Big Data and the Productivity Challenge for Wine Grapes

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Agricultural Outlook Forum

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Big Data and the Productivity Challenge for Wine Grapes

Outline

- Current production challenges
- Lessons learned from annual crops
- How will we utilize Big Data to meet our challenges?
  - Measure
  - Model
  - Manage
- Summary

The Productivity Challenge for Wine Grapes

- Suitable land, labor and water for agriculture are becoming more scarce and expensive
- Need to increase grape supply without increasing production area and environmental impact
- Must increase *both* yield and quality simultaneously
- Similar challenges are faced by nearly all agricultural commodities worldwide

How are annual crops addressing these challenges?

Dramatic increases in the productivity of agronomic crops have been achieved during the past century via:

- Genetics – traditional breeding and genomics
- Improved agronomic practices and resource management
- Application of remote sensing and other technologies

How are perennial crops different in their approach?

Progress has been much slower in wine grapes and other perennial crops:

- Critical mass – limited acres = limited attention despite farm-gate value
- Genetics – research, breeding cycle and market tradition
- Production cycle and innovation adoption
- Yield – quality relationships

Integrated systems are required for improving productivity *and* quality

Germplasm Improvement	Systems Biology	Precision Agriculture
• Clonal selection • Cultivar and rootstock improvement via traditional breeding • Pest/disease resistance	• Elucidate the regulation of key yield and fruit quality pathways • Functional genomics – linking genes to key traits	• Characterize the parameters regulating vine productivity and quality • Model key relationships • Variable rate management

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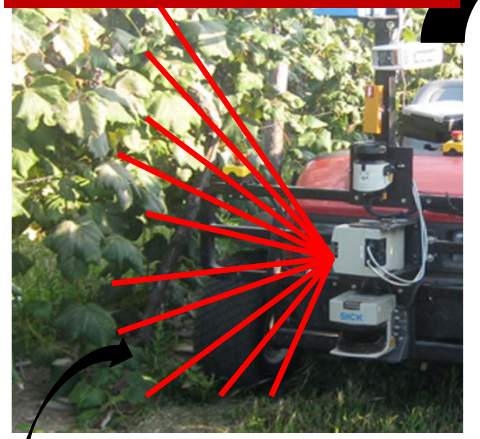
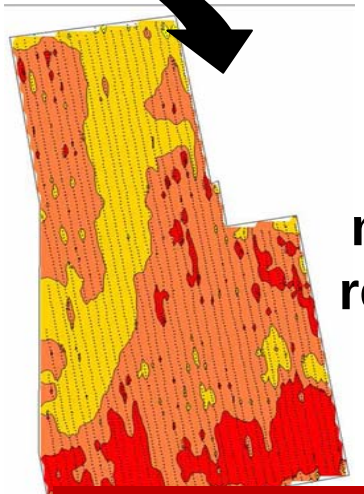
The Future of Grape Growing

MEASURE

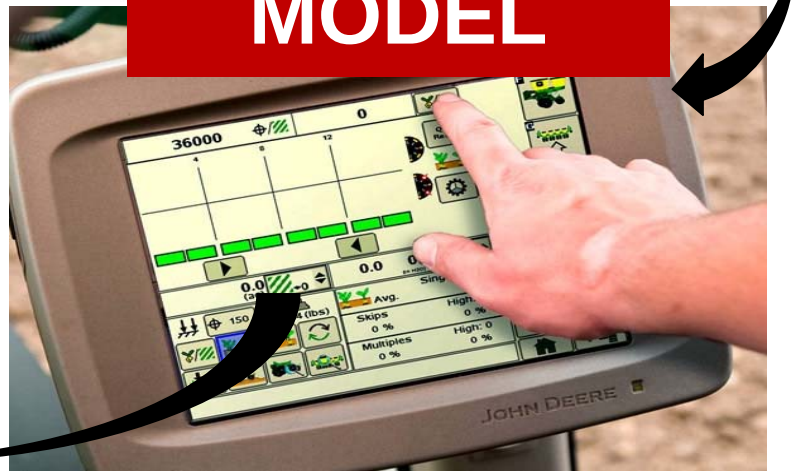


Automated sensors measuring intra-field variability – crop load, canopy size, irrigation requirements



Measures used to construct geospatial maps of key relationships

MODEL

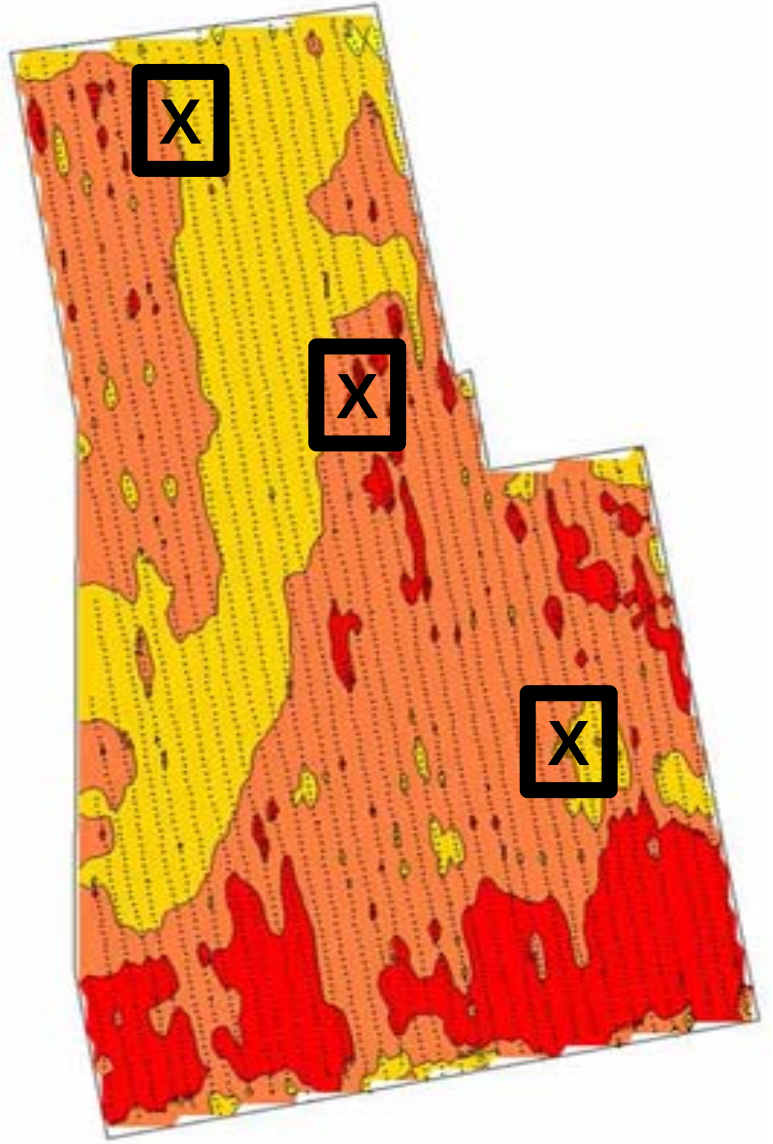


MANAGE

Information used to spatially alter cultural practices

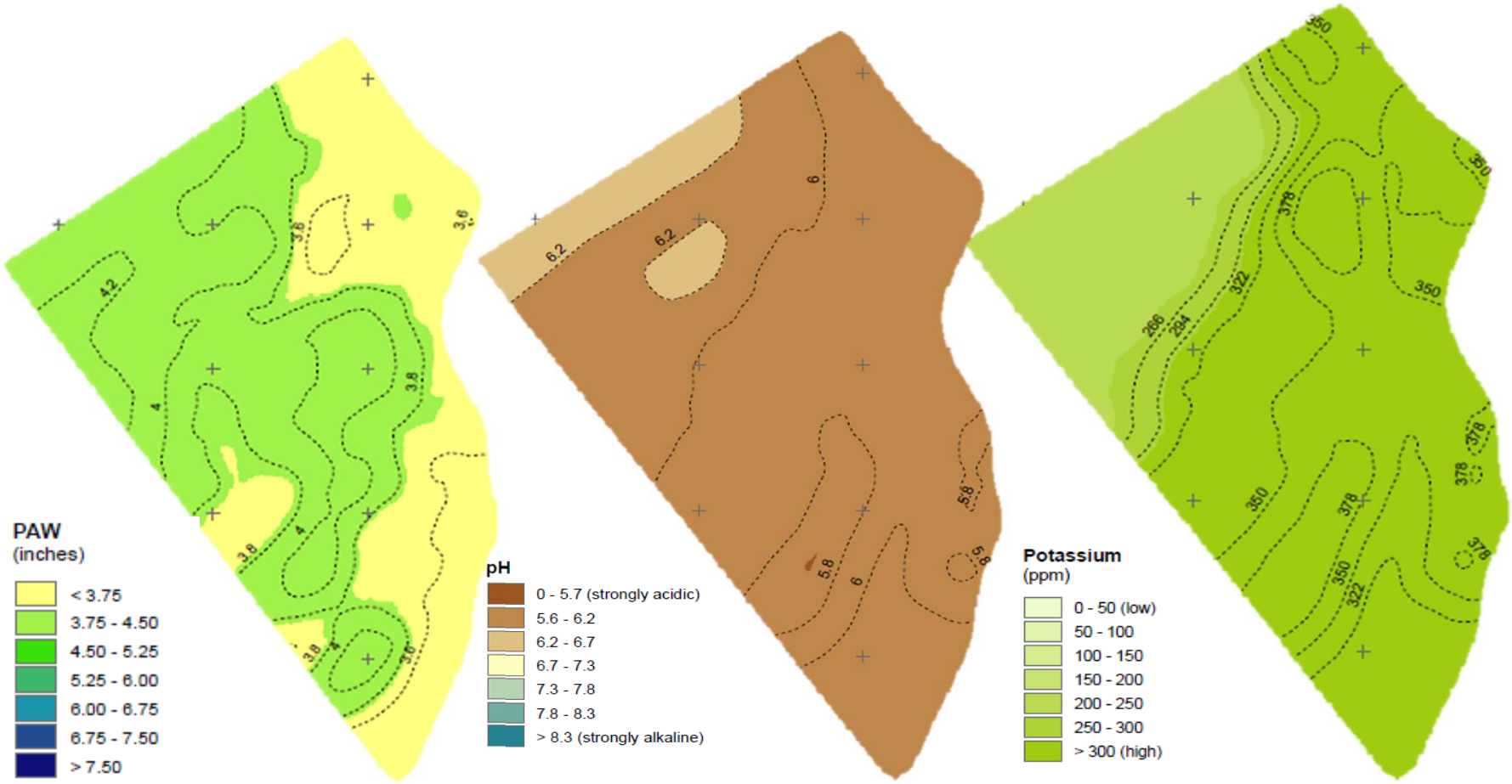
Historical sensors are site specific

Historical soil measures



Sensors provide high density soil information

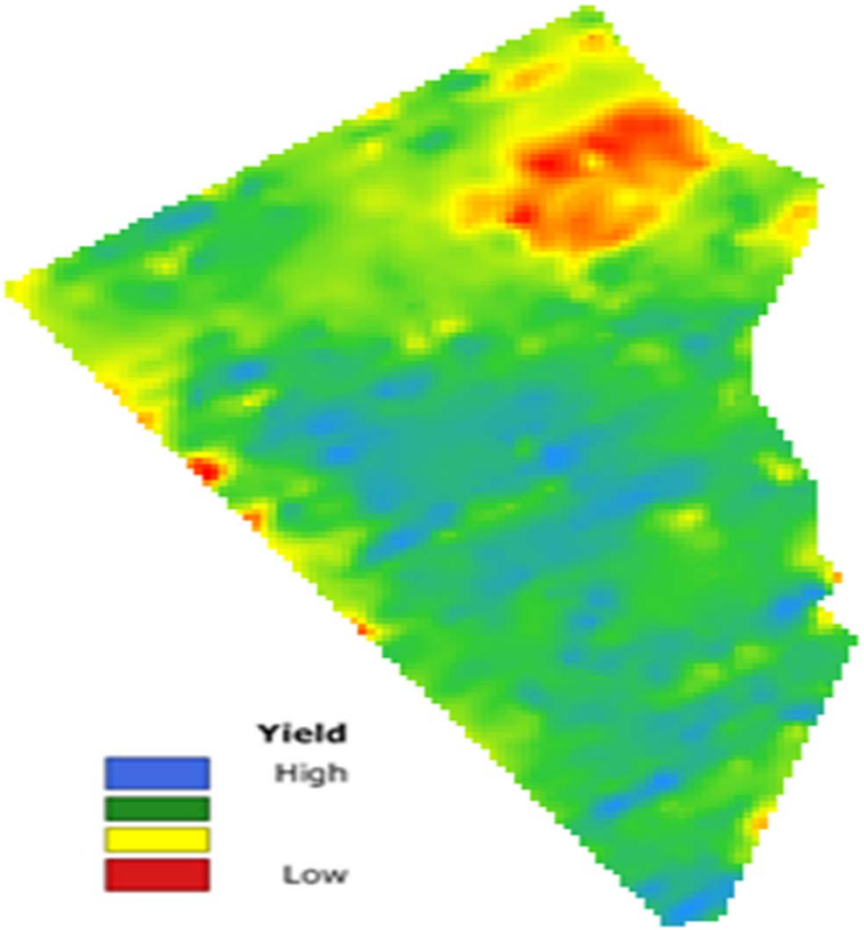
High Resolution Maps - EM Sensor



Characterizing Yield Variability

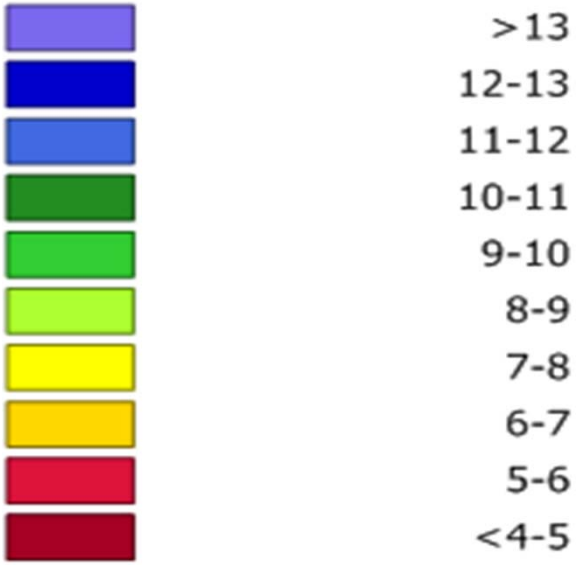

DANGER

Why does variability matter?



Cabernet Sauvignon

9.2 tons/acre
22.7 tons/ha



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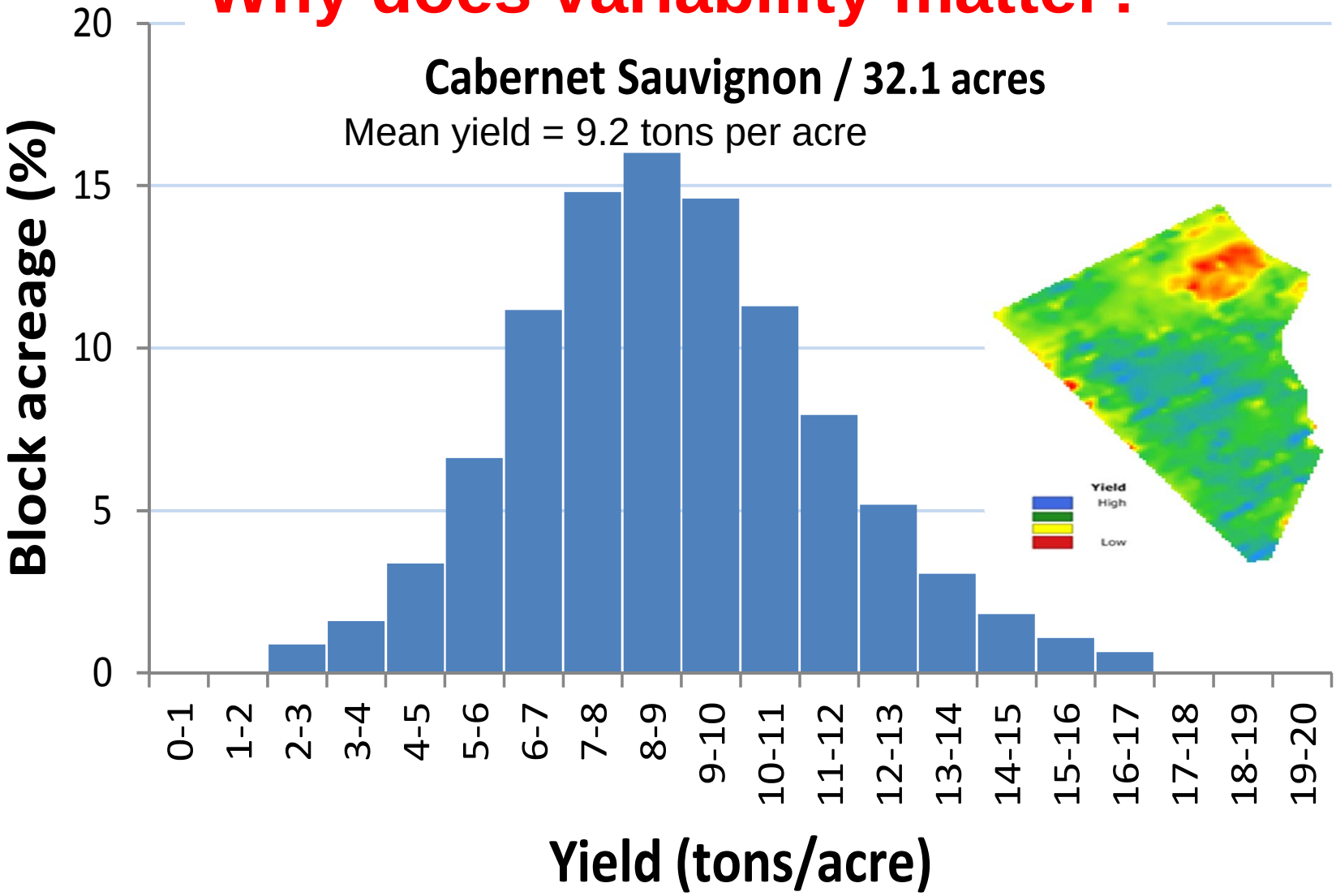

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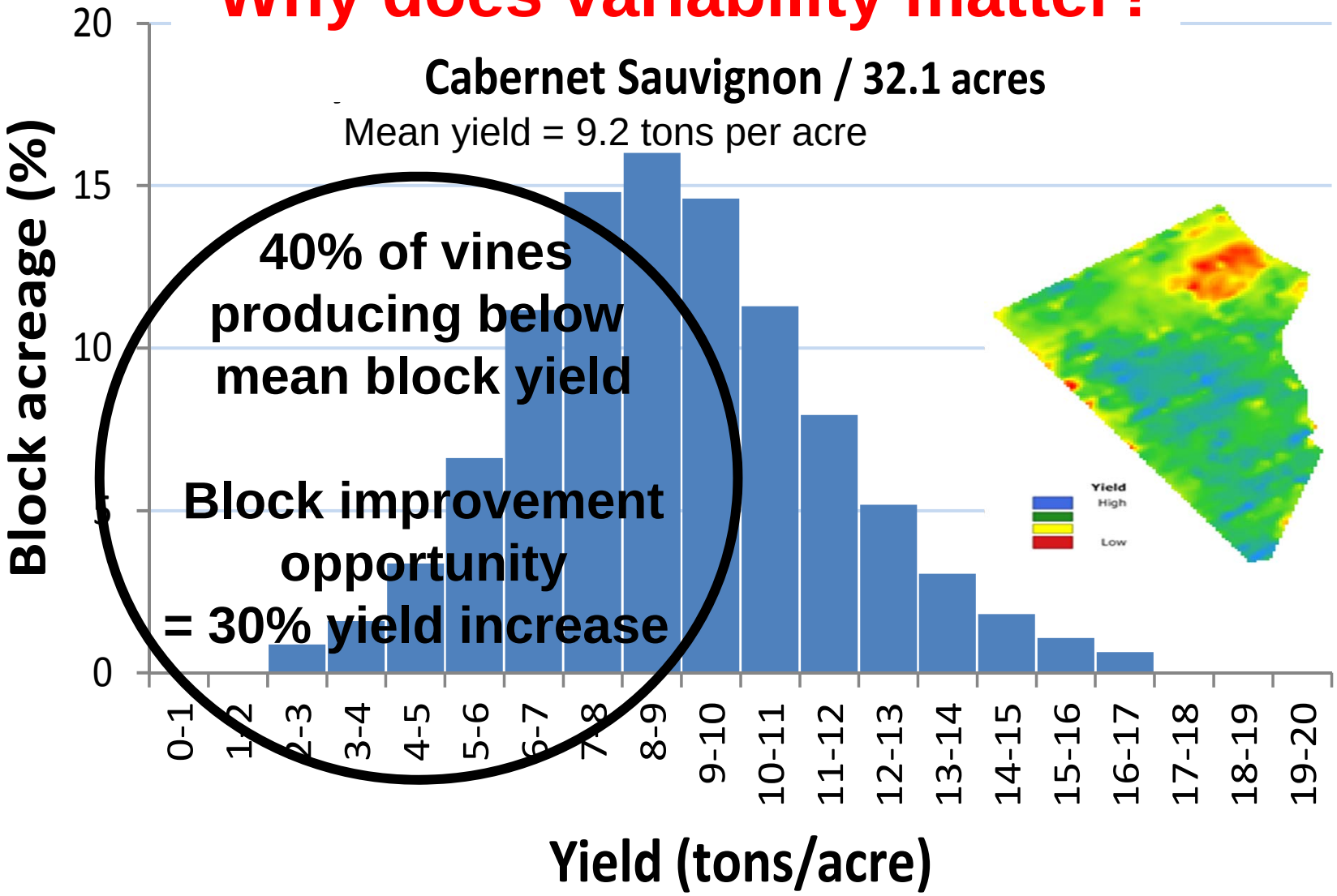

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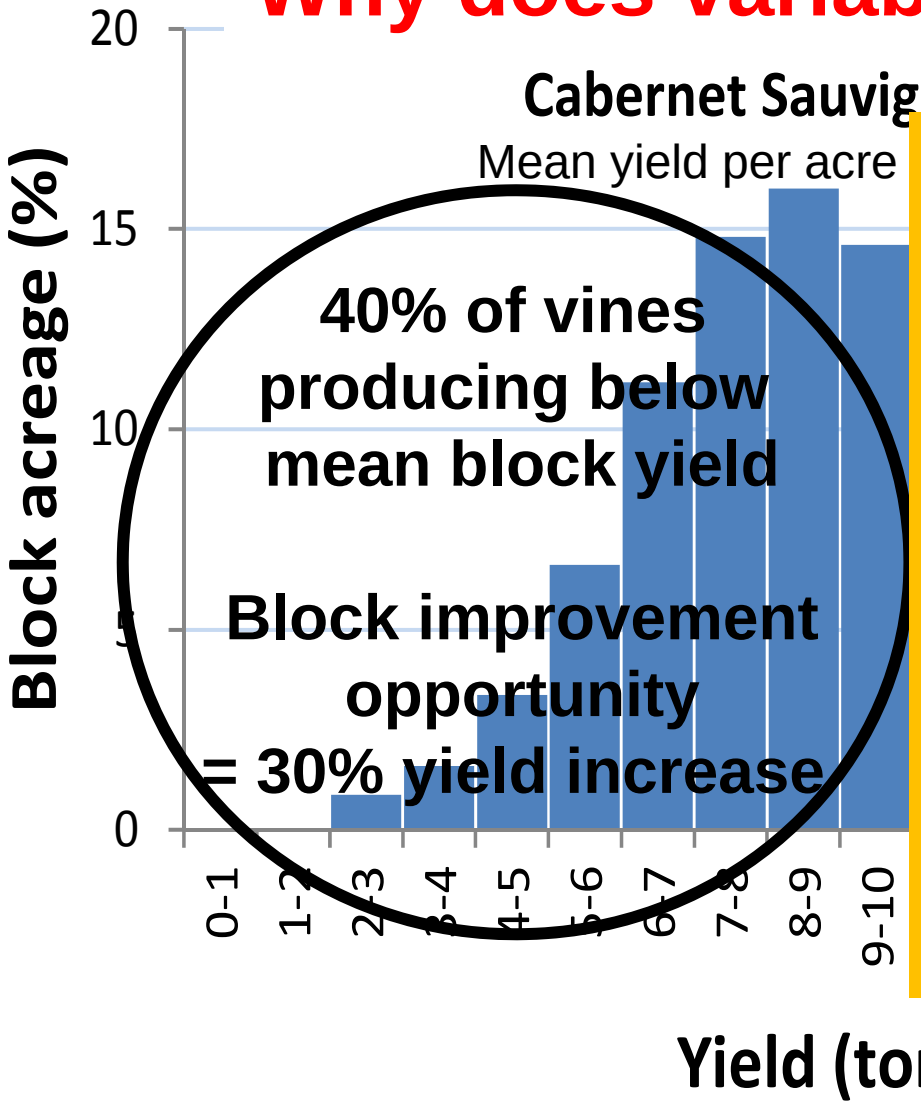
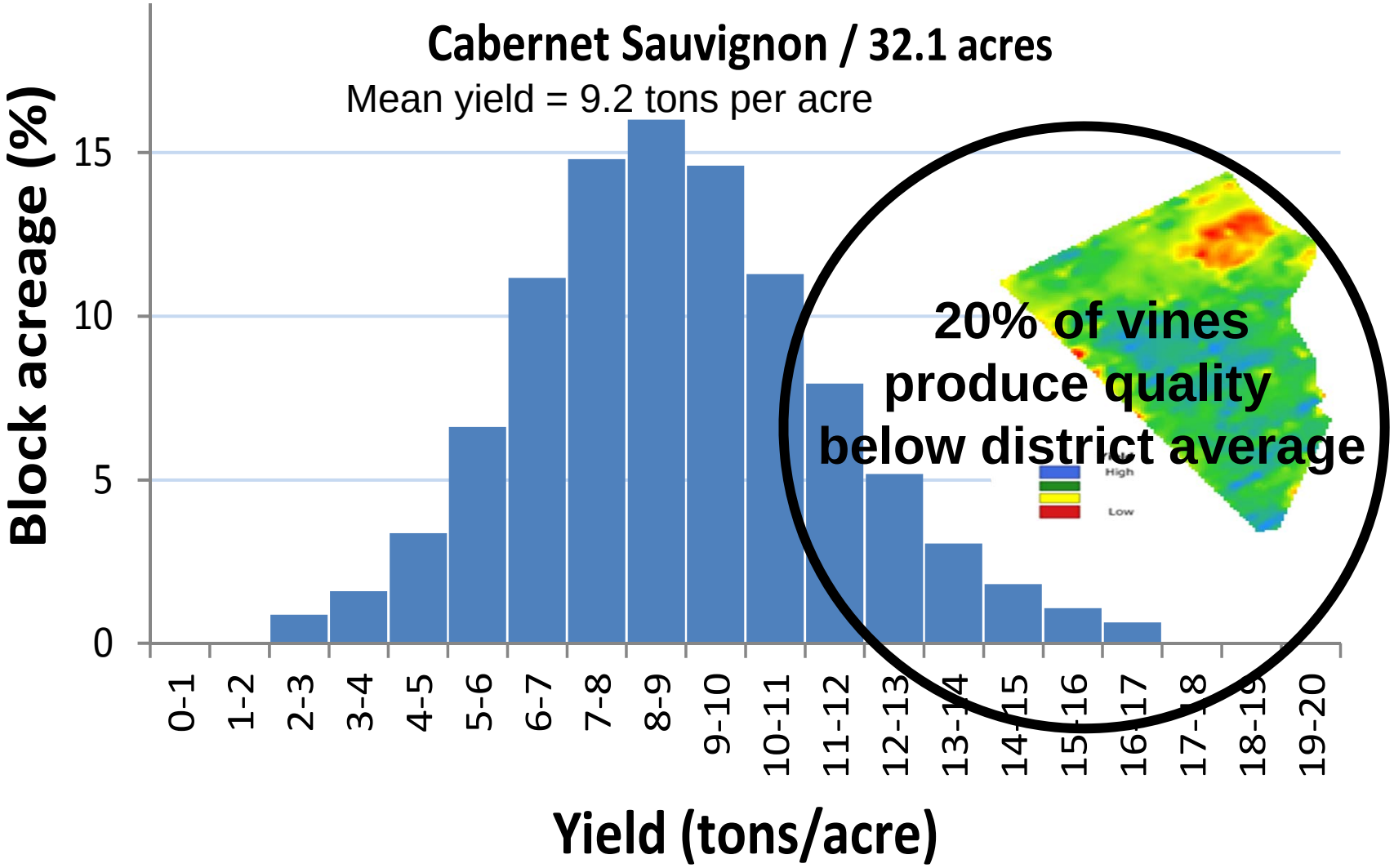


- **Annual increase in revenue = $900/acre**
- **Estimated cost = $100/acre**
- **30% yield increase without planting additional acreage**

<u>Capital avoidance/acre</u>
Land - $50,000
Establishment - $35,000

What is the size of the prize for Big Data?



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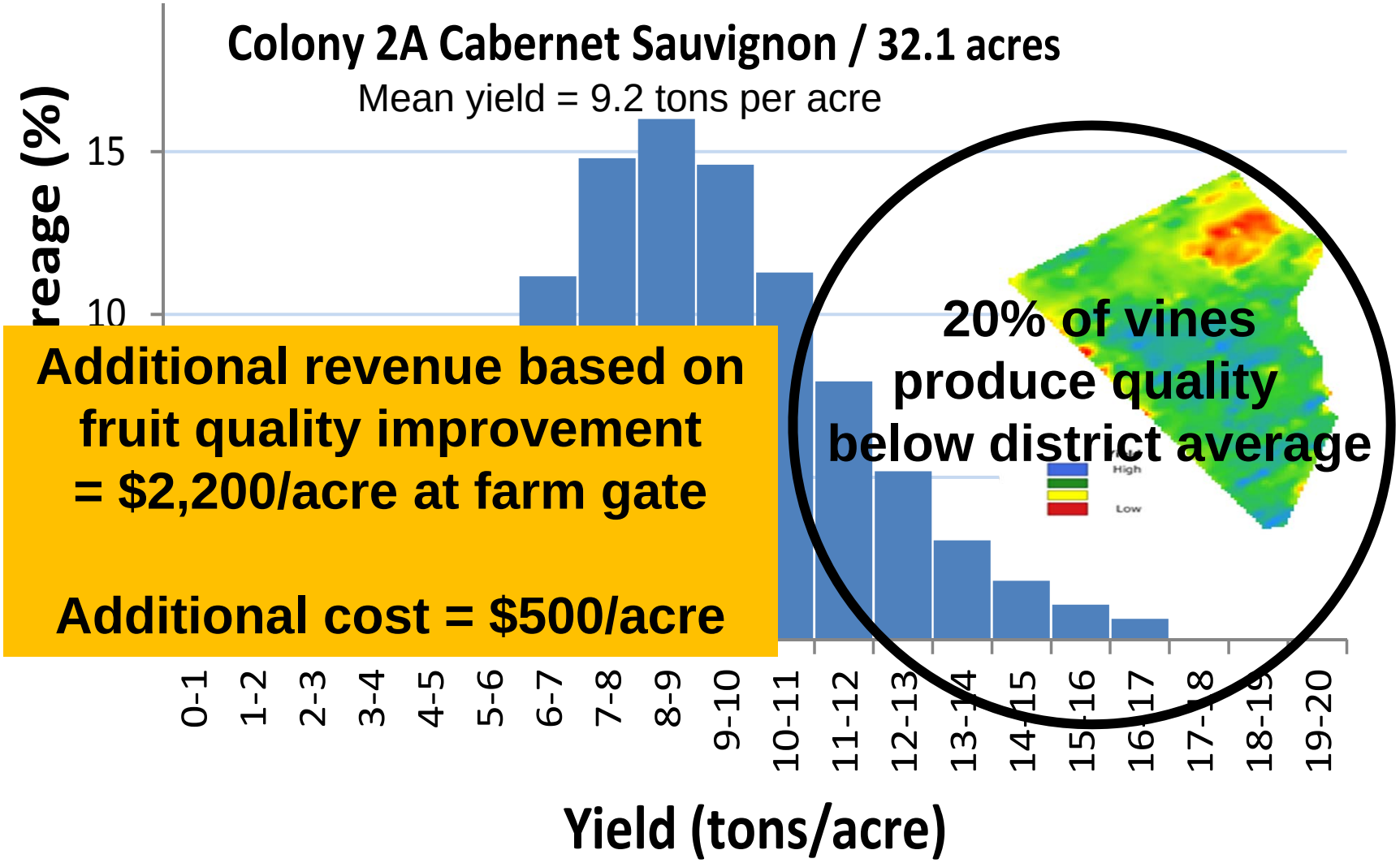
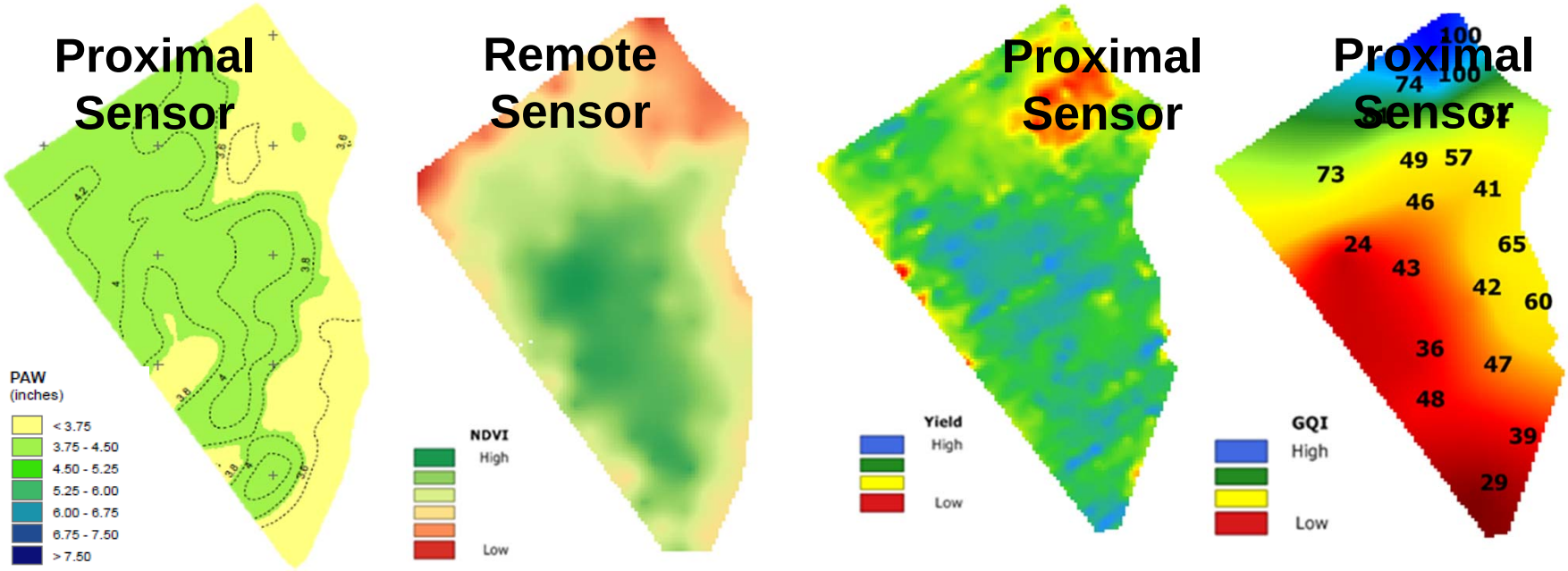


Integrated systems - analytics



Plant available water in soil → Vegetation Index (NDVI) → Yield → Fruit Quality

Modeling Yield and Fruit Quality Data with Soil Parameters

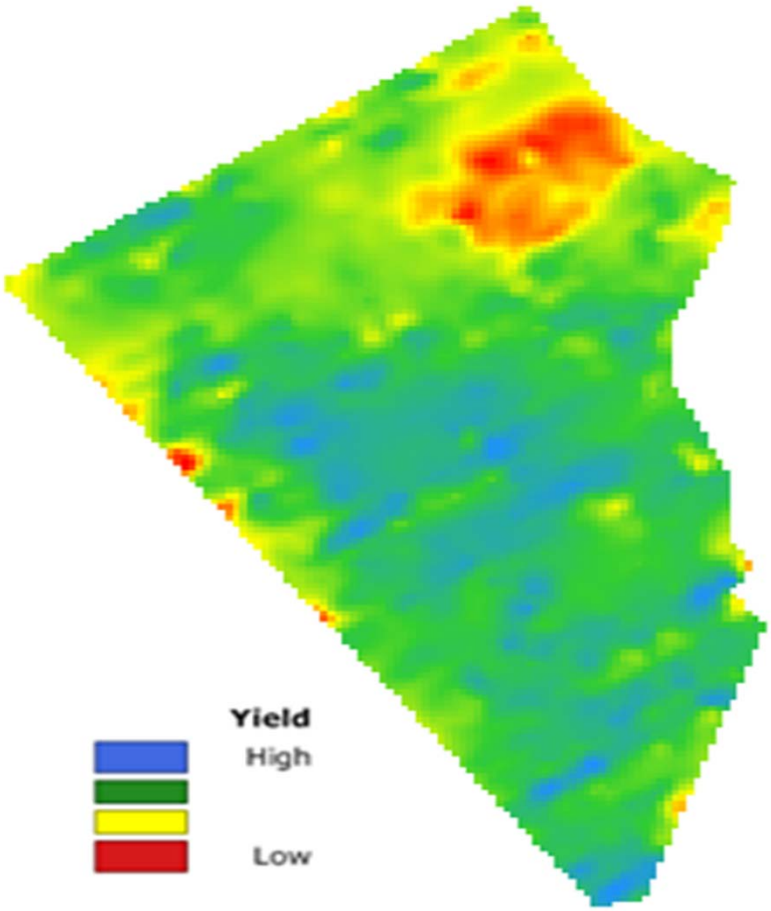
Significant Correlations with Fruit Yield

Parameter	Correlation (r^2)
Subsurface K^+	0.903
Soil rooting depth	**0.774**
Subsurface pH	– 0.805
Subsurface P	– 0.805
Subsurface organic matter	– 0.882
Subsurface K/Mg ratio	– 0.890

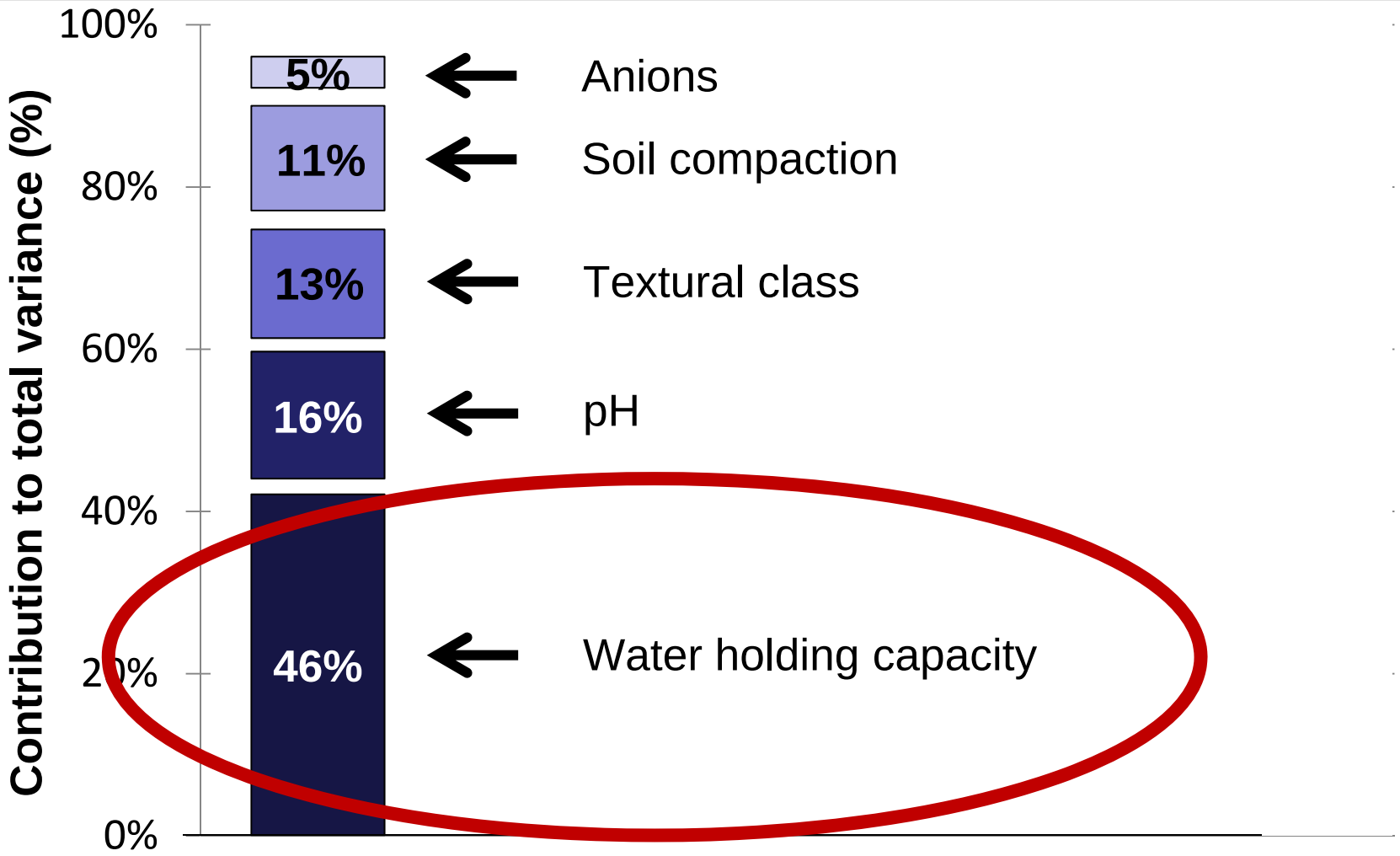
Significant Correlations with Fruit Quality

Parameter	Correlation (r^2)
Soil rooting depth	**– 0.673**
Surface CA	– 0.506
Subsurface CA / Mg ratio	– 0.510
Surface CEC	– 0.554

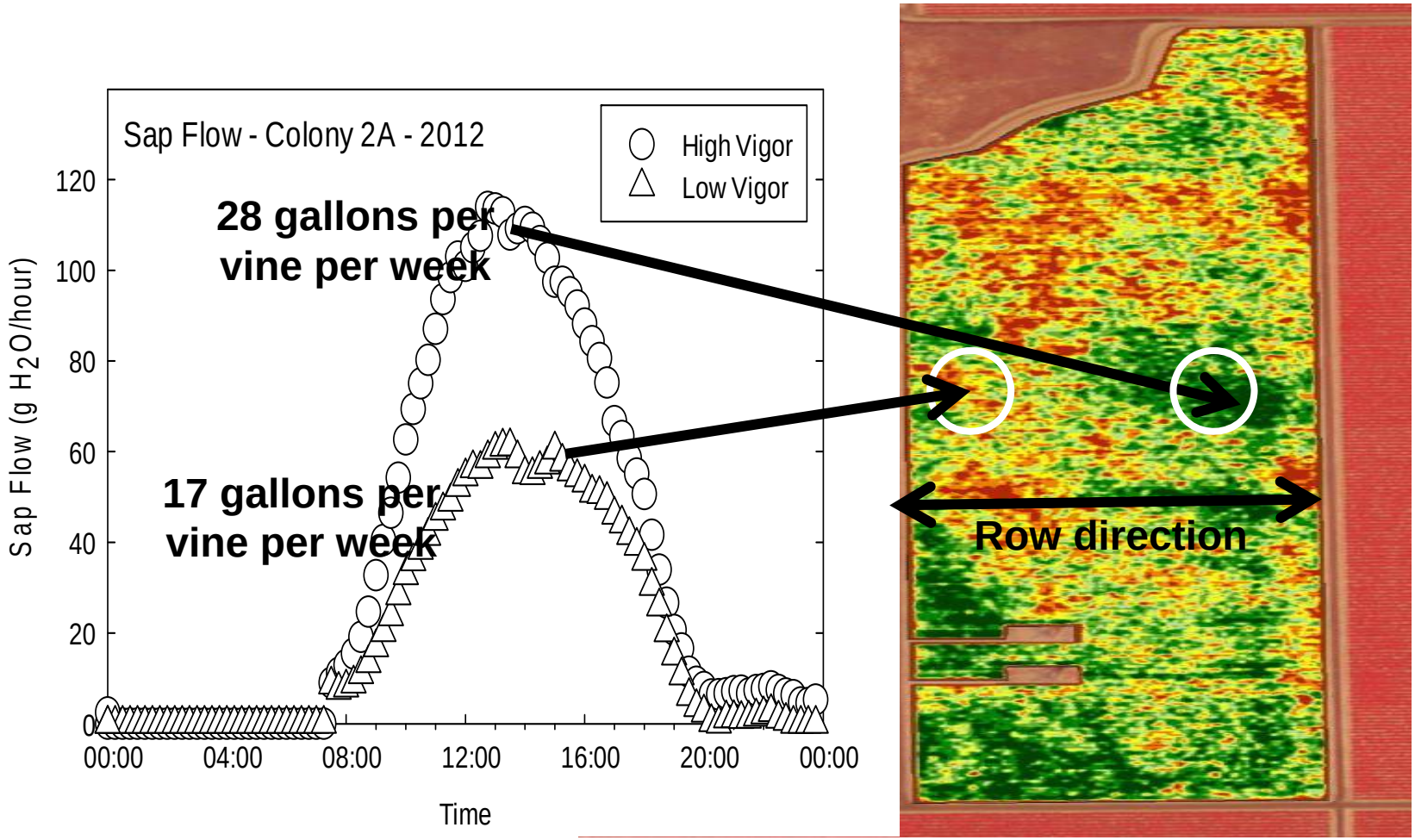
Variable rate management



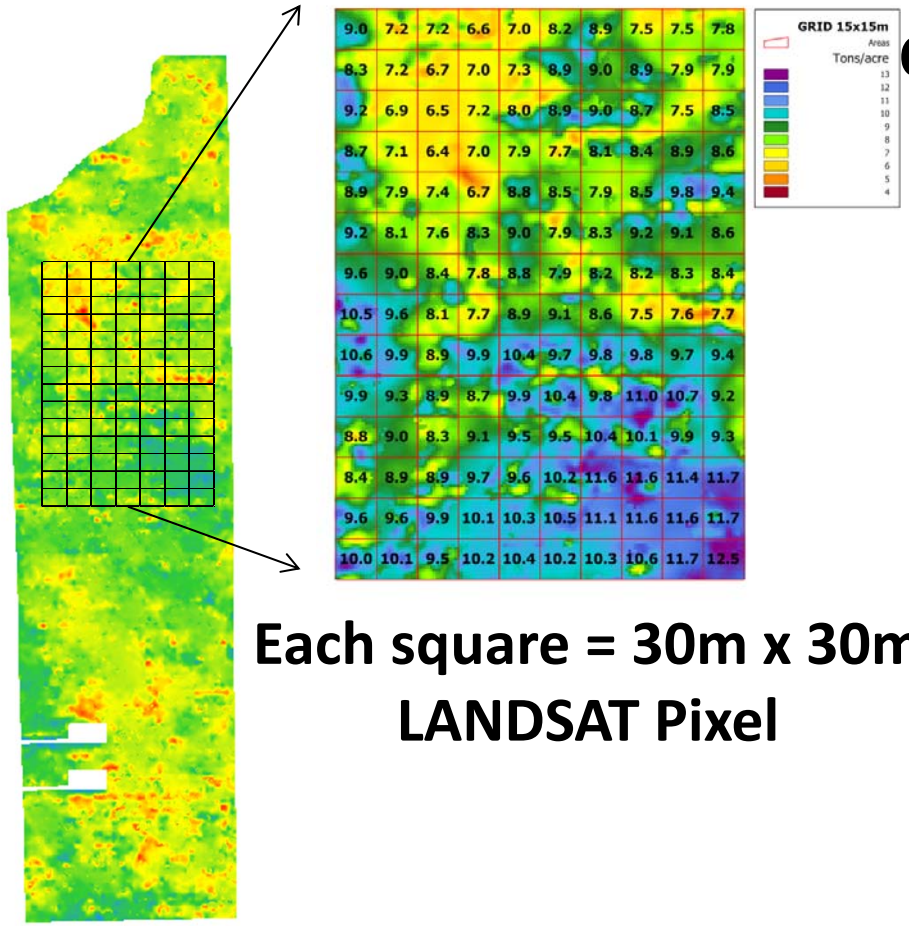
Relative importance of soil parameters to block yield variability



Vine water use is variable based on canopy size

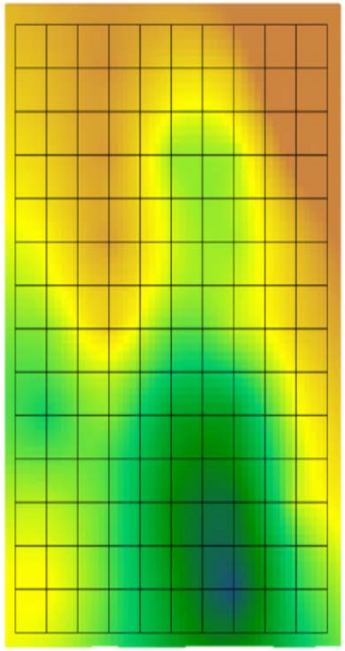


Variable Rate Drip Irrigation

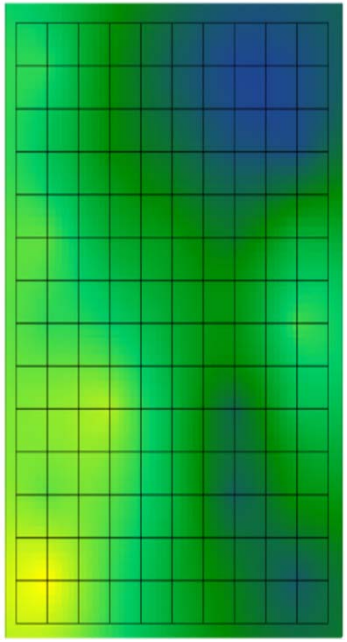


Each square = 30m x 30m LANDSAT Pixel

Changes in canopy vigor (NDVI)



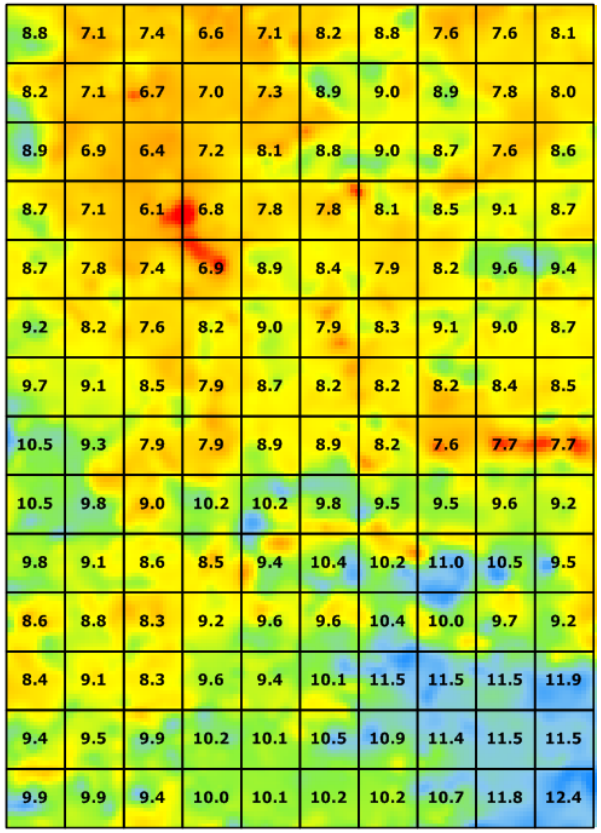
Before variable rate irrigation



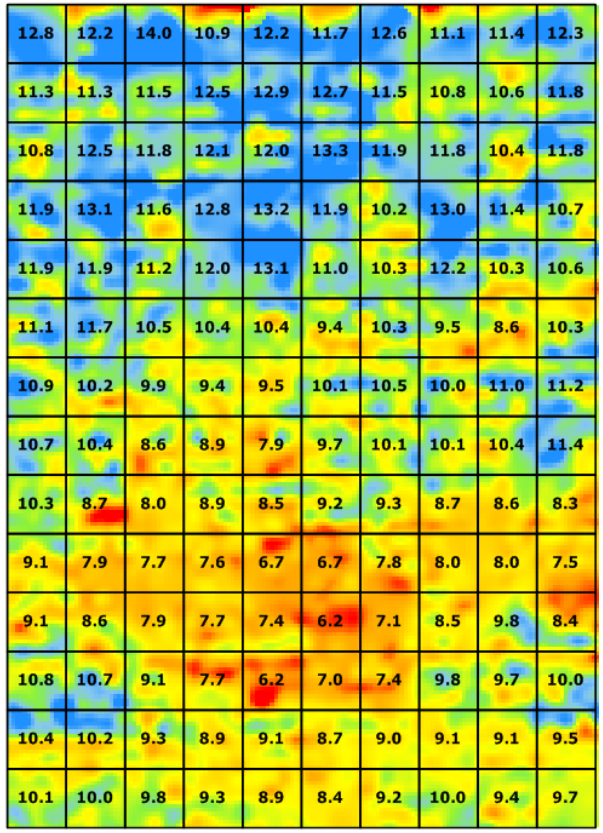
After variable rate irrigation

Pixel level management based on canopy size

Impact of Precision Irrigation



2012 Block Yield
8.1 tons/ac



2015 Block Yield
10.2 tons/ac

Yield improved 20%; Water use efficiency improved 30%

Summary and future challenges

- Sensor technology has advanced real-time, high density data collection
  - Geospatial analytics for characterizing vineyard variables – environment, growth, yield and quality
- Our ability to measure exceeds our ability to interpret
  - Understand what is important and actionable
- Large gaps exist in variable rate application technologies for geospatial management
  - Example: Variable rate drip irrigation
- Research collaboration (USDA - ARS) and industry partnership are essential to advance