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# Fiction and Reality of On-the-go Soil Mapping

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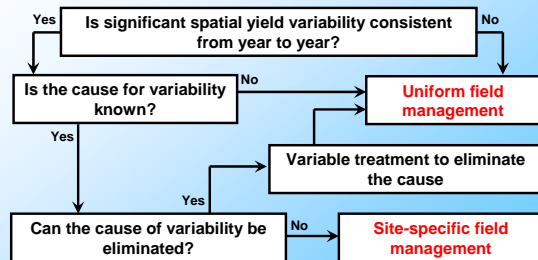


## Problem Statement

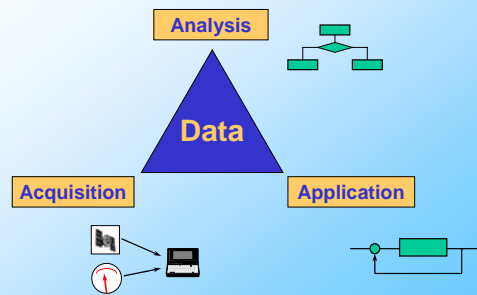
- The assessment of soil variability is one of the most important steps in site specific management
- Varying application rates is inappropriate without accurate information about soil spatial structure
- Obtaining descriptive information about a field is expensive using conventional soil sampling methods
- There is a need to develop equipment for mapping soil attributes on the go
- On the go sensing technology must be reliable, rapid, simple, inexpensive, repeatable



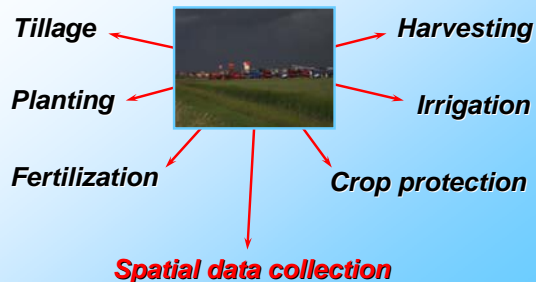
## Uniform Treatment vs. VRT



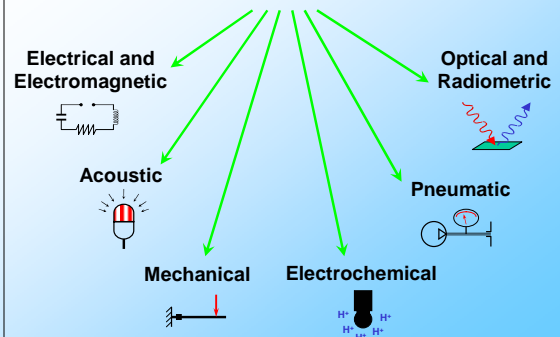
## AAA Concept

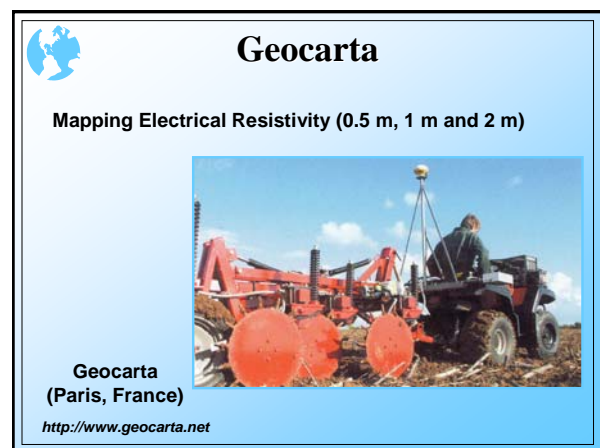
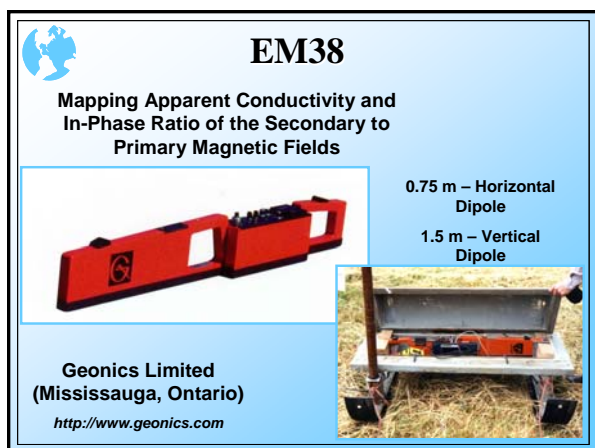
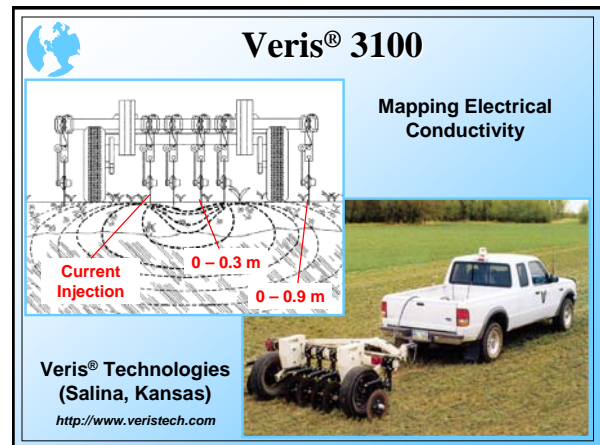
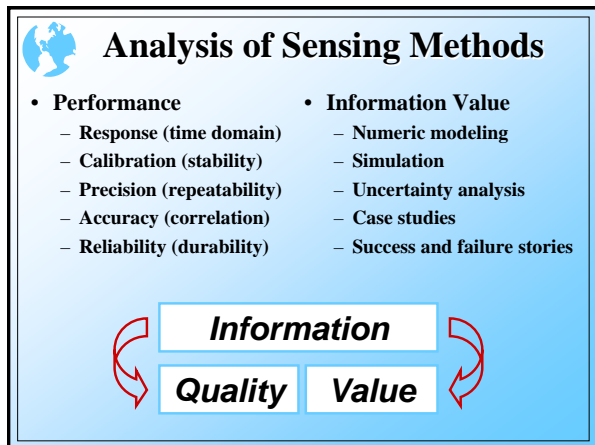
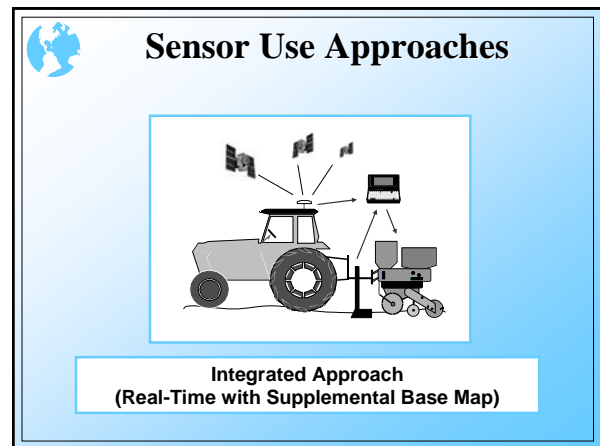
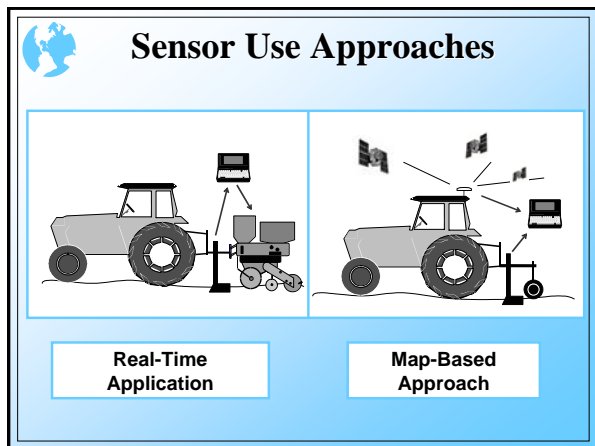


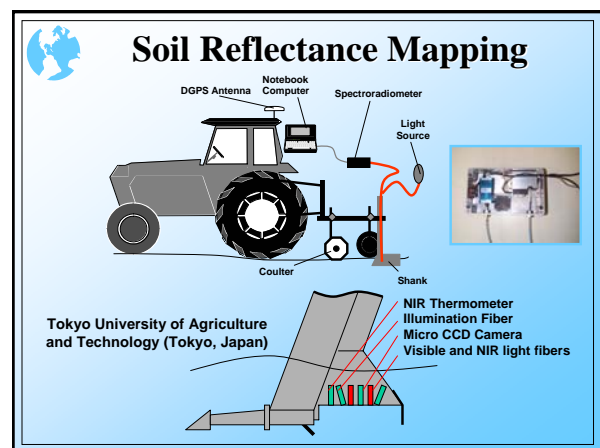
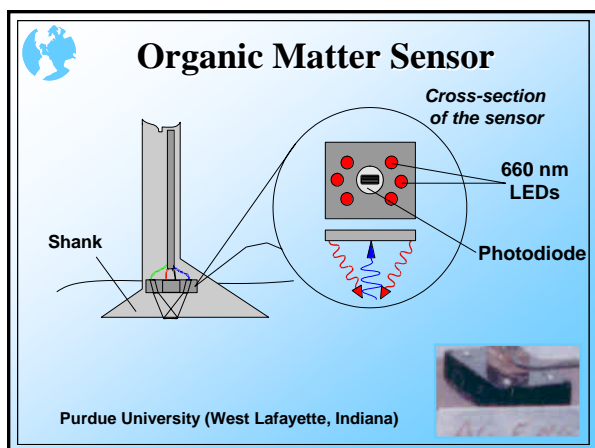
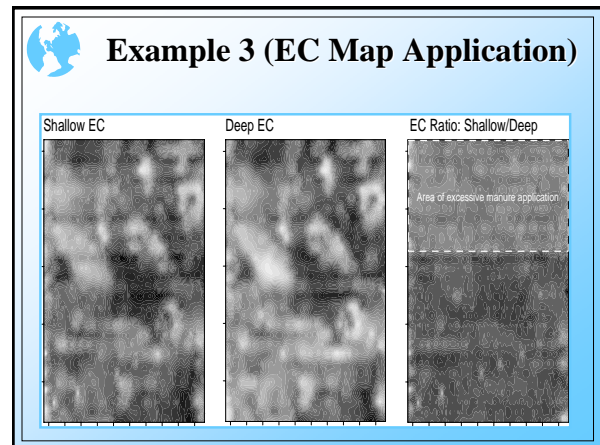
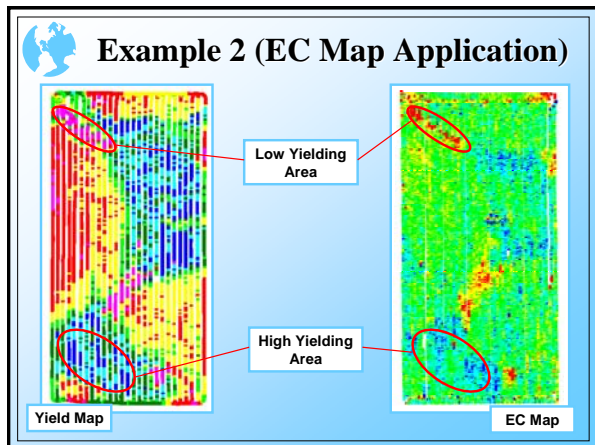
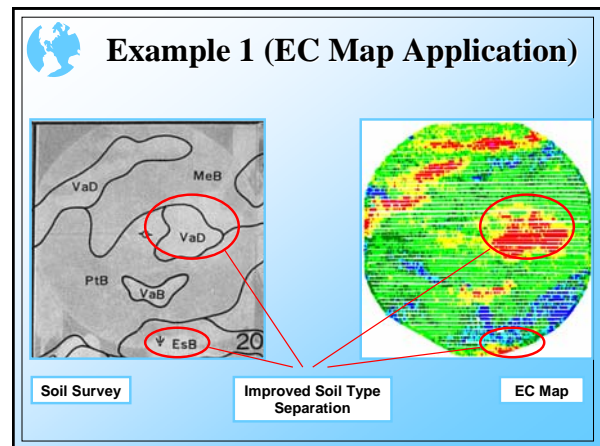
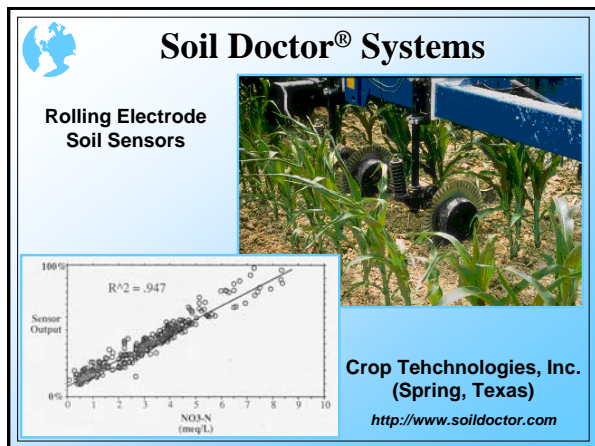
## Agricultural Machine Systems



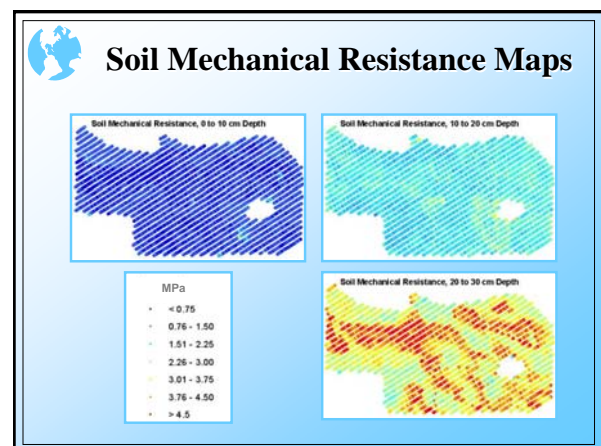
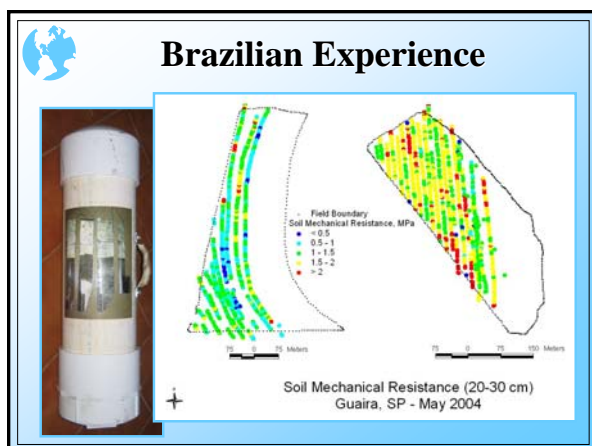
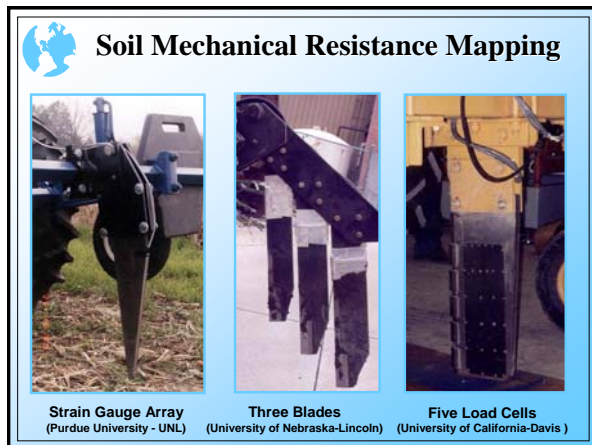
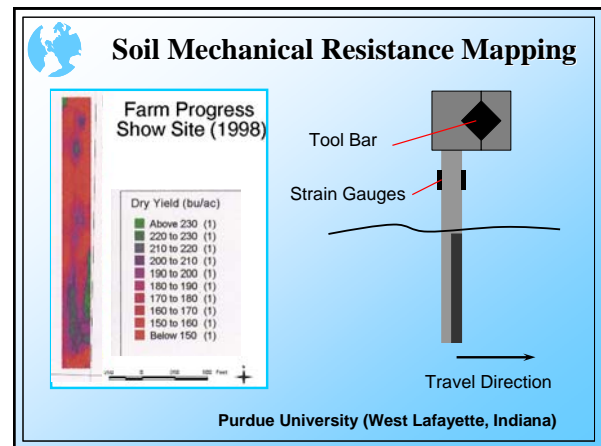
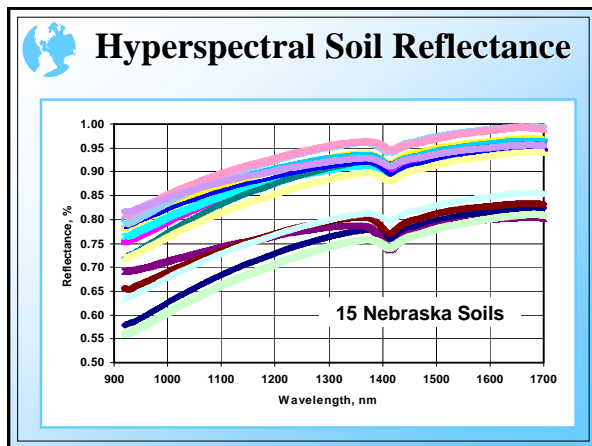
## On-the-go Soil Sensors

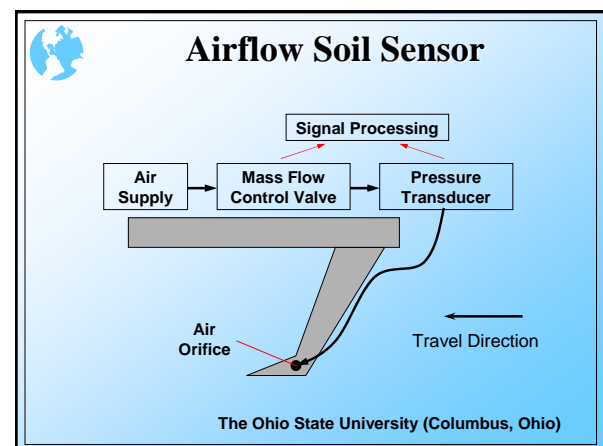
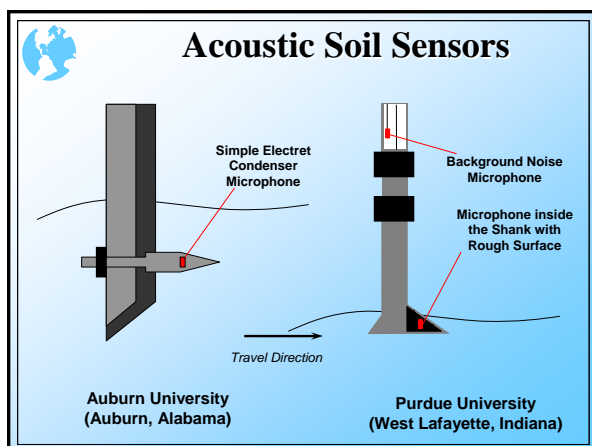
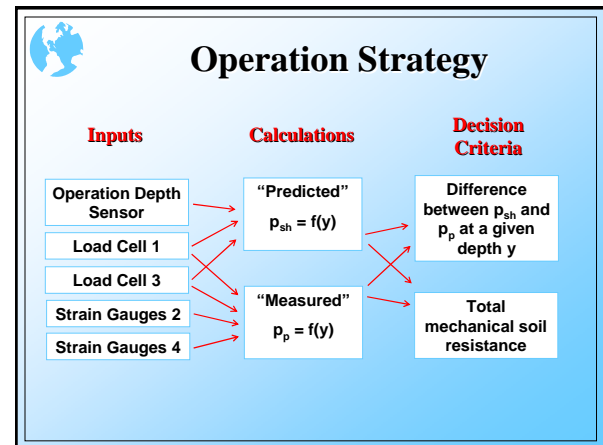
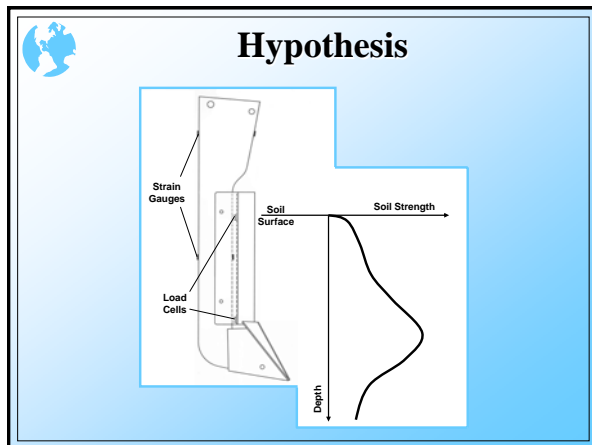
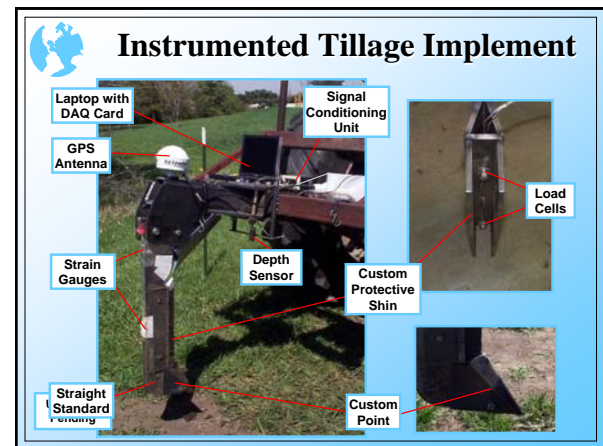
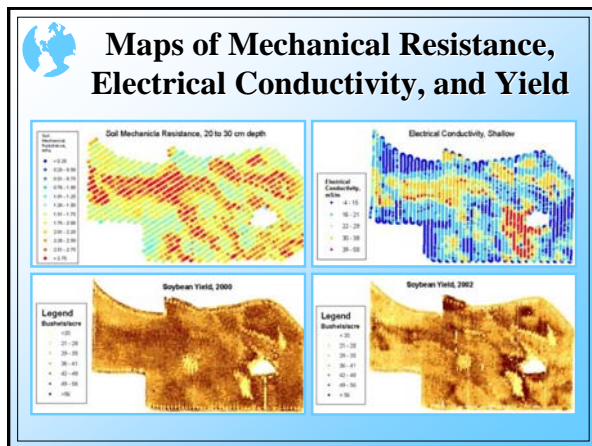








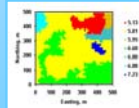
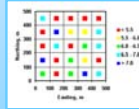
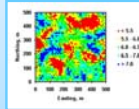






## Conventional Soil Sampling

- Random
- Grid (Systematic) Sampling
  - Grid Point (Cluster) Method
    - Regular (Center)
    - Staggered and Random Start
    - Systematic Unaligned
    - Random
  - Grid Cell Method
- Adaptive
  - By Soil Types
  - By Management Zones

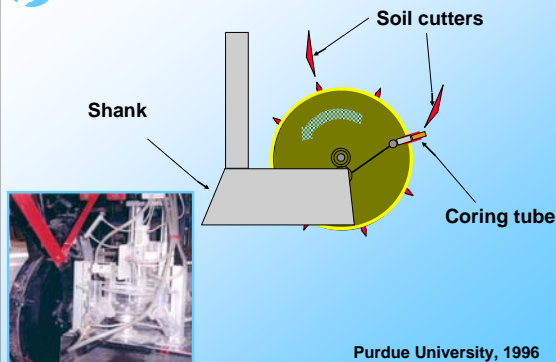


## Standard Soil pH Test

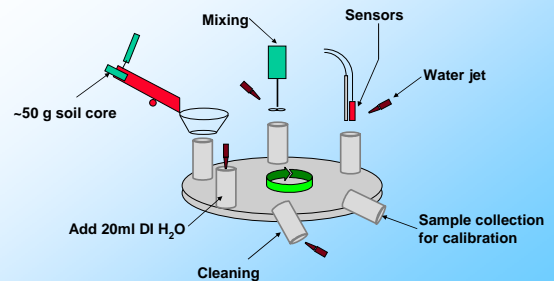
- Preparation (drying, crushing, sieving)
- Solution
  - 1:1 soil/water solution
- Extraction
  - DI water (soil pH)
  - SMP buffer solution (buffer pH)
- Measurement
  - Ion-selective electrode
  - Glass bulb



## Soil Nutrients Mapping



## Soil Nutrients Mapping



## Direct Soil Measurement

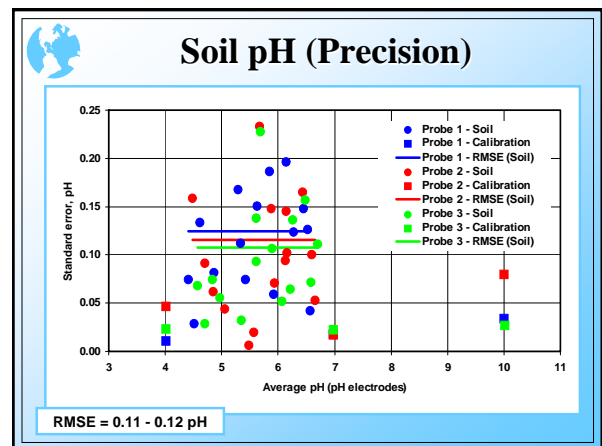
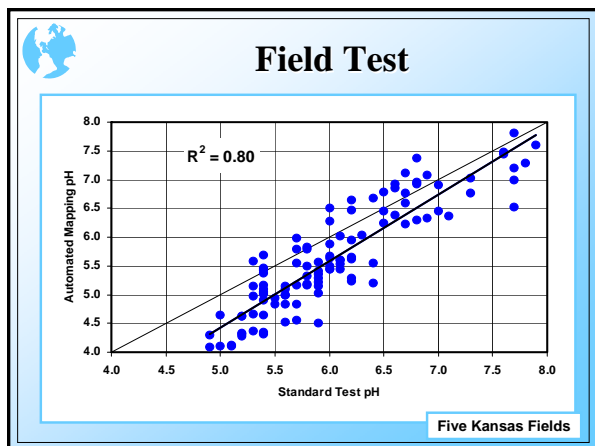
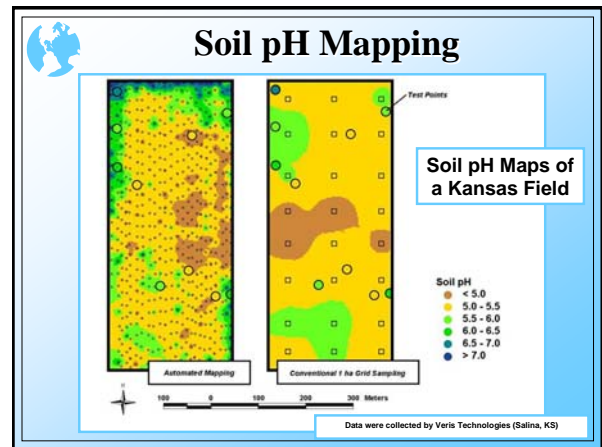
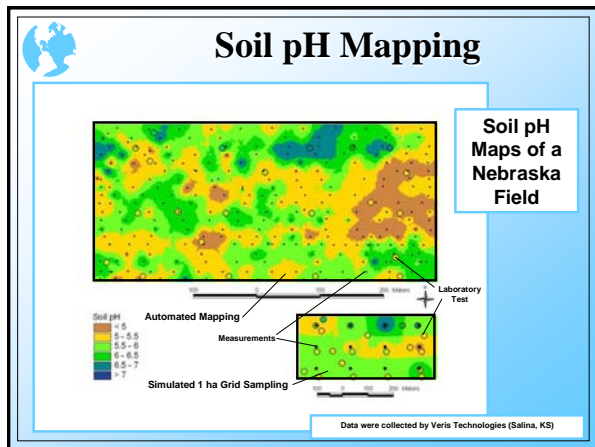
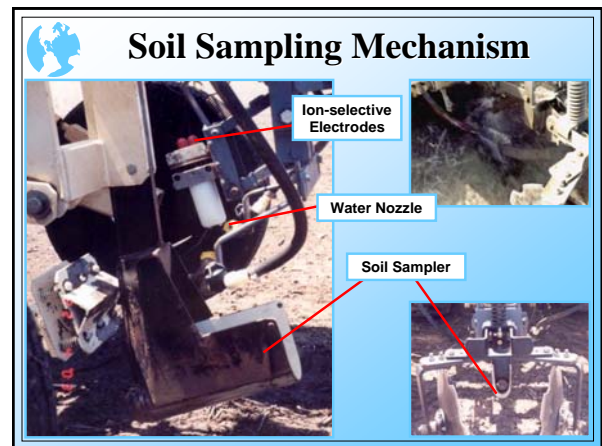
- Preparation
  - Field conditions
- Solution
  - Naturally moist soil
- Extraction
  - Available ion activity
- Measurement
  - Ion-selective electrode
  - Flat (dome) surface

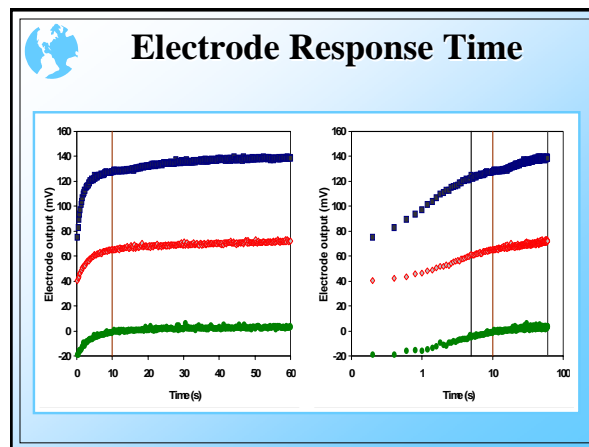
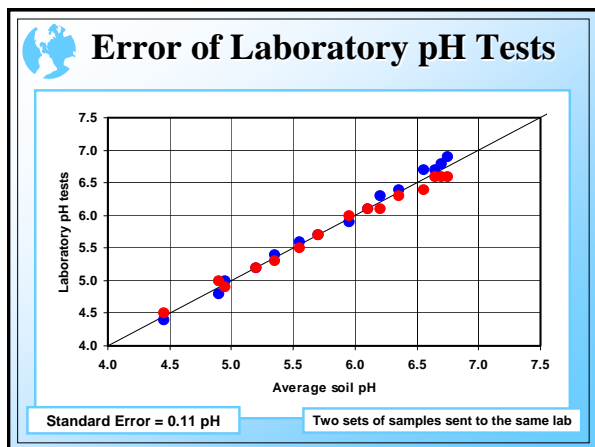
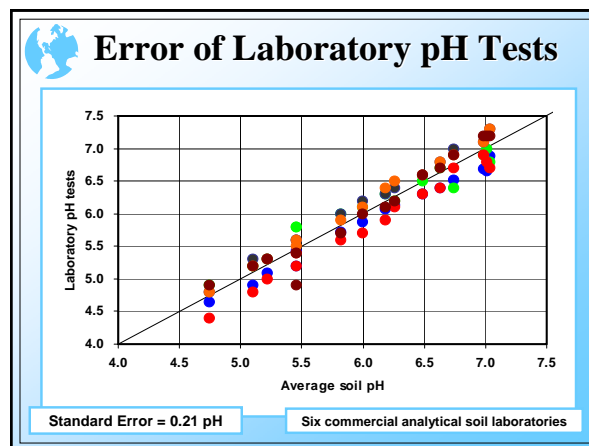
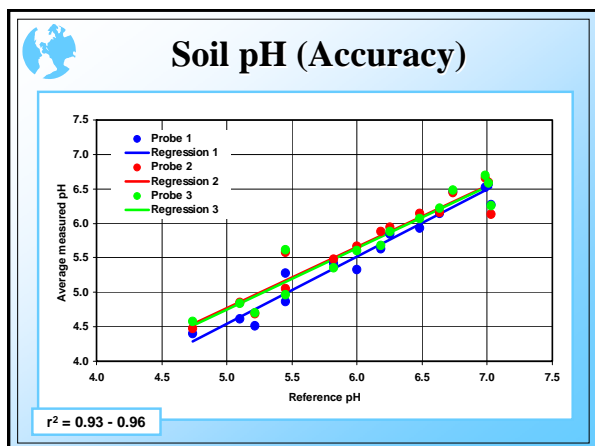


## Automated Soil pH Mapping Systems



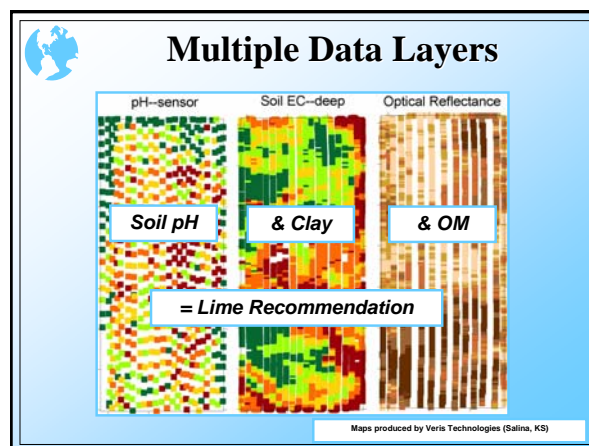




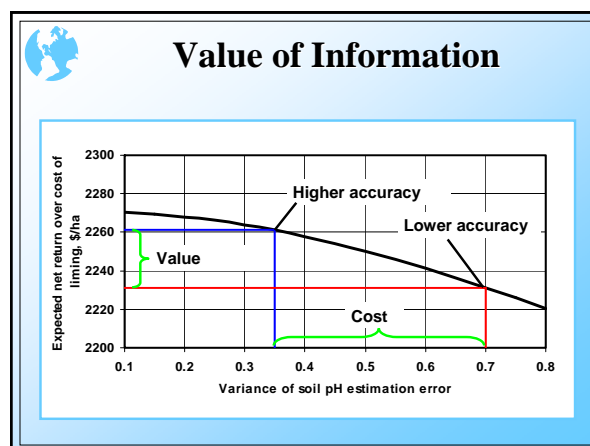
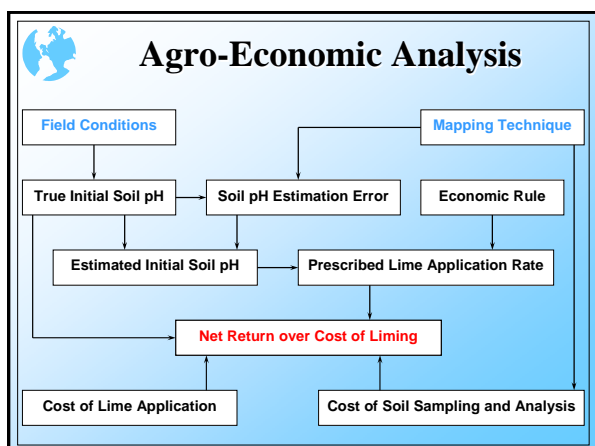


### Buffer pH and Lime Requirement

- Assume constant soil buffering for homogeneous areas  
 $Buffer\ pH = f(Soil\ pH)$
- Use electrical conductivity (EC) in combination with soil pH to predict buffer pH  
 $Buffer\ pH = f(Soil\ pH, EC)$
- Add soil reflectance measurements to improve buffer pH prediction  
 $Buffer\ pH = f(Soil\ pH, EC, Reflection)$







### Applicability of On-the-Go Soil Sensors

Soil property	Good	OK	Some	Good	OK	Some
Soil texture (clay, silt and sand)	Good	OK			OK	
Soil organic matter or total carbon	Some	Good				
Soil water (moisture)	Good	OK				
Soil salinity (sodium)	OK	Some				Some
Soil compaction (bulk density)			Good	OK		
Depth variability (hard pan)	Some	Some	OK	OK		
Soil pH		Some				Good
Residual nitrate (total nitrogen)	Some	OK				OK
Other nutrients (potassium)						OK
CEC (other buffer indicators)	OK	Good				

- ### Summary
- On-the-go soil sensors can provide high density information about soil properties
  - Our ability to map specific agronomic soil attributes remains questionable
  - Combining (fusion) of different sensors may be beneficial
  - New and improved sensors are under development
  - Agro-economic evaluation of the value of information is needed

- ### Potential Applications
- Prescribe variable rate soil treatment
    - Direct utilization of sensor data
    - Improvement of management zones definition
  - Support on-farm research
    - Crop response
    - Fertilizer and lime effect
    - Spatially variable temporal changes
  - Improve existing recommendations on soil management

