SOIL SENSIBILITY AND DATA UTILITY

Lewis Baarda And Adil Akbar **FARMING** SMARTER

- 32 data points (sparse)
- Cost: ~\$1600/field (\$10/acre)
 - Soil Nutrients NPKS top 15cm
- High cost, low density

Electrical Conductivity Sensor

- 49,152 data points (dense)
- Cost: ~\$880/field (\$5.50/acre)
 - EC (clay and moisture content)
 - Low cost, high density



RESEARCH QUESTIONS

1. What can soil sensors tell us?

Veris.

- 2. How can this information create zones?
- 3. Are these zones useful or meaningful?

THE SOIL SENSORS

Veris MSP3

• Electrical Conductivity (Resistance)

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• On the go pH measurements

STATE STAT

• Organic Matter



EM38-MK2

• Electrical Conductivity (EM Induction)



1. WHAT CAN SOIL SENSORS TELL US?

Account for in-field variability

Give insight into soil properties

Data are pooled so that layers can be quantitatively compared to one another Elevation Pooled Data Map

Elevation Map





Yield Map 2010





Veris EC Map Fall 2013

- Visual spatial patterns between data layers are evident
- Are these patterns random, or are they meaningful and predictable?



How do different layers of data relate to one another?

- Correlation Matrix
 - Statistically measures relationships between data layers
- Green indicates positive correlation
- Red indicates negative correlation

1. EC data patterns were <u>statistically</u> similar to one another

- Consistent over space
- Consistent over time
- Consistent from one sensor to another

2. Yield patterns were statistically quite variable

Relationship between yield and sensor data changes over time Yield patterns over time are more dynamic than we might expect

How do different layers of data relate to measured soil data?

- Correlation Matrix
 - Statistically measures relationships between mapped data layers and measured soil samples
- Green indicates strong correlation



- EC patterns were often related to measured soil texture and soil moisture
- EC patterns often did not relate strongly to soil nutrients (NPKS)

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1 WHAT CAN SOIL SENSORS TELL US?

- EC readings are highly consistent
- EC is a strong indicator of the presence of clay and soil moisture
- Very few strong correlations between EC and either yield or soil nutrients
- Yield patterns can be quite variable

2 How can this information create zones?

- What data should we use to create zones?
- How many zones?
- What are the boundaries between zones?

Principal Component Analysis

- Uses statistics to reduce many data layers into a few **Factors**
- Examines relationships between data layers
- Identifies the 'key variables' that best account for variability



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K-means Cluster Analysis

- A mathematical process for grouping of complex data
- Separates data into clusters with similar properties
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K-means Cluster Analysis

- A mathematical process for grouping of complex data
- Separates data into clusters with similar properties



Data Clusters: EC vs Yield



Source: Barl, Digital Slote, SeoBye, Loured, Barinstar Seographics, CNES/Alfrus D.S., USDA, USDS, AEX, Setmappin

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Historic Yield

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Historic Yield



Electrical Conductivity

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Composite

Composite (Yield + EC)

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3. ARE THESE ZONES USEFUL OR MEANINGFUL?

Do zones yield differently?

Can zones be managed differently?



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Surface Geography – Yield Response

Surface Geography -- Yield Response to Nitrogen



Grid Soil Samples – Yield Response



Grid Soil Samples -- Yield Response to Nitrogen

Historic Yield – Yield Response



Electrical Conductivity – Yield Response



Composite – Yield Response

Composite -- Yield Response to Nitrogen



Did zones yield differently? Statistically significant difference of means project-wide



(No zones yielded differently)

(Some zones yielded differently)

Complete Success (All zones yielded differently)

Could zones be managed differently? Statistically significant difference between response curves

100% Number of IIntances (Out of 10 possible) 90% 80% 70% 60% 50% 40% 30% 20% 10% 0% Surface Geography **Grid Soil Samples** Historical Yield **Electrical Conductivity** Composite (EC & Yield) **Delineation Methods**

Complete Success (All zones yielded differently) Some Success

(Some zones yielded differently)

No Success (No zones yielded differently)

3. ARE THESE ZONES MEANINGFUL?

- Success in differentiating zones of productivity
- Limited success in differentiating optimal nitrogen rates for zones identified

CONCLUSION

- Soil sensor measurements were found to be highly consistent
- EC is good tool to better understand soil variability
- No obvious correlations between EC and soil nutrient properties
- EC is just one piece of a complex puzzle

CONCLUSION

- Every field is different, and the relationship between soil sensor data and soil properties, and yield can vary over space and time
- Variable Rate Technology requires a Variable approach
- Be prepared to tailor a specific VR strategy for specific fields
- The process is as important as the results
 - VR strategies are not universal, but they are testable



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