### **Horticultural Crop Value**

Crop	Acres	Farm Gate Value		
Grapes	1,000,000	6 Billion		
Nuts	1,300,000	6 Billion		
Citrus	800,000	3.5 Billion		
Tree fruit	250,000	1.0 Billion		



### Horticulture Research Roadmap

Drive research to maximize productivity, sustainability and competitiveness of US horticultural crops

#### **Genomics**

Gene identification and function
Gene regulation
Traditional breeding
Molecular breeding

## Resources & Environment

Air Water Land Labor Sustainability

## Precision Management

Remote sensing
Proximal sensing
Automation
Mechanization
Big data and
informatics

### Horticulture Research Roadmap

Drive research to maximize productivity, sustainability and competitiveness of US horticultural crops

**Genomics** 

Gene identification

Resources & Environment

Air

Precision Management

Remote sensing

### **Next Generation Water Management**

Traditional breeding Molecular breeding

Labor Sustainability Mechanization
Big data and
informatics

Genome x Environment x Management

# **Current Methods for Water Management**

- Standard, discrete methods for monitoring plant water and soil moisture status have significant limitations for production
  - Subjective
  - Location specific
  - Labor intensive and expensive
  - Too few measurements are collected









## Next Generation Water Management Remote sensing allows an integrated look at the vineyard

### Remote sensing

- Multispectral, hyperspectral, thermal provide measures of plant water use and status
- Vegetation indices provide measures of canopy development and size
- Integration of remote sensing provides our most accurate assessment of whole-block water use and crop irrigation requirements







### **Next Generation Water Management**

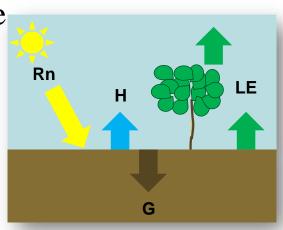
Models based on remote sensing data will replace current methods for irrigation management

### METRIC (Mapping evapotranspiration at high resolution and internalized calibration)

• ET residual of surface energy balance

$$Rn + LE + G + H = 0$$

- Inputs
  - Landsat (visible & infrared)
  - CIMIS weather data
- Outputs
  - ETc
  - Kc (f/NDVI)
- Watering of each zone:



## Building robust models based on remote sensing requires ground truthing

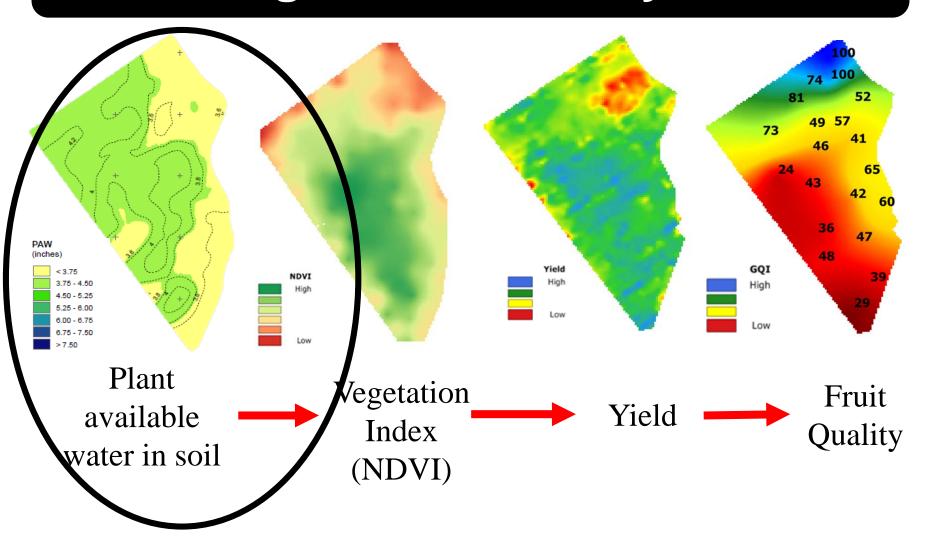




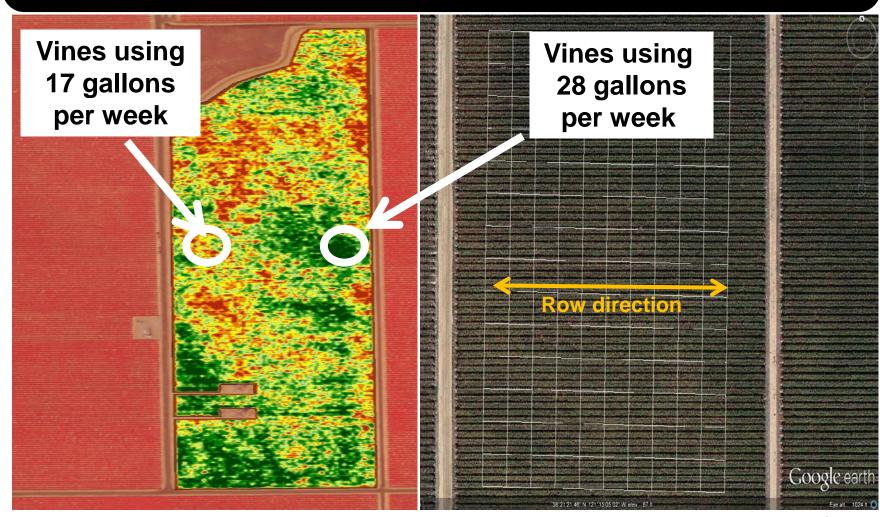


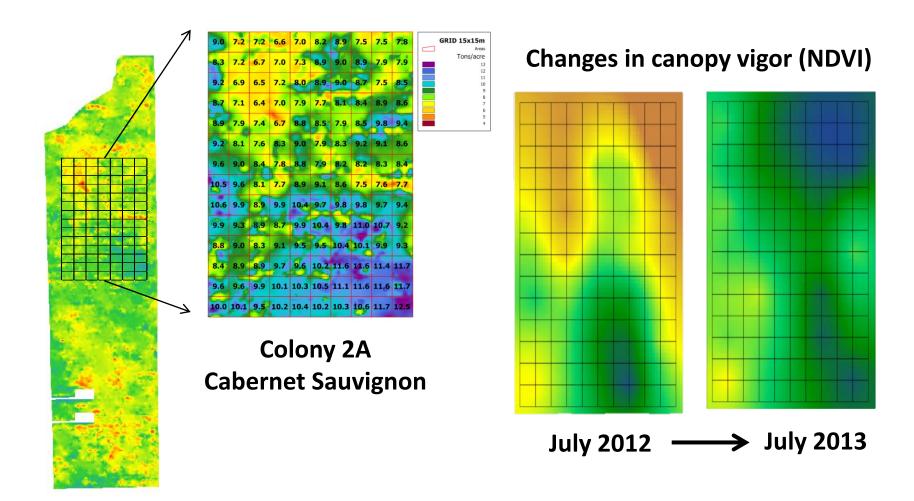


### Integrated data analytics



### Variable rate drip irrigation





### Variable Rate Irrigation

### Precision Irrigation

8.8	7.1	7.4	6.6	7.1	8.2	8.8	7.6	7.6	8.1
8.2	7.1	6.7	7.0	7.3	8.9	9.0	8.9	7.8	8.0
8.9	6.9	6.4	7.2	8.1	8.8	9.0	8.7	7.6	8.6
8.7	7.1	6.1	6.8	7.8	7.8	8.1	8.5	9.1	8.7
8.7	7.8	7.4	6.9	8.9	8.4	7.9	8.2	9.6	9.4
9.2	8.2	7.6	8.2	9.0	7.9	8.3	9.1	9.0	8.7
9.7	9.1	8.5	7.9	8.7	8.2	8.2	8.2	8.4	8.5
10.5	9.3	7.9	7.9	8.9	8.9	8.2	7.6	7.7	7.7
10.5	9.8	9.0	10.2	10.2	9.8	9.5	9.5	9.6	9.2
9.8	9.1	8.6	8.5	9.4	10.4	10.2	11.0	10.5	9.5
8.6	8.8	8.3	9.2	9.6	9.6	10.4	10.0	9.7	9.2
8.4	9.1	8.3	9.6	9.4	10.1	11.5	11.5	11.5	11.9
9.4	9.5	9.9	10.2	10.1	10.5	10.9	11.4	11.5	11.5
9.9	9.9	9.4	10.0	10.1	10.2	10.2	10.7	11.8	12.4

12.8	12.2	14.0	10.9	12.2	11.7	12.6	11.1	11.4	12.3
11.3	11.3	11.5	12.5	12.9	12.7	11.5	10.8	10.6	11.8
10.8	12.5	11.8	12.1	12.0	13.3	11.9	11.8	10.4	11.8
11.9	13.1	11.6	12.8	13.2	11.9	10.2	13.0	11.4	10.7
11.9	11.9	11.2	12.0	13.1	11.0	10.3	12.2	10.3	10.6
11.1	11.7	10.5	10.4	10.4	9.4	10.3	9.5	8.6	10.3
10.9	10.2	9.9	9.4	9.5	10.1	10.5	10.0	11.0	11.2
10.7	10.4	8.6	8.9	7.9	9.7	10.1	10.1	10.4	11.4
10.3	8.7	8.0	8.9	8.5	9.2	9.3	8.7	8.6	8.3
9.1	7.9	7.7	7.6	6.7	6.7	7.8	8.0	8.0	7.5
9.1	8.6	7.9	7.7	7.4	6.2	7.1	8.5	9.8	8.4
10.8	10.7	9.1	7.7	6.2	7.0	7.4	9.8	9.7	10.0
10.4	10.2	9.3	8.9	9.1	8.7	9.0	9.1	9.1	9.5
10.1	10.0	9.8	9.3	8.9	8.4	9.2	10.0	9.4	9.7

2012 Block Yield 8.9 t/ac

2013 Block Yield 10.2 t/ac 20% less water applied

### **Next Generation Water Management**

#### **MEASURE**

soil and plant water status

Develop integrated, block level measures to monitor plant water and soil moisture status

#### MODEL

remote and proximal sensor data

Correlate relationships among remote sensing, proximal sensing, traditional measures and other data sources and plant water and soil moisture status

#### MANAGE

Irrigation to maximize water use efficiency

Develop precision irrigation systems for variable rate irrigation management, including Best Practices for irrigation amount, timing and frequency to optimize water use efficiency

### Summary

- Increased focus on specialty crops
  - Modern tools to measure, model and manage water and improve water use efficiency
- Commodity group collaboration to extend ARS efforts
  - Potential source of funding
  - Link to extension of information to grower community
- Establish Grape LTAR in California
  - Focus on water agro-ecosystem and management

