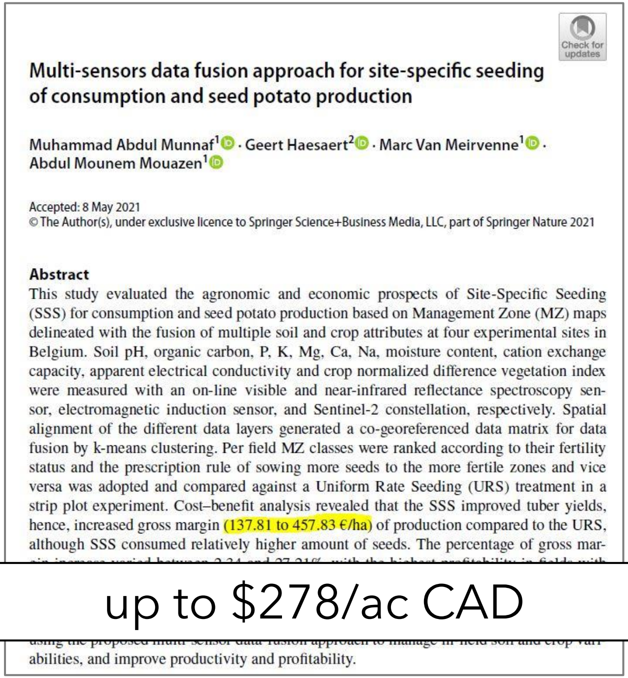
"depending on planting strategy, increases in income up to 153 euros per hectare ($93/ac CAD) can be obtained." Reckleben, Grau, Schulz & Trumpf 2017



Check for updates

### Multi-sensors data fusion approach for site-specific seeding of consumption and seed potato production

Muhammad Abdul Munnaf[1] · Geert Haesaert[2] · Marc Van Meirvenne[1] · Abdul Mounem Mouazen[1]

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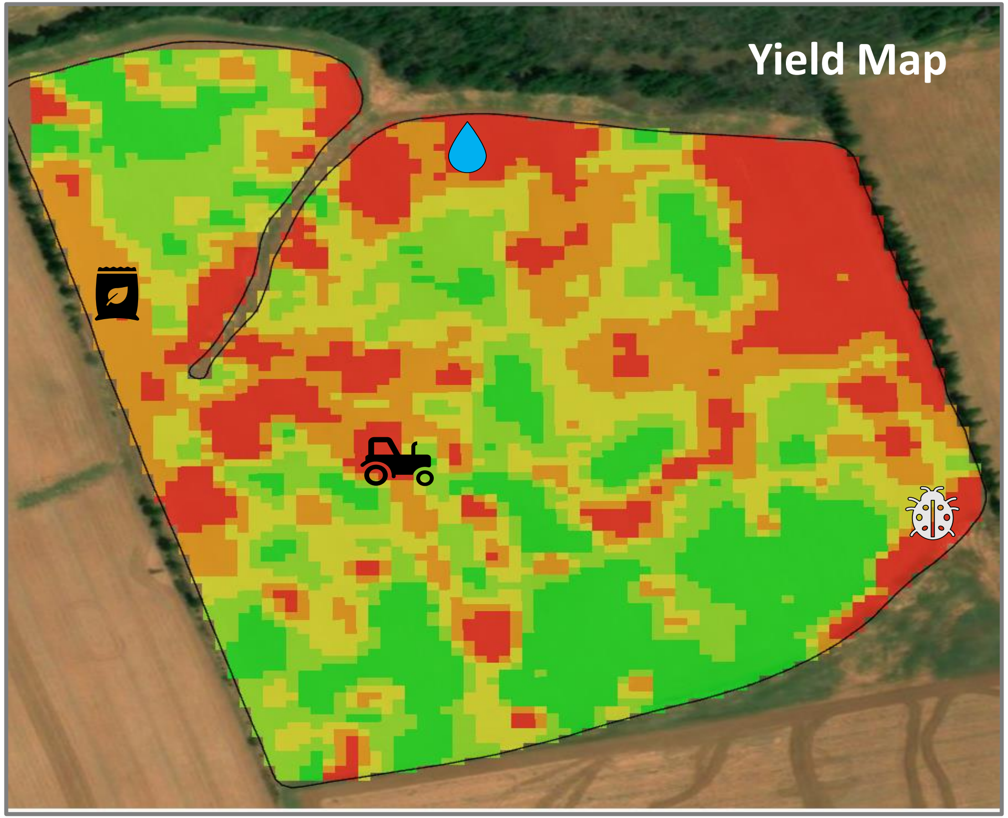
**Abstract**
This study evaluated the agronomic and economic prospects of Site-Specific Seeding (SSS) for consumption and seed potato production based on Management Zone (MZ) maps delineated with the fusion of multiple soil and crop attributes at four experimental sites in Belgium. Soil pH, organic carbon, P, K, Mg, Ca, Na, moisture content, cation exchange capacity, apparent electrical conductivity and crop normalized difference vegetation index were measured with an on-line visible and near-infrared reflectance spectroscopy sensor, electromagnetic induction sensor, and Sentinel-2 constellation, respectively. Spatial alignment of the different data layers generated a co-georeferenced data matrix for data fusion by k-means clustering. Per field MZ classes were ranked according to their fertility status and the prescription rule of sowing more seeds to the more fertile zones and vice versa was adopted and compared against a Uniform Rate Seeding (URS) treatment in a strip plot experiment. Cost–benefit analysis revealed that the SSS improved tuber yields, hence, increased gross margin (137.81 to 457.83 €/ha) of production compared to the URS, although SSS consumed relatively higher amount of seeds. The percentage of gross mar-

abilities, and improve productivity and profitability.

up to $278/ac CAD

# How to determine "Zones" for VR planting?




Yield maps?

They provide a report card at the end of the season and can help a farmer understand which areas of the field performed best that particular year. But yield maps are dynamic and change from year to year since they are influenced by many different factors


What influences within-field yield variability in PEI?

Published: 18 February 2021

# Soil Factors Related to within-Field Yield Variation in Commercial Potato Fields in Prince Edward Island Canada

Bernie J. Zebarth, Sherry Fillmore, Steve Watts, Ryan Barrett & Louis-Pierre Comeau

American Journal of Potato Research 98, 139–148 (2021) | Cite this article



## Abstract

Stagnating potato tuber yields in Prince Edward Island (PEI) are a major economic concern.

soil texture. Under the rainfed potato production on sandy-loam soils in PEI, finer soil texture is likely related to increased yield through its effect on improved soil water holding capacity.

measures of soil physical and chemical properties and soil pathogens were measured. Principal component analysis identified three principal components (PCs) which accounted for 85.6% of the total variation. The PC1 (reflecting 42.3% of the total variance) was associated primarily with soil texture (i.e., sand, clay) and parameters which were highly correlated with soil texture. Under the rainfed potato production on sandy-loam soils in PEI, finer soil texture is likely related to increased yield through its effect on improved soil water holding capacity. The PC2 (reflecting 29.0% of the total variance) was primarily associated with soil fertility and the PC3 (reflecting 14.4% of the total variance) was associated primarily with soil organic matter quality and soil structure. Although soil pathogens were measured at levels high enough to impact yield, they did not differ significantly between high and low yield locations. The findings of this study highlight the value in using multivariate approaches to overcome the challenges in identifying factors which control within-field yield variability.

# Forecasting potato tuber yield using a soil electromagnetic induction method

Aitazaz A. Farooque, Mahnaz Zare, Farhat Abbas, Melanie Bos, Travis Esau, Qamar Zaman

First published: 05 December 2019 | https://doi.org/10.1111/ejss.12923 | Citations: 8

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## Abstract

Timely forecasting of crop yield is vital for precision agriculture management practices. This study used on-the-go proximal soil sensing using electromagnetic induction (EMI)

mapping/prediction accuracy. Results showed that ECa correlated well ($R^2$ = 0.81–0.90) with a 1:5 soil-to-water ratio solution's electrical conductivity (EC1:5). The actual tuber yield, which moderately varied (CV = 18.9–27.5%) across the fields and significantly correlated with ECa, explained more than 55% of the yield variability ($R^2$ = 0.57–0.66). Tl

forecasted tuber yield calculated from cubic regression models of the actual tuber yield versus ECa was non-significantly different from the actual tuber yield (RMSE = 12.2–18.3%; $R^2$ = 0.57–0.66). Interpolated maps of the predicted and the actual yields, and their correlation analyses, showed similar trends of variations within the study fields (*r* = 0.69–0.80). The higher values of cation exchange capacity, calcium, phosphate, potash, organic matter and soil moisture content in the New Brunswick soils compared to the Prince Edward Island soils resulted in an overestimation of the predicted tuber yield than the actual yield at the lower ECa values, and an underestimation of the predicted tuber yield at higher ECa values for New Brunswick. The results revealed that the province-based calibrations produced more accurate predictions when compared with the single calibration by combining all of the data from New Brunswick and Prince Edward Island. The non-destructive prediction of potato tuber yield can enable the development of precision agricultural techniques and management practices for yield forecasting, in addition to making informed decisions for enhanced potato productivity.

### *3.1. Potato yield variability*

Visual observations during harvest indicated substantial reductions in yield on the highly eroded sections of the field. Along with the reduced yields, highly eroded areas appeared to have smaller tubers and a higher population of stones.

Relating potato yield to the level of soil degradation using a bulk yield monitor and

residue management having the higher value. It could be interpreted that improved management on the entire field after years of degradation may result in better overall yields but the area with higher LS may never again be as productive as the remainder of the field. It must be remembered that this field has undergone a

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# Precision Agriculture in Potato Production

A. N. Cambouris · B. J. Zebarth · N. Ziadi · I. Perron

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Published online: 25 December 2014

rate of application of P and K based on the kriged maps of P and K and local fertilization recommendations (CPVQ 1996). In one year out of three, VRA of P and K significantly increased the total and marketable tuber yield compared with the uniform application of P and K (Fig. 3a). However, the effect of soil series on tuber yield was more significant and more consistent over growing seasons than the effect of application treatment (Fig. 3b). The lessons learned from this experiment were as

≤1:10,000), soil property data, or ideally, apparent soil electrical conductivity, was more effective than VRA at managing variability and enhancing potato productivity and profitability while reducing the environmental impacts of agricultural practices.

**Keywords** Management zone · Proximal sensors · Soil electrical conductivity · Variable rate application

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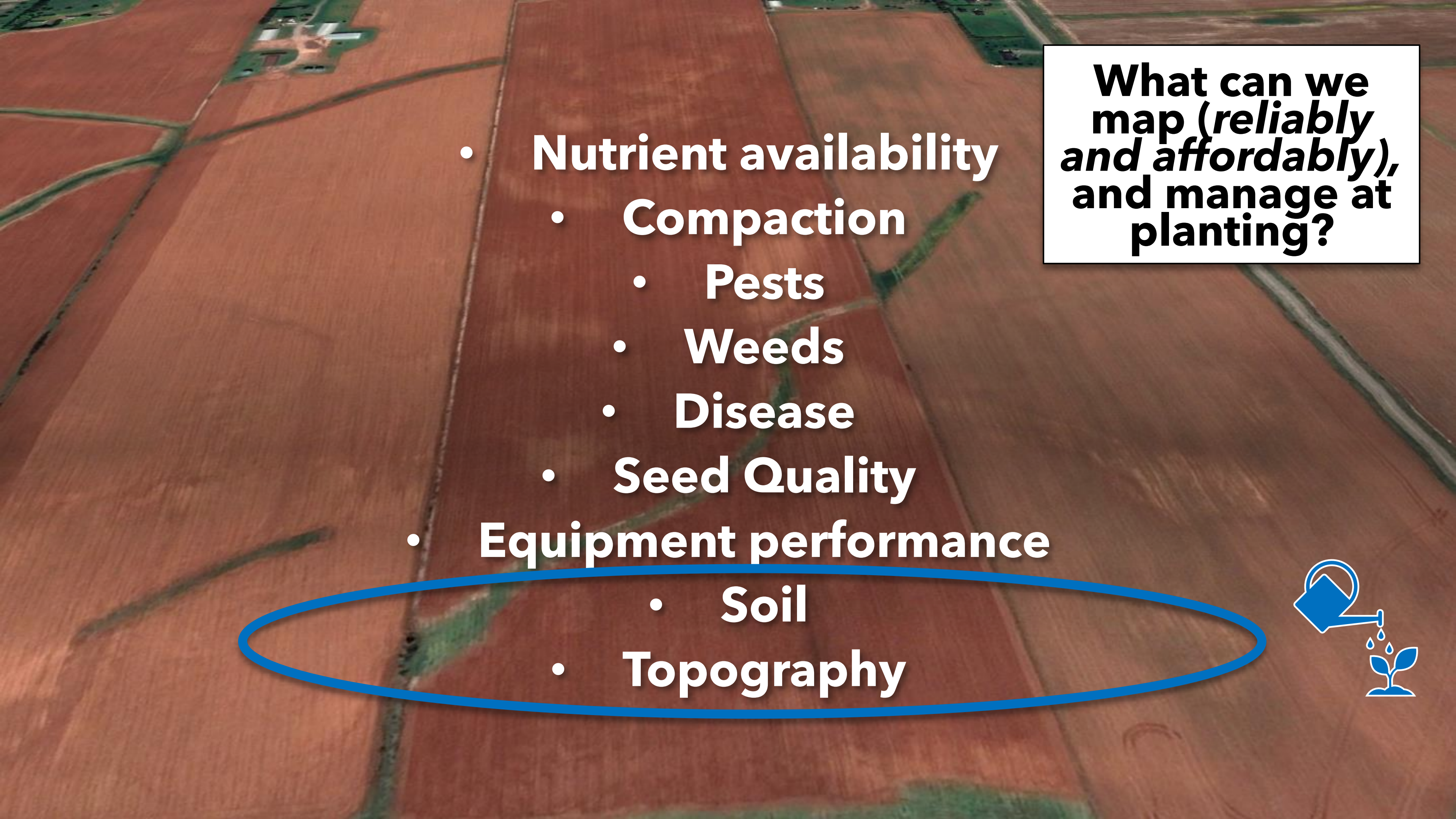
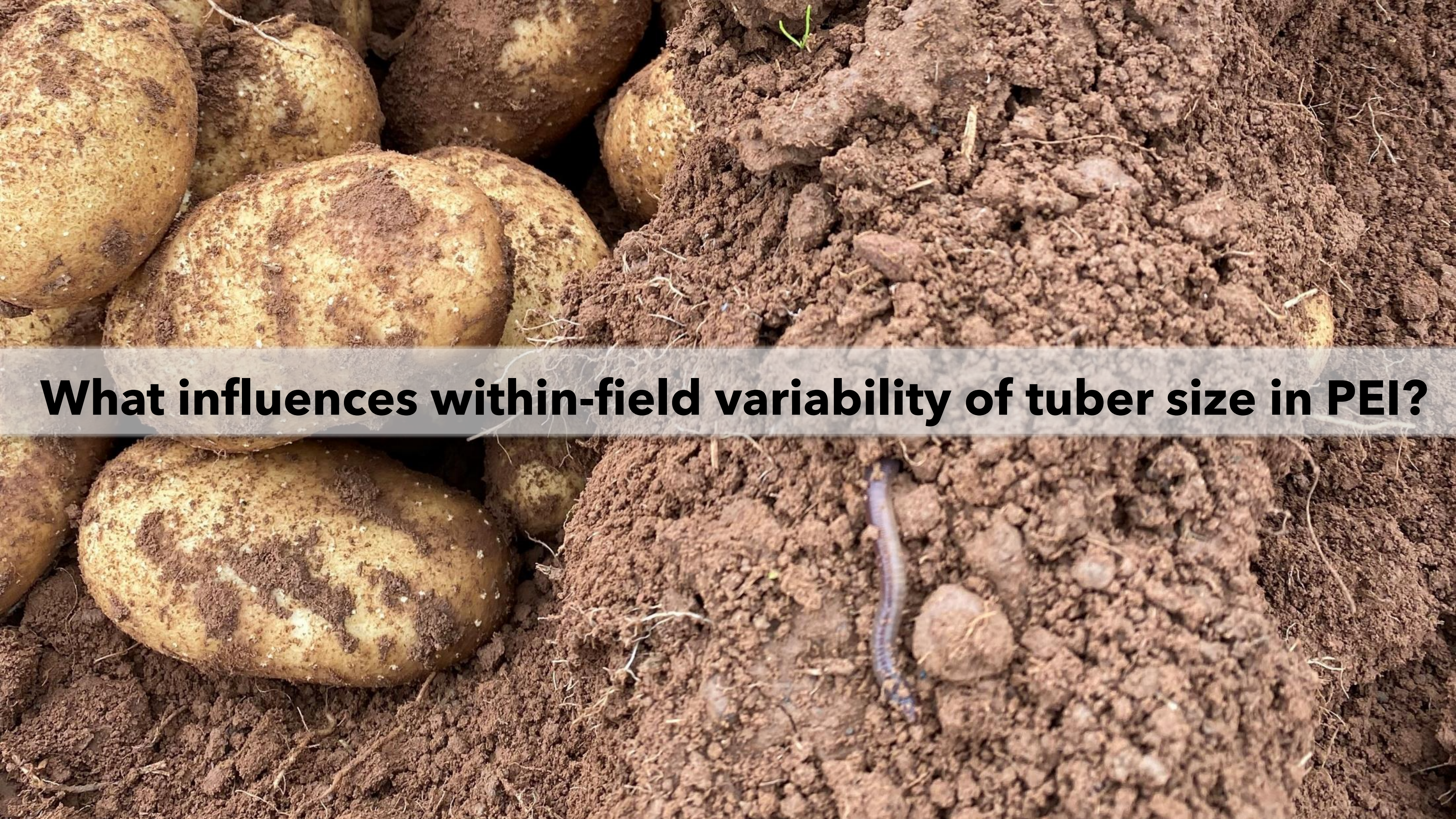
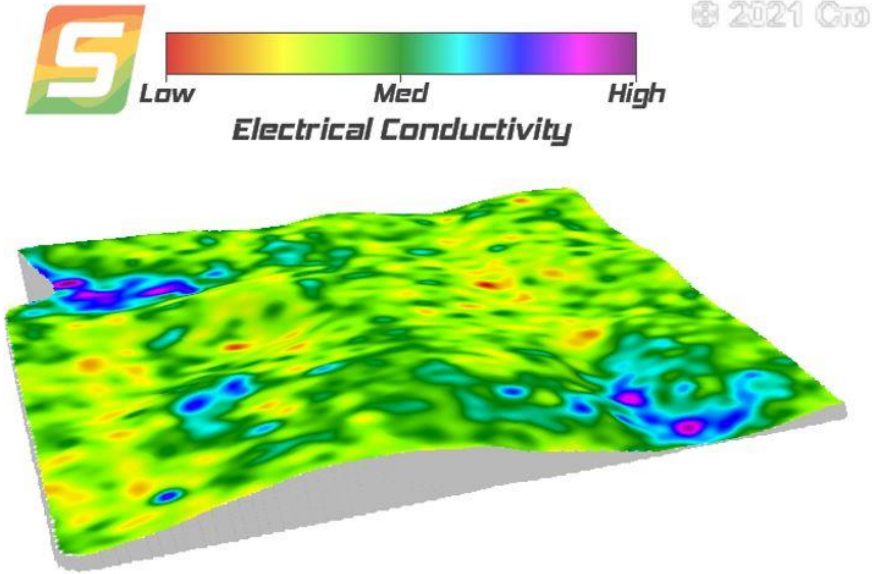
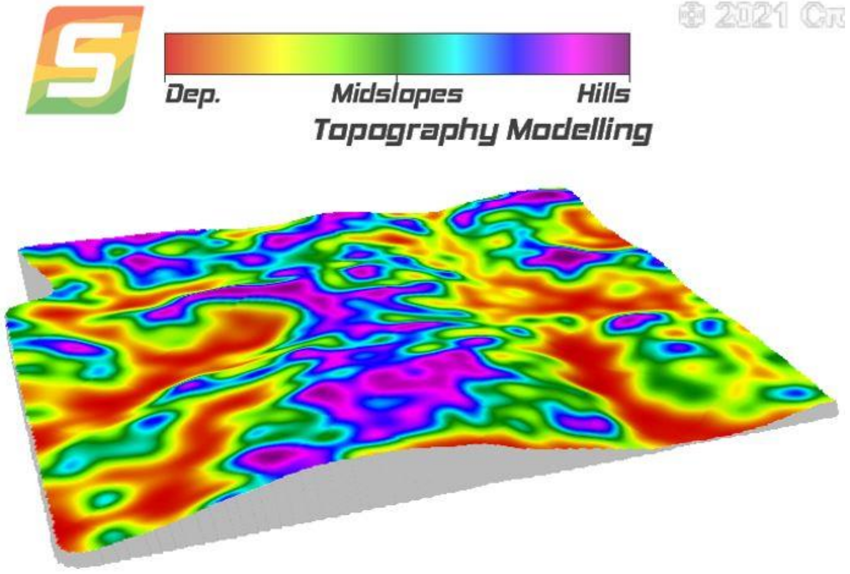

What can we map (*reliably and affordably*), and manage at planting?
• Nutrient availability
• Compaction
• Pests
• Weeds
• Disease
• Seed Quality
• Equipment performance
• Soil
• Topography


What influences within-field variability of tuber size in PEI?

- Seed size
- Seed spacing
- Physiological age
- Nutrient availability

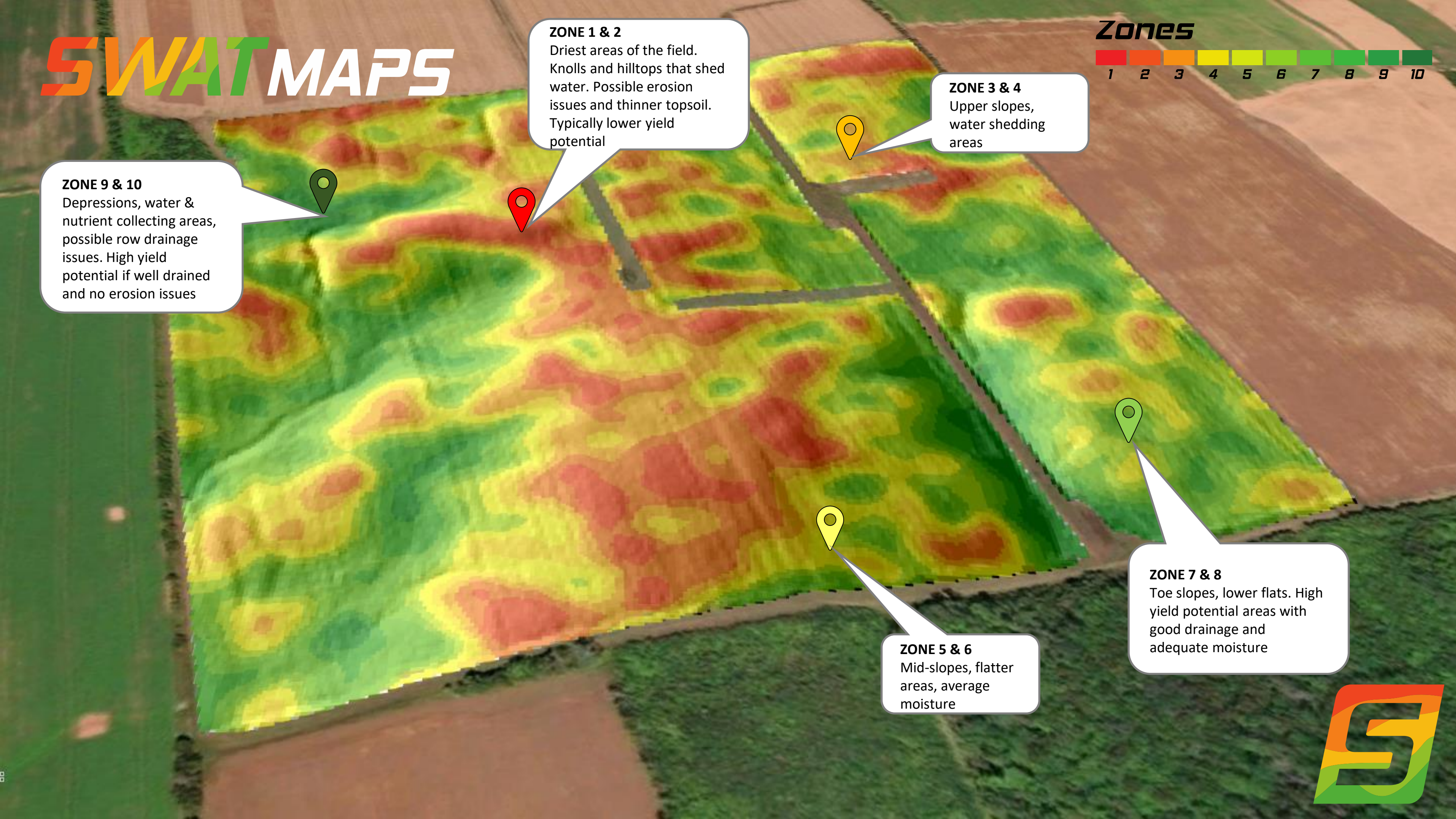
- Soil types?
- Topography?



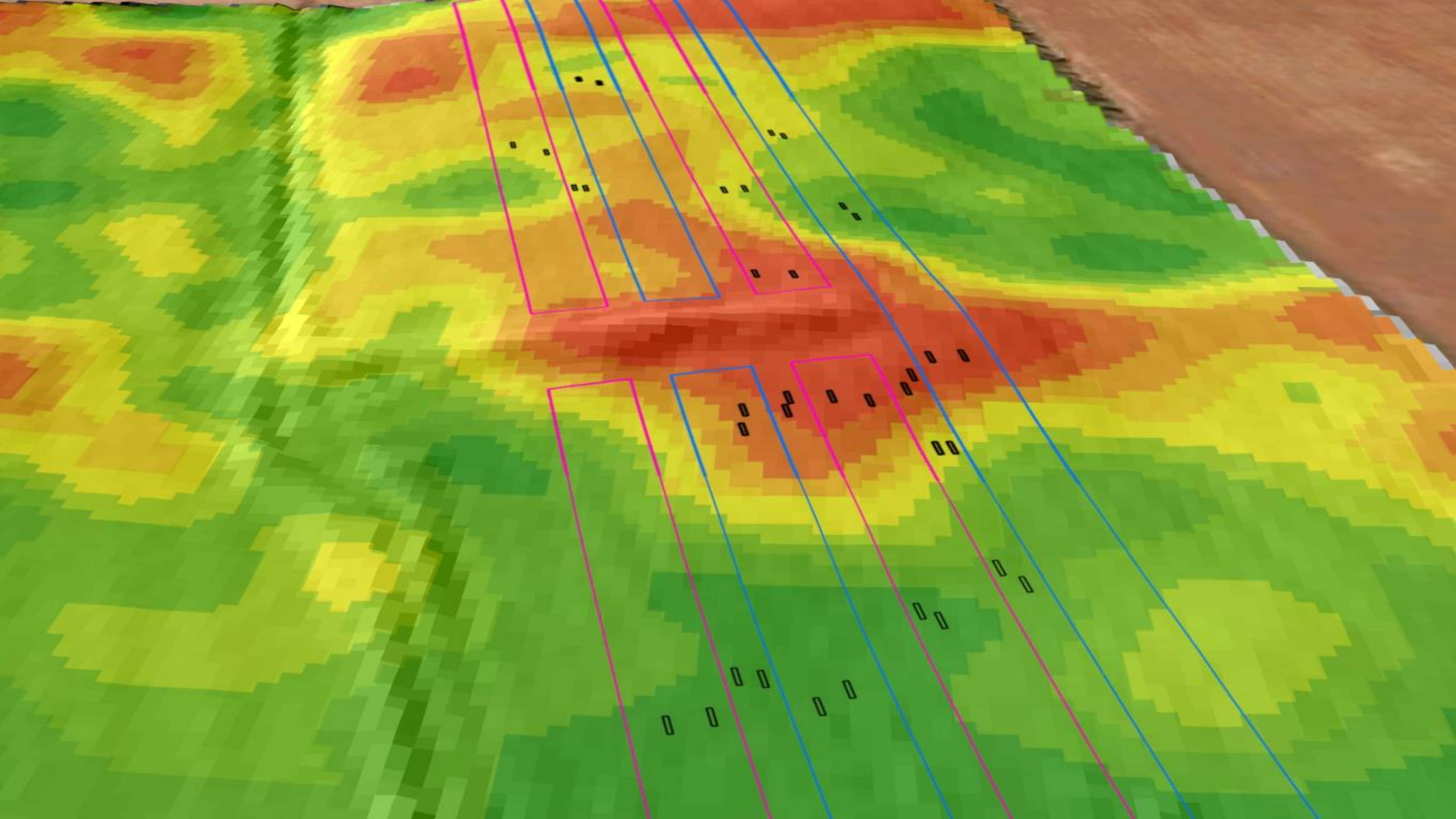




# SWATMAPS

**Soil, Water, and Topography Maps**


SWAT MAPS
Zones
1 2 3 4 5 6 7 8 9 10
ZONE 1 & 2
Driest areas of the field. Knolls and hilltops that shed water. Possible erosion issues and thinner topsoil. Typically lower yield potential
ZONE 3 & 4
Upper slopes, water shedding areas
ZONE 9 & 10
Depressions, water & nutrient collecting areas, possible row drainage issues. High yield potential if well drained and no erosion issues
ZONE 5 & 6
Mid-slopes, flatter areas, average moisture
ZONE 7 & 8
Toe slopes, lower flats. High yield potential areas with good drainage and adequate moisture

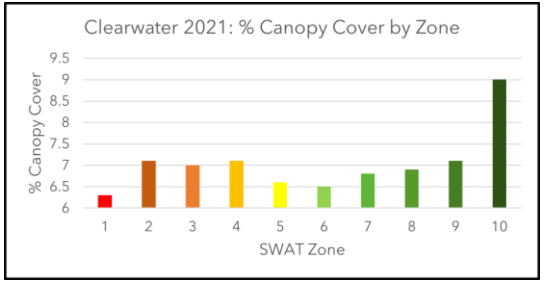

Zone 1
Zone 7
Zone 10

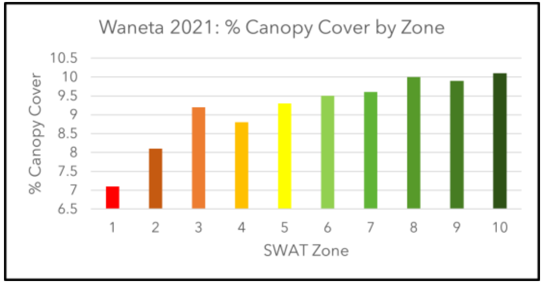


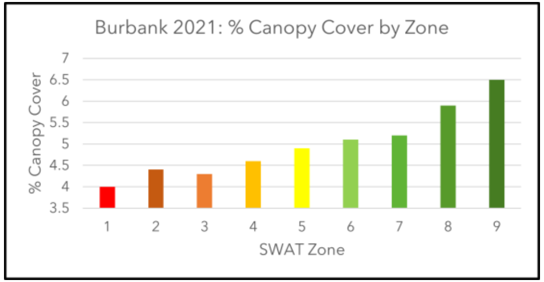
| Site 1: Springfield West, PE Planter Accuracy Assessment | | | |
|---|---|---|---|
| **Spacing Treatment (n)** | **Target Spacing (cm)** | **Measured Spacing (cm)** | **Difference** |
| Tighter (28,908) | 30.5 | 31.8 | -4.0% |
| GSP (41,568) | 35.6 | 35.1 | 1.0% |
| Wider (21,945) | 40.6 | 38.6 | 4.9% |

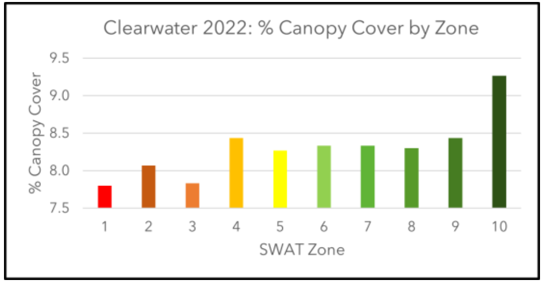
| Site 2: Tryon, PE Planter Accuracy Assessment | | | |
|---|---|---|---|
| **Spacing Treatment (n)** | **Target Spacing (cm)** | **Measured Spacing (cm)** | **Difference** |
| Tighter (42,529) | 19 | 22.5 | -15.6% |
| GSP (111,074) | 22.9 | 23.3 | -1.7% |
| Wider (32,800) | 26.7 | 25.2 | 6.0% |

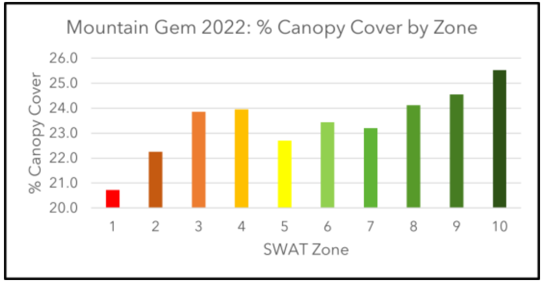
| Site 3: Red Point, PE Planter Accuracy Assessment | | | |
|---|---|---|---|
| **Spacing Treatment (n)** | **Target Spacing (cm)** | **Measured Spacing (cm)** | **Difference** |
| Tighter (35,003) | 35.6 | 34.5 | 3.1% |
| GSP (191,750) | 40.6 | 39.9 | 1.7% |
| Wider (26,538) | 45.7 | 45.2 | 1.1% |

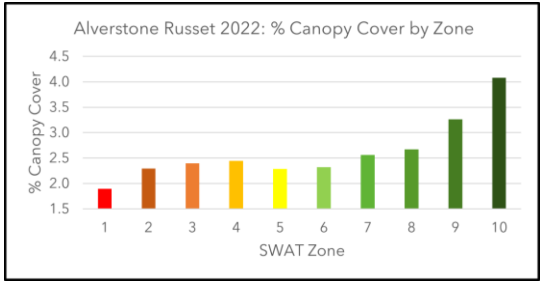

Clearwater 2021: % Canopy Cover by Zone
% Canopy Cover
9.5
9
8.5
8
7.5
7
6.5
6
1 2 3 4 5 6 7 8 9 10
SWAT Zone


Waneta 2021: % Canopy Cover by Zone
% Canopy Cover
10.5
10
9.5
9
8.5
8
7.5
7
6.5
1 2 3 4 5 6 7 8 9 10
SWAT Zone


Burbank 2021: % Canopy Cover by Zone
% Canopy Cover
7
6.5
6
5.5
5
4.5
4
3.5
1 2 3 4 5 6 7 8 9
SWAT Zone


Clearwater 2022: % Canopy Cover by Zone
% Canopy Cover
9.5
9.0
8.5
8.0
7.5
1 2 3 4 5 6 7 8 9 10
SWAT Zone


Mountain Gem 2022: % Canopy Cover by Zone
% Canopy Cover
26.0
25.0
24.0
23.0
22.0
21.0
20.0
1 2 3 4 5 6 7 8 9 10
SWAT Zone

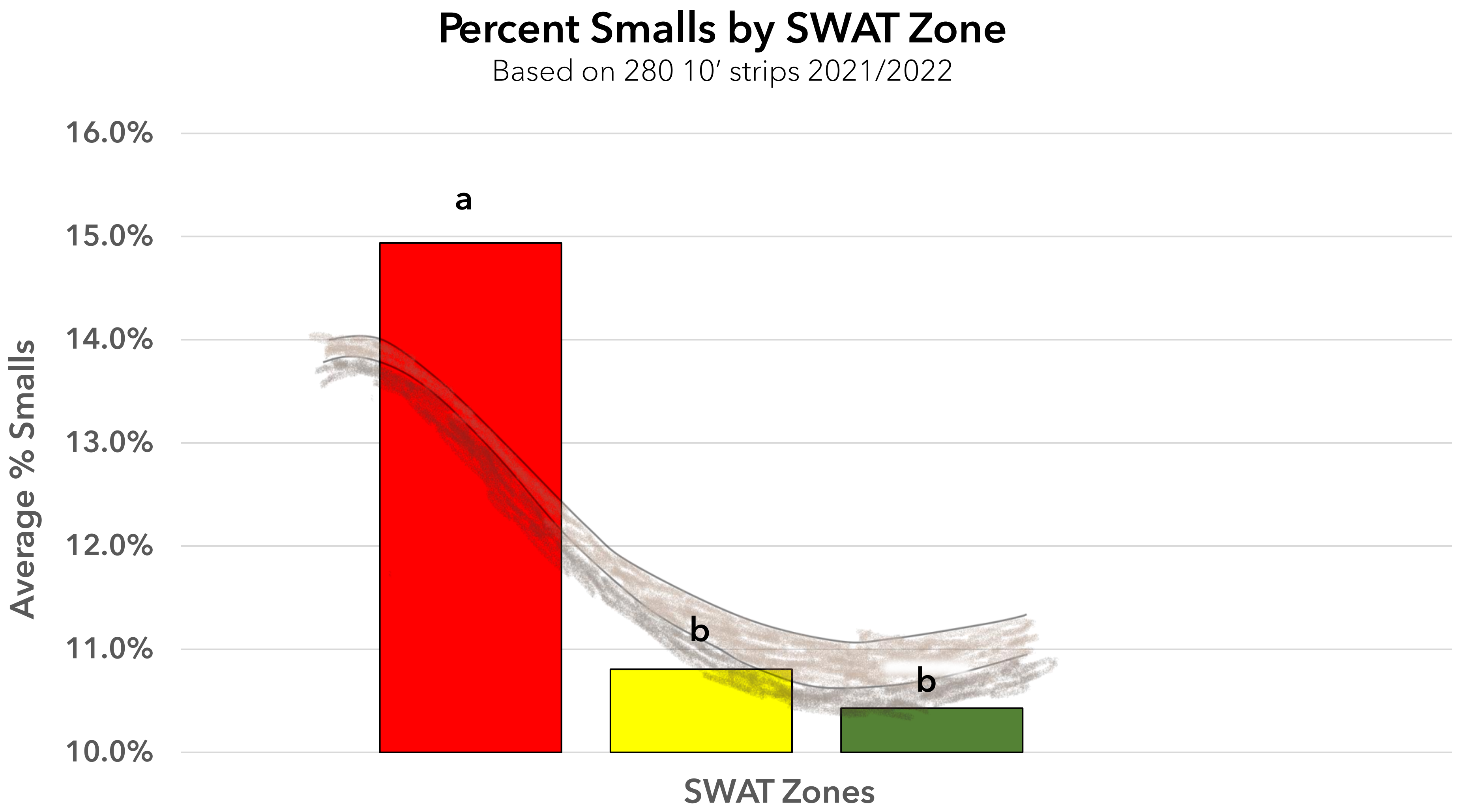

Alverstone Russet 2022: % Canopy Cover by Zone
% Canopy Cover
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1 2 3 4 5 6 7 8 9 10
SWAT Zone

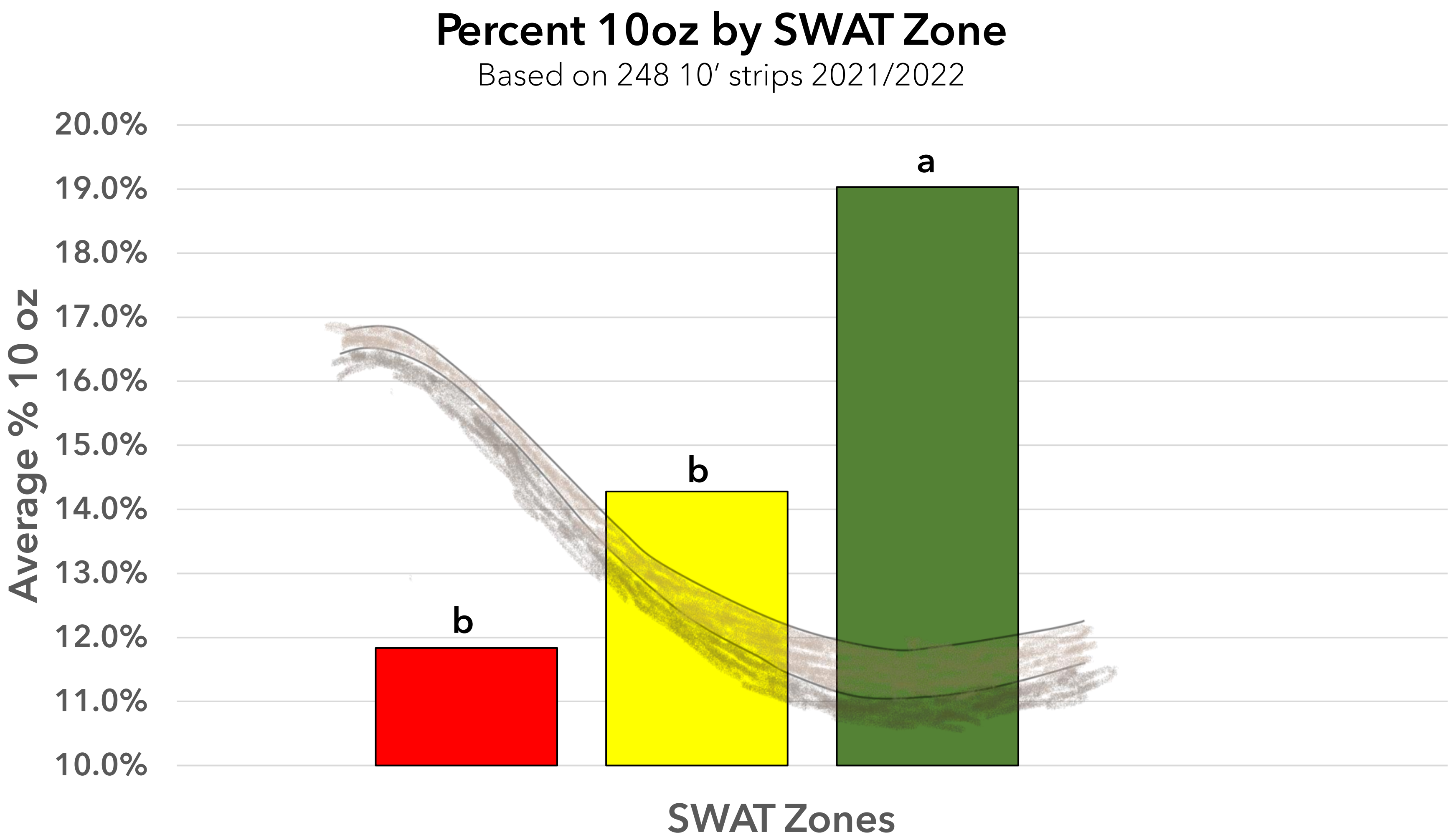
## Objective

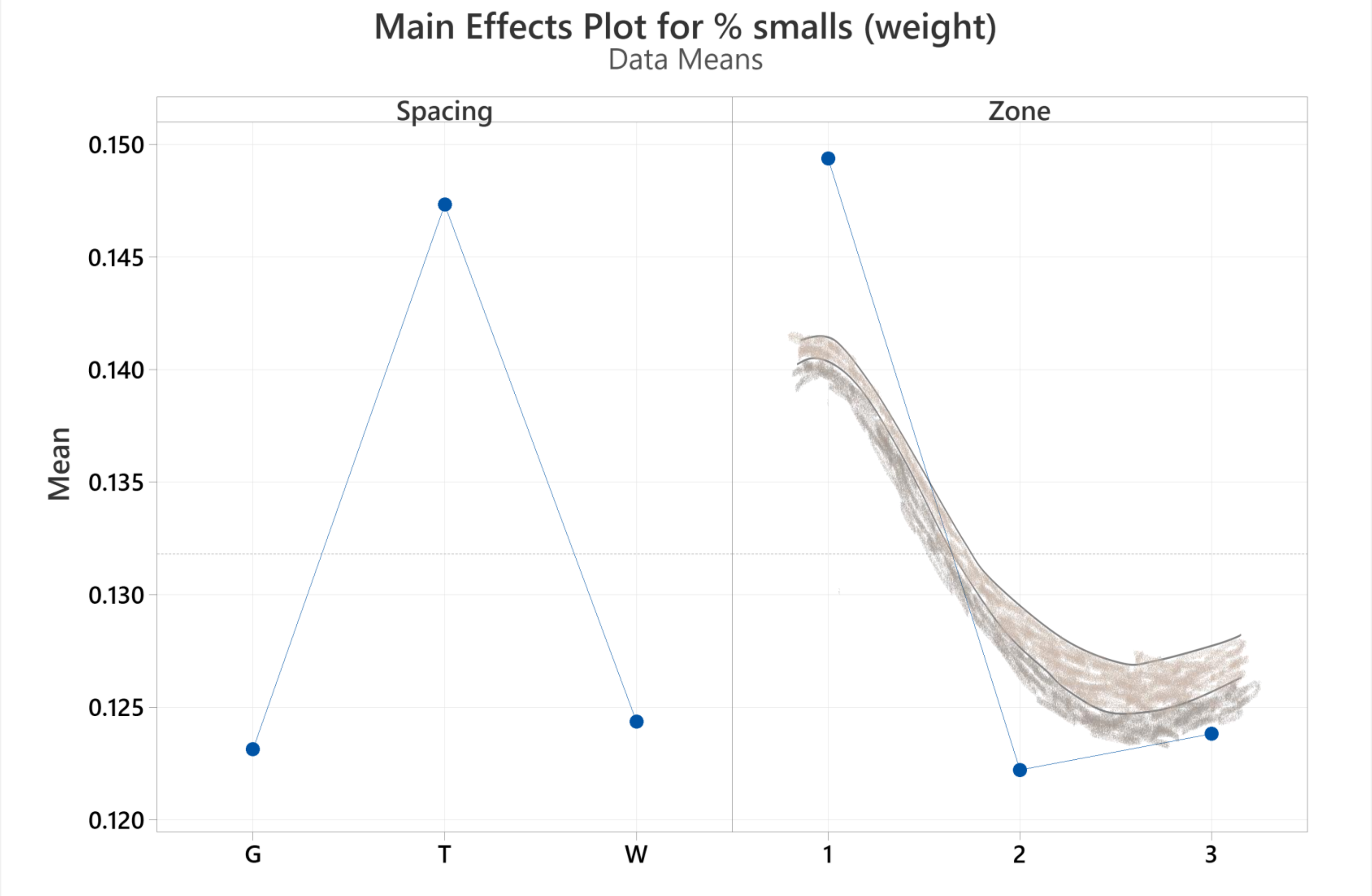
- To assess the economic impacts of variable rate (vr) planting of potatoes using soil, water and topography maps (SWAT MAPS)
- To examine the effects of vr planting on size profile

# VR Planting Results

Values include factors such as seed costs, smalls dockage, 10 oz bonus (if applicable), contract prices

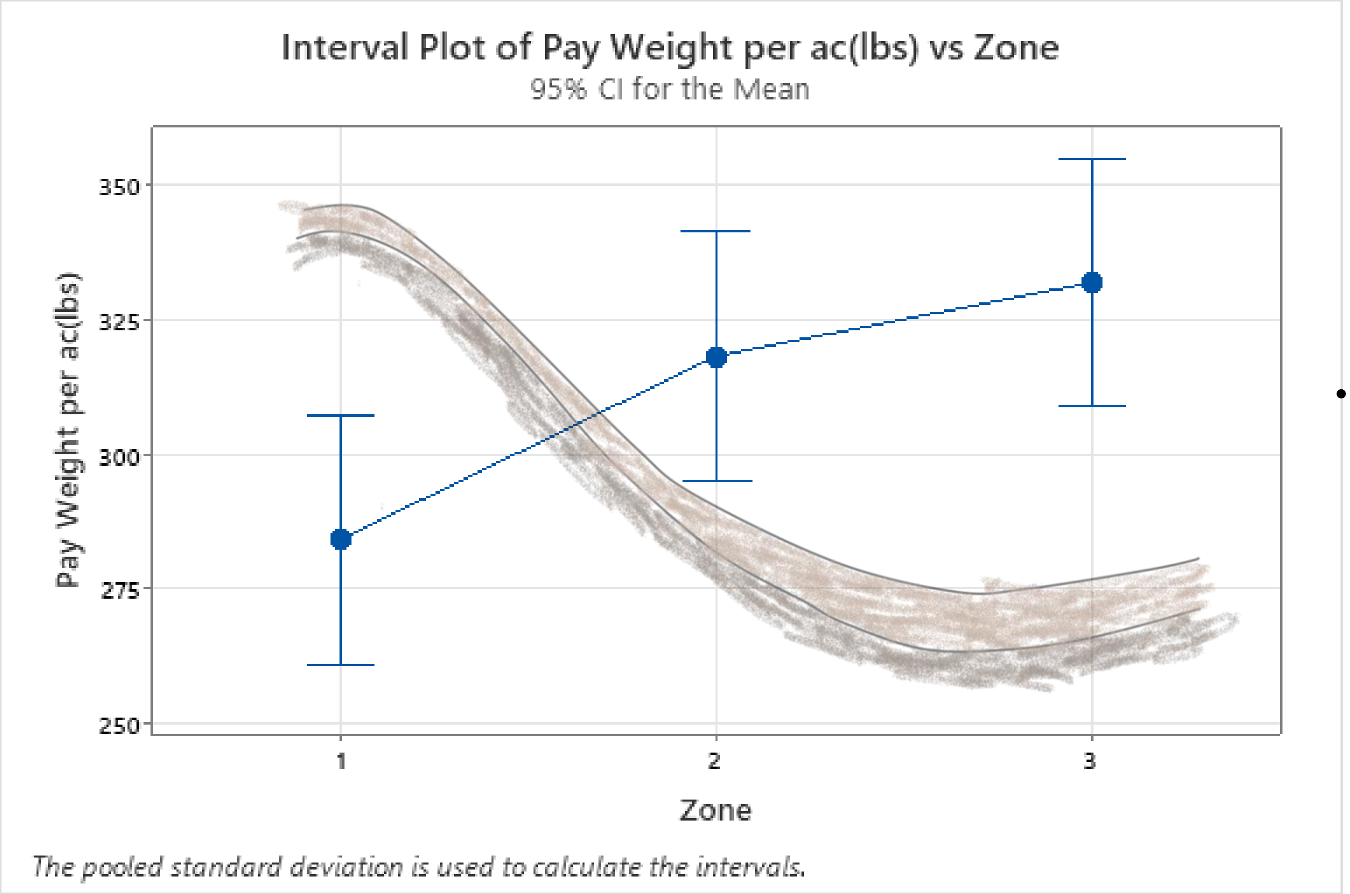

Percent Smalls by SWAT Zone
Based on 280 10' strips 2021/2022
16.0%
15.0%
14.0%
13.0%
12.0%
11.0%
10.0%
Average % Smalls
a
b
b
SWAT Zones


Percent 10oz by SWAT Zone
Based on 248 10′ strips 2021/2022
20.0%
19.0%
18.0%
17.0%
16.0%
15.0%
14.0%
13.0%
12.0%
11.0%
10.0%
Average % 10 oz
a
b
b
SWAT Zones

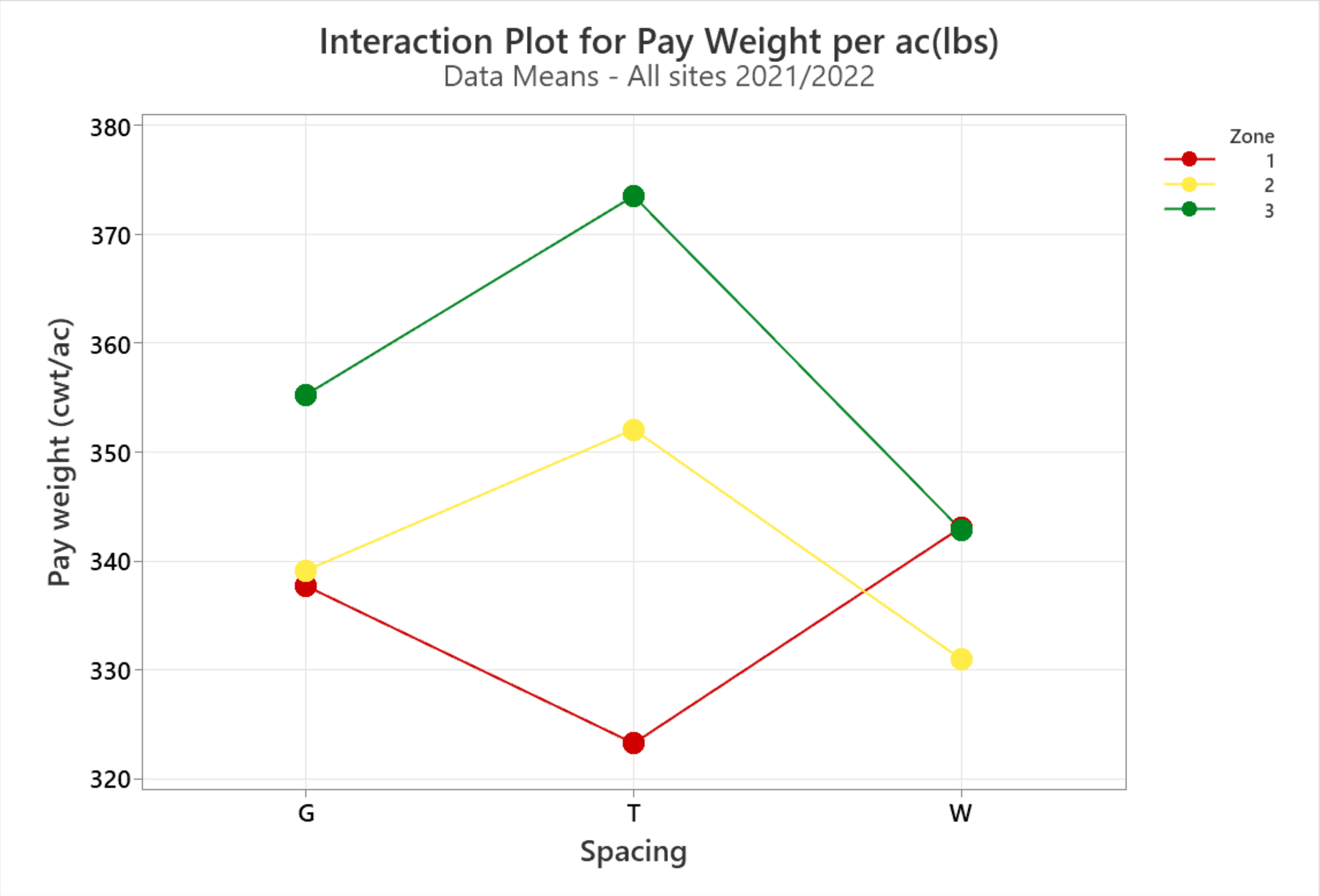


Main Effects Plot for % smalls (weight)
Data Means
Spacing
Zone
0.150
0.145
0.140
0.135
0.130
0.125
0.120
Mean
G
T
W
1
2
3

Main Effects Plot for % 10 oz
Data Means
Spacing
Zone
Mean
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
G
T
W
1
2
3




- 108 10-foot strips from 2022



Interaction Plot for Pay Weight per ac(lbs)
Data Means - All sites 2021/2022
Pay weight (cwt/ac)
380
370
360
350
340
330
320
G
T
W
Spacing
Zone
1
2
3

| Zone 1 | Value per ac ($ CAD) | | | |
|---|---|---|---|---|
| FieldYearVariety | Tight | GSP | Wide | Difference |
| 2021Clearwater | $ 3,610 | $ 4,726 | $ 4,473 | -$ 253 |
| 2021Burbank | $ 5,417 | $ 5,307 | $ 6,026 | $ 719 |
| 2021Waneta | $ 5,933 | $ 6,618 | $ 6,815 | $ 197 |
| 2022Clearwater | $ 2,747 | $ 3,279 | $ 3,910 | $ 631 |
| 2022Alverstone | $ 3,770 | $ 4,396 | $ 4,063 | -$ 333 |
| 2022MountainGem | $ 5,600 | $ 4,625 | $ 4,967 | $ 342 |
| | | | | |
| Average: | $ 4,513 | $ 4,825 | $ 5,042 | $ 217 |

| Zone 3 | Value per ac ($ CAD) | | | |
|---|---|---|---|---|
| FieldYearVariety | Tight | GSP | Wide | Difference |
| 2021Clearwater | $ 4,878 | $ 4,412 | $ 4,726 | $ 466 |
| 2021Burbank | $ 5,019 | $ 4,842 | $ 4,744 | $ 177 |
| 2021Waneta | $ 6,695 | $ 6,713 | $ 7,917 | -$ 18 |
| 2022Clearwater | $ 3,943 | $ 3,991 | $ 3,427 | -$ 48 |
| 2022Alverstone | $ 4,678 | $ 4,396 | $ 4,804 | $ 282 |
| 2022MountainGem | $ 7,131 | $ 6,183 | $ 5,573 | $ 948 |
| | | | | |
| Average: | $ 5,391 | $ 5,090 | $ 5,199 | $ 301 |

## Summary

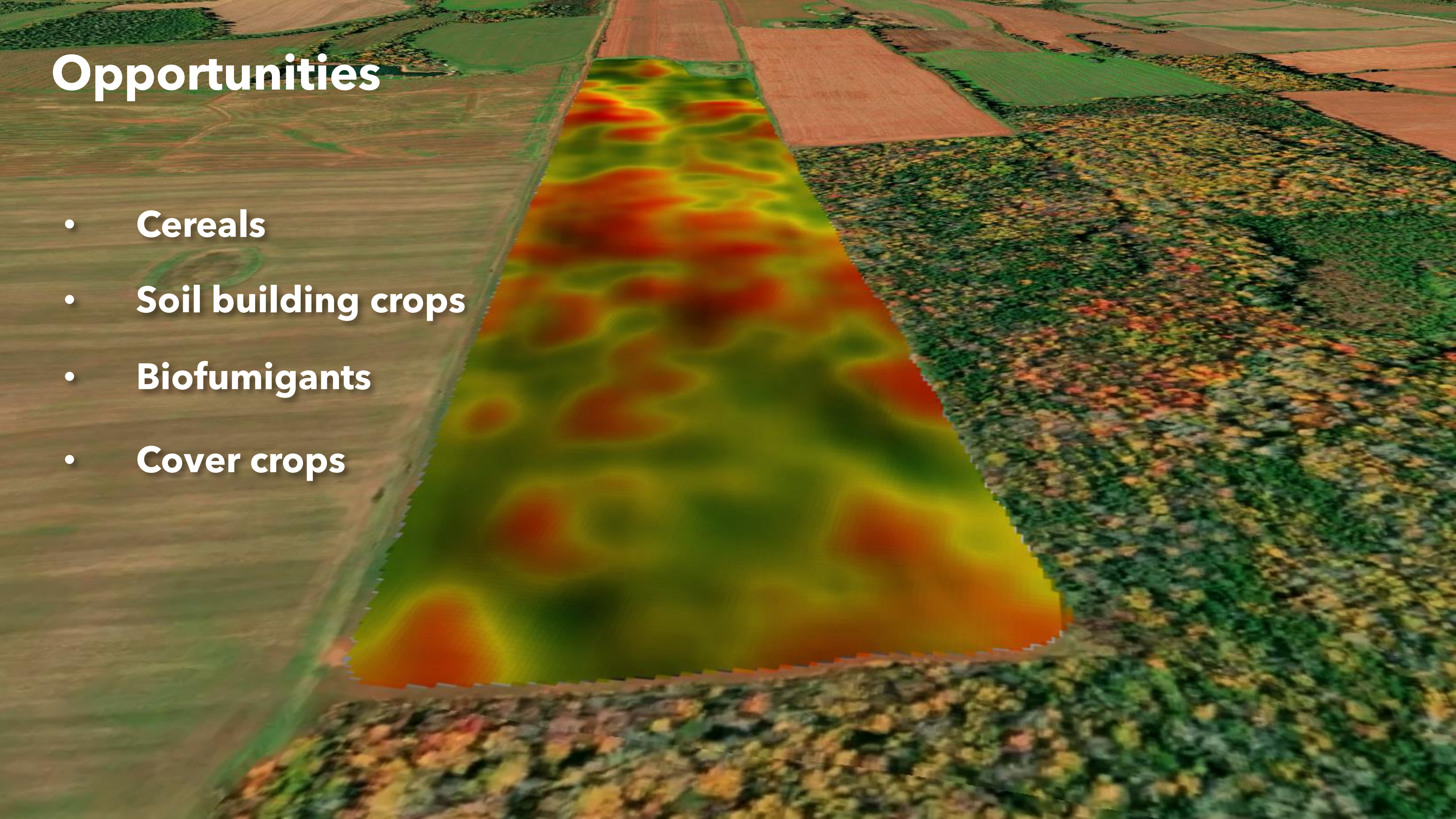
- On average, in all 6 fields, tighter spacing in lower landscape areas resulted in **$303/ac** more value than standard spacing. Outperformed standard spacing 4/6 times

- On average, in all 6 fields, wider spacing in upper landscape areas resulted in **$217/ac** more value than standard spacing. Outperformed standard spacing 4/6 times

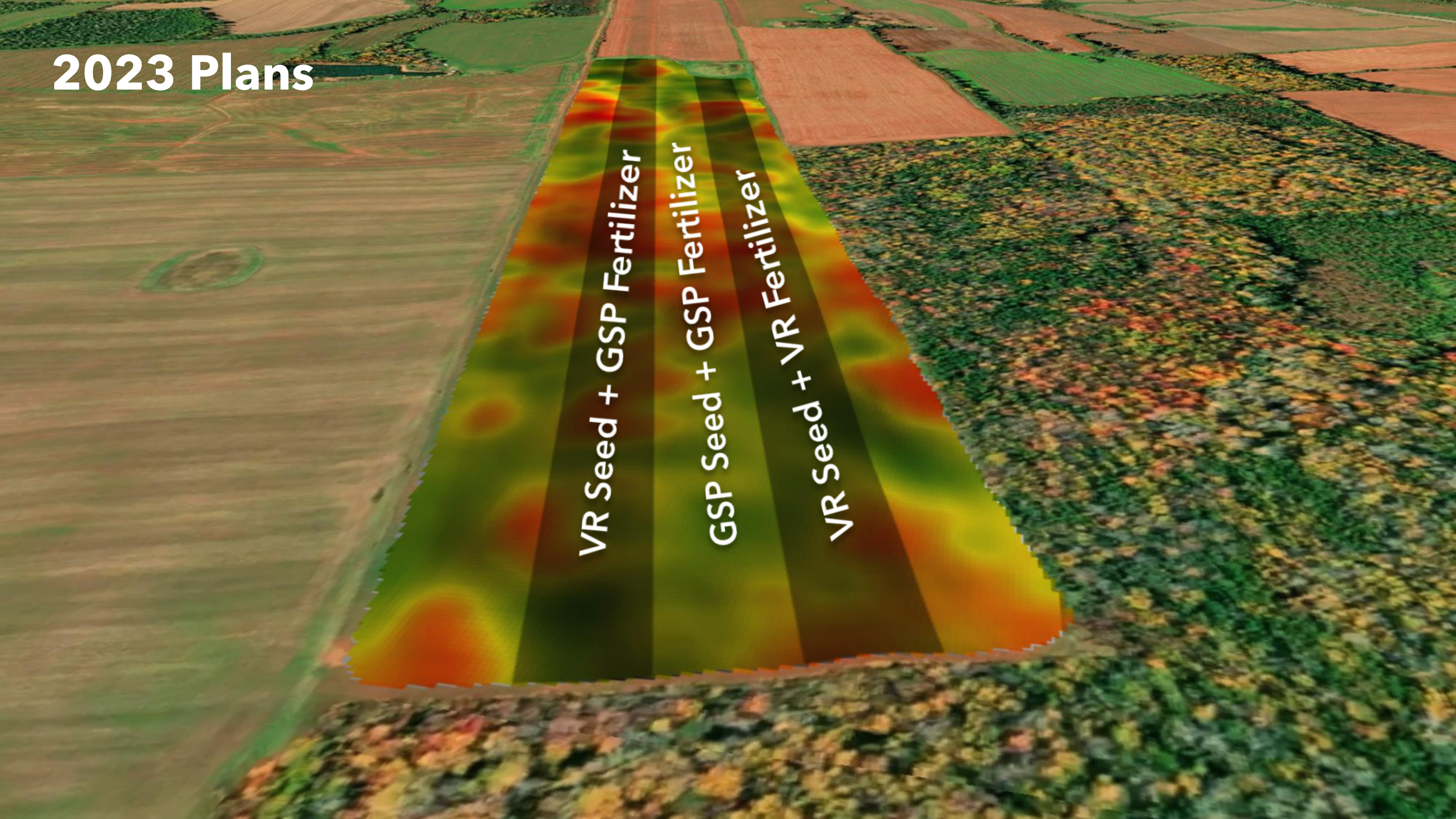
- 2021/2022 were above average growing years in PEI

# Opportunities

- Cereals
- Soil building crops
- Biofumigants
- Cover crops



# 2023 Plans


VR Seed + GSP Fertilizer
GSP Seed + GSP Fertilizer
VR Seed + VR Fertilizer

Don’t let perfection get in the way of progress!

Prince Edward Island PEI POTATOES

CAAIN
Canadian Agri-Food Automation and Intelligence Network
connect. create. cultivate.

FRUIT & VEGETABLE GROWERS OF CANADA | PRODUCTEURS DE FRUITS ET LÉGUMES DU CANADA

# Thank You!

CROPTIMISTIC TECHNOLOGY

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