Site-Specific Soil Fertility Management

With Emphasis on P, K, and Lime

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Site Specific Management

- What is a site? A field or sections of a field worth managing differently
- Describe, georeference, and account for variation in soil types, soil tests, yields, and other soil or crop measurements
- Use diagnostic tools, information, and equipment that allow for managing field sections in different ways
- Use and manage information better

Precision Agriculture Technologies

- GPS devices, yield monitors
  - Already proved very useful and key tools
- Variable rate technology
  - Proved very useful for P, K and lime
- Aerial/satellite images, electrical conductivity, canopy sensing, precision banded input application
  - We are still learning how to use them effectively and the value for specific nutrients and conditions

Describe and Record Variability

- Reasons for yield variation often are obvious: Leaf diseases, pests, weeds, moisture, N deficiency in corn
- Often reasons are not obvious, such as for P and K fertility
- What is cause or effect? Yield may be high when a measurement is high or low just because others changed at the same time, sometimes not measured

Reasons for Nutrient Variability

- **Organic matter:** natural causes
- **pH:** natural and management causes
- **P and K:** mainly management due to residual effects of fertilizers and manure, long histories of fertilization, removal variation due to yield variation
- The variation patterns differ among nutrients, **but we measure all in the same sample!**

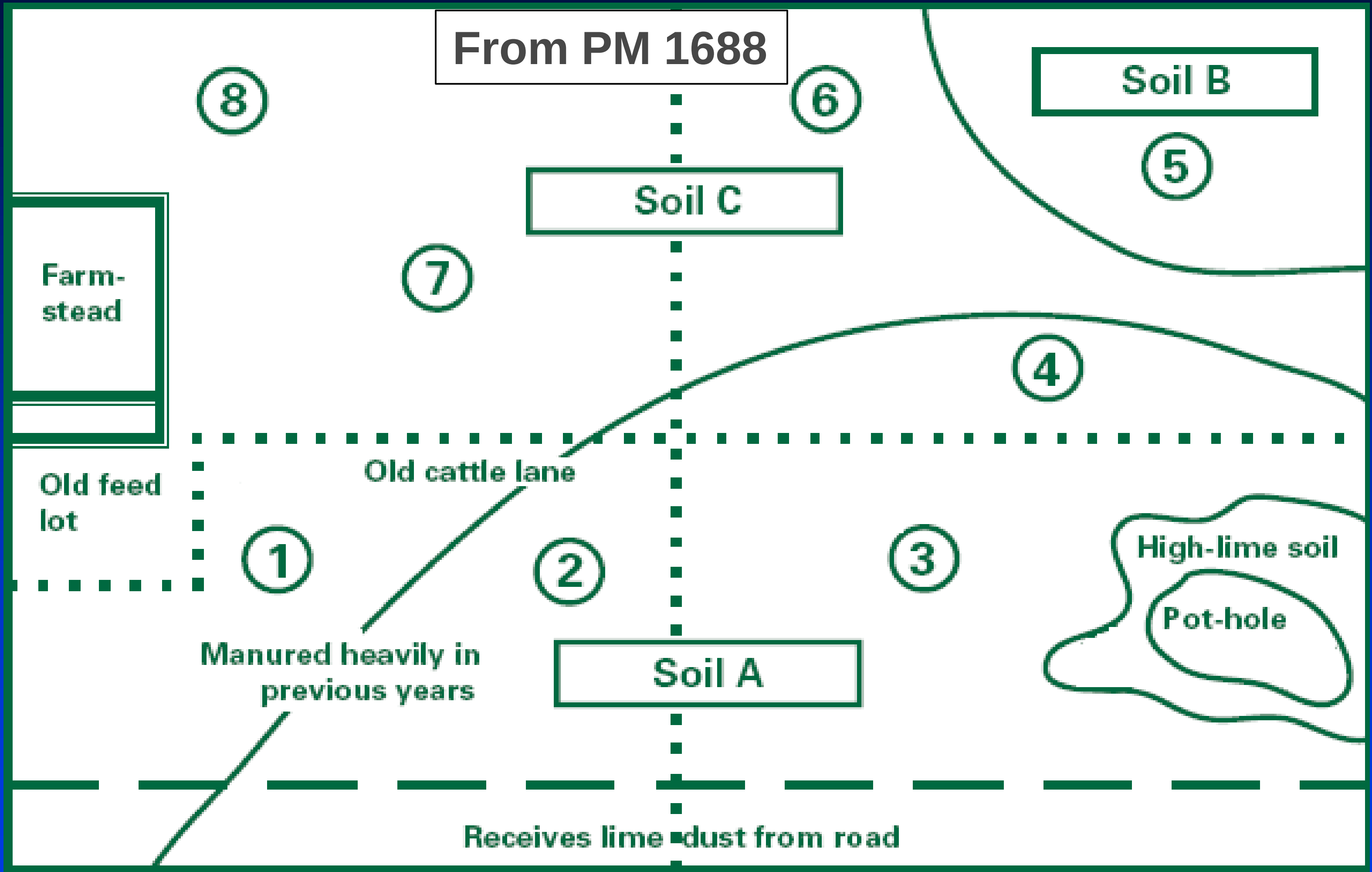
Updated Soil Sampling Publication

CROP 3108 - December 2016

One of the most important steps in soil testing is collecting soil samples. The soil sample is the first part of the soil testing process and the foundation for information derived from laboratory analyses, soil test interpretations, and recommendations. Soil sampling is also the largest and most

recommended sampling times and cannot be used with suggested interpretations. Field research calibrations for phosphorus (P), potassium (K), and pH soil tests are based on samples collected in the fall or spring. Recent research suggests that samples taken in late spring or early summer, before around the V6 growth

Sampling by Soil Type and Topography

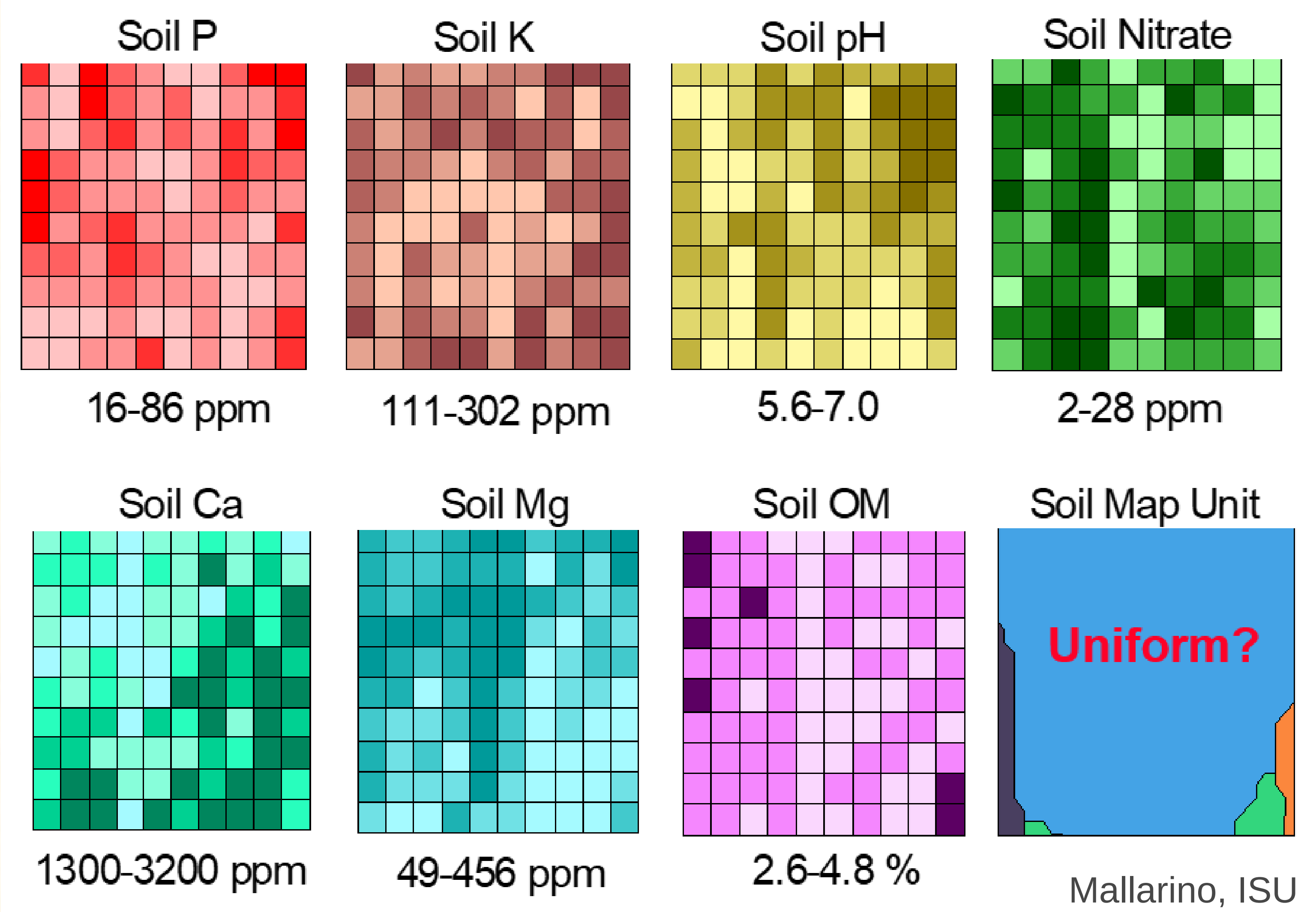


Most states recommend one sample every 10 to 15 acres

Sampling by Soil Type & Topography

- Soil formation factors may influence nutrient levels:
  - Mineralogy, chemical properties, and texture of parent materials
  - Topography influences soil profile development, water dynamics, erosion, leaching, and organic matter accumulation
- Soil physical properties may influence yield potential and nutrient removal

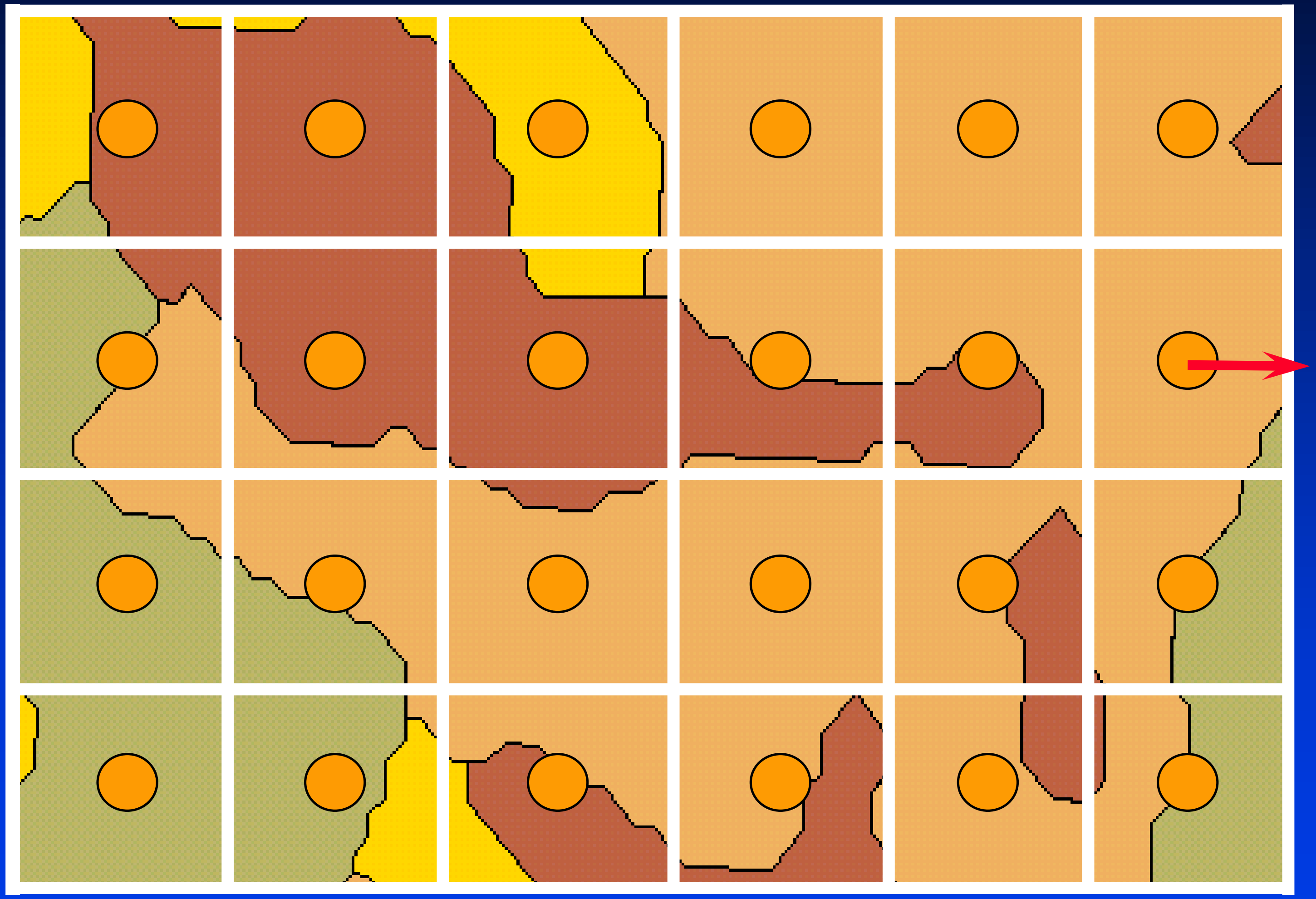
Variation Within Soil Map Units



Grid Soil Sampling

- More samples are taken compared to sampling by soil type and topography, and should describe nutrient variability better but is more expensive
- Assumes that nutrient differences aren't due only to soil types or topography, or that it is accounted for if it exists
- Ideal as the base for using variable-rate application technology

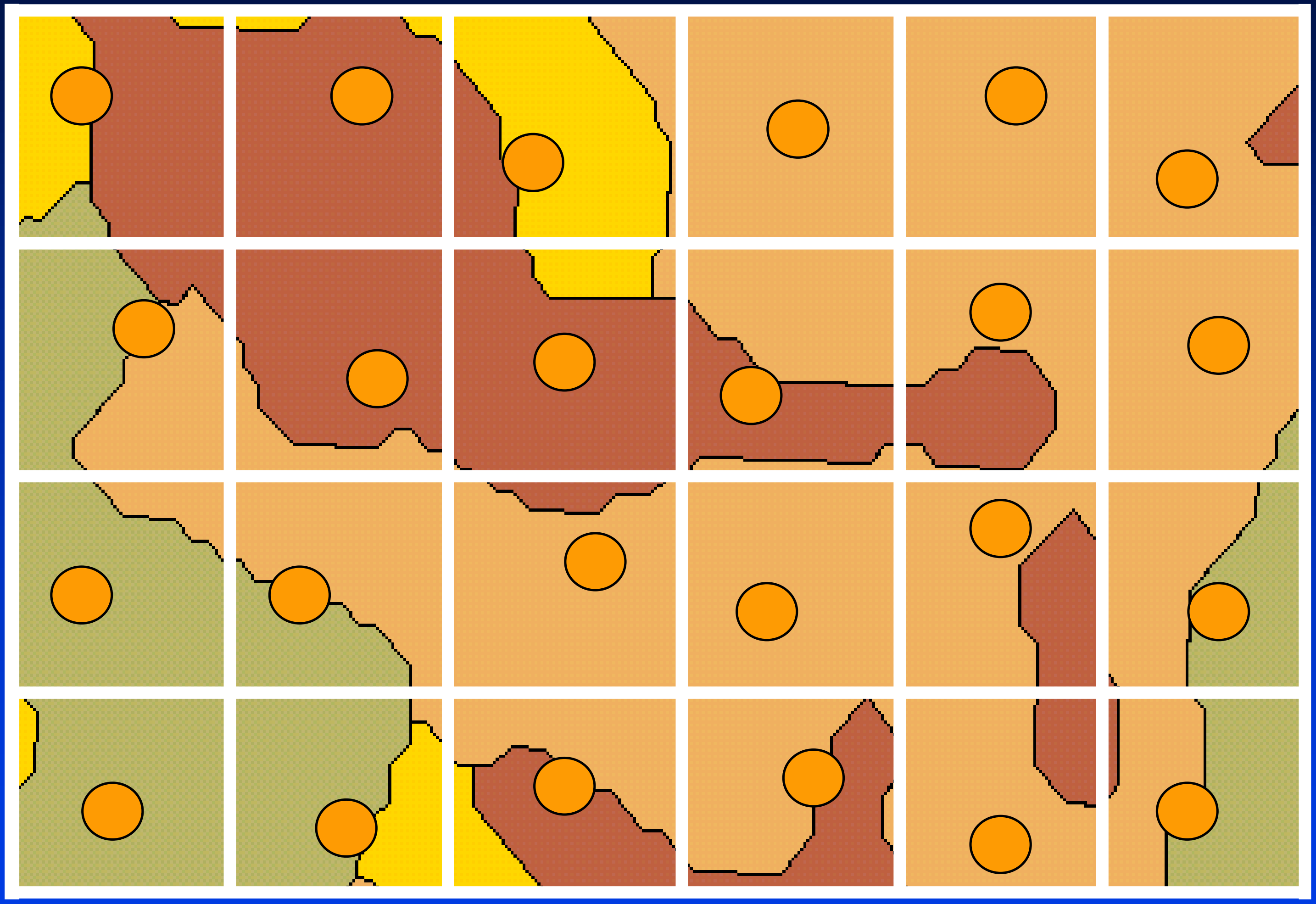
Systematic Grid-Point Sampling



Small point take 10-12 cores per composite sample

(sampling points overlaid on soil map units)

Unaligned or Random Grid-Point



Could position sampling points to avoid soil map unit borders

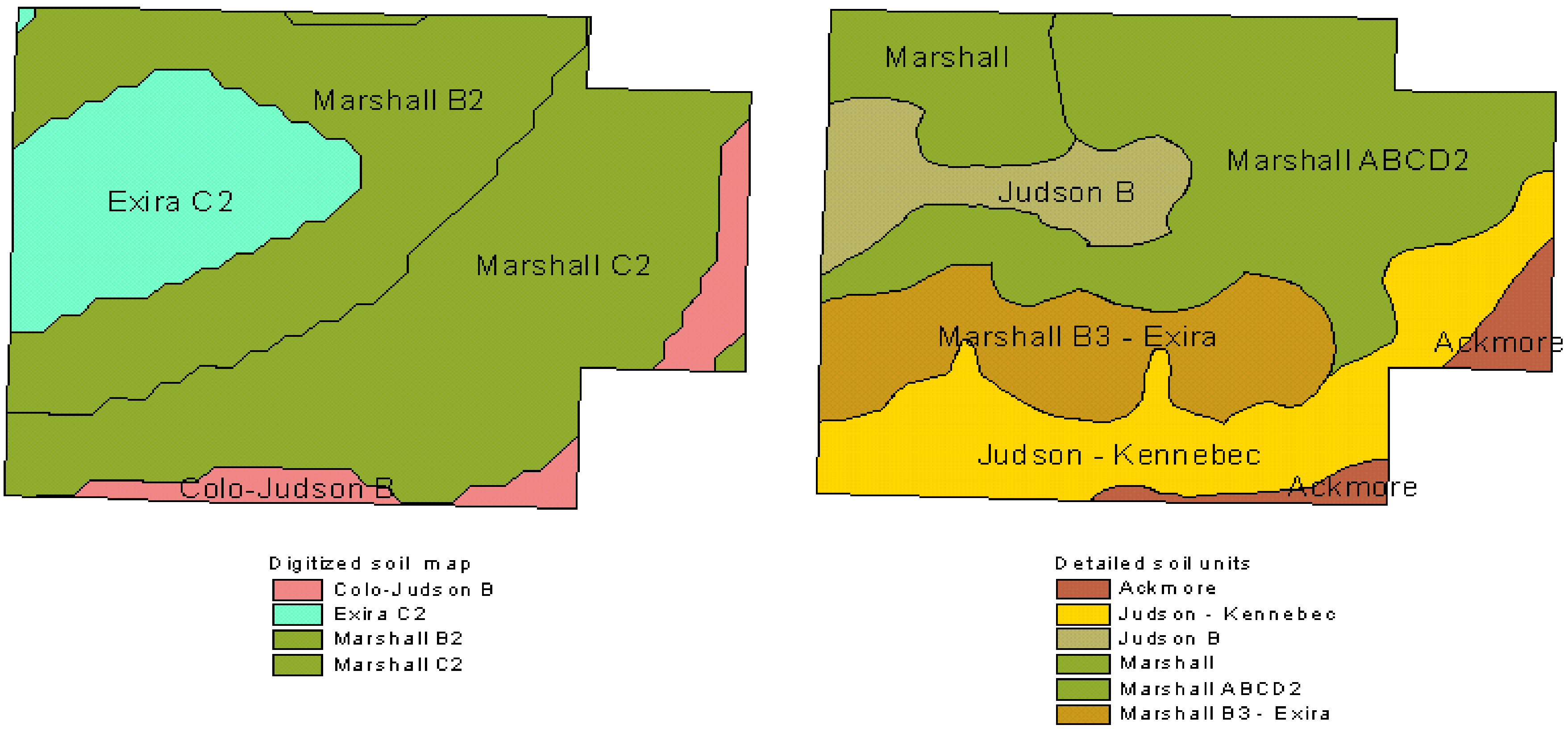
(sampling points overlaid on soil map units)

What Is Being Found in Iowa?

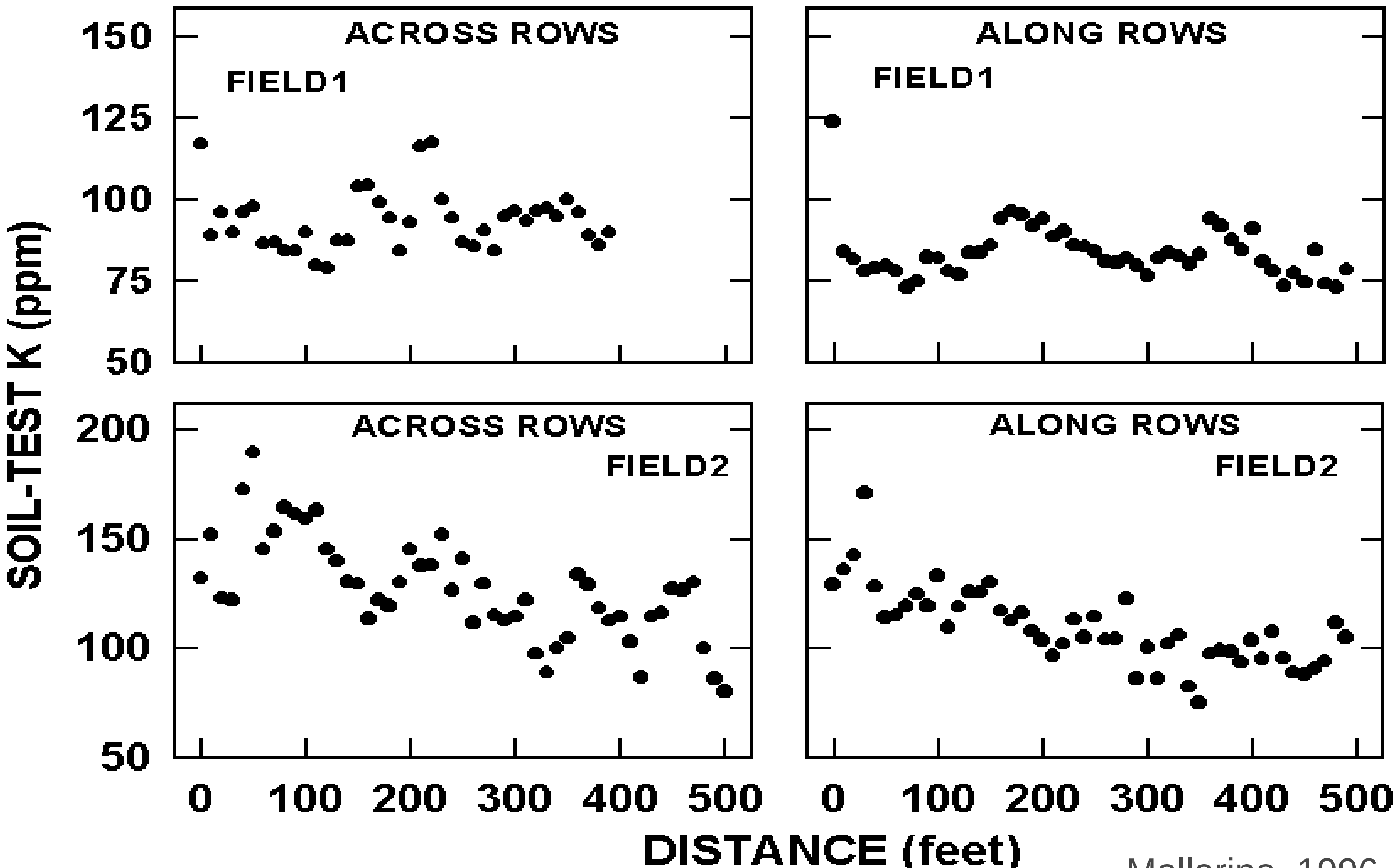
- About 20,000 samples from field-scale research to study soil-test P, K, pH, and OM variation and VRT
- Amount and patterns of variability vary across fields and nutrients, and there is very high small-scale variability
- No sampling plan can expected to be best across all fields and nutrients
- Cost-benefit of dense sampling?

Precision of Soil Survey Maps?

Comparison of Detailed and Digital Soil Type Maps

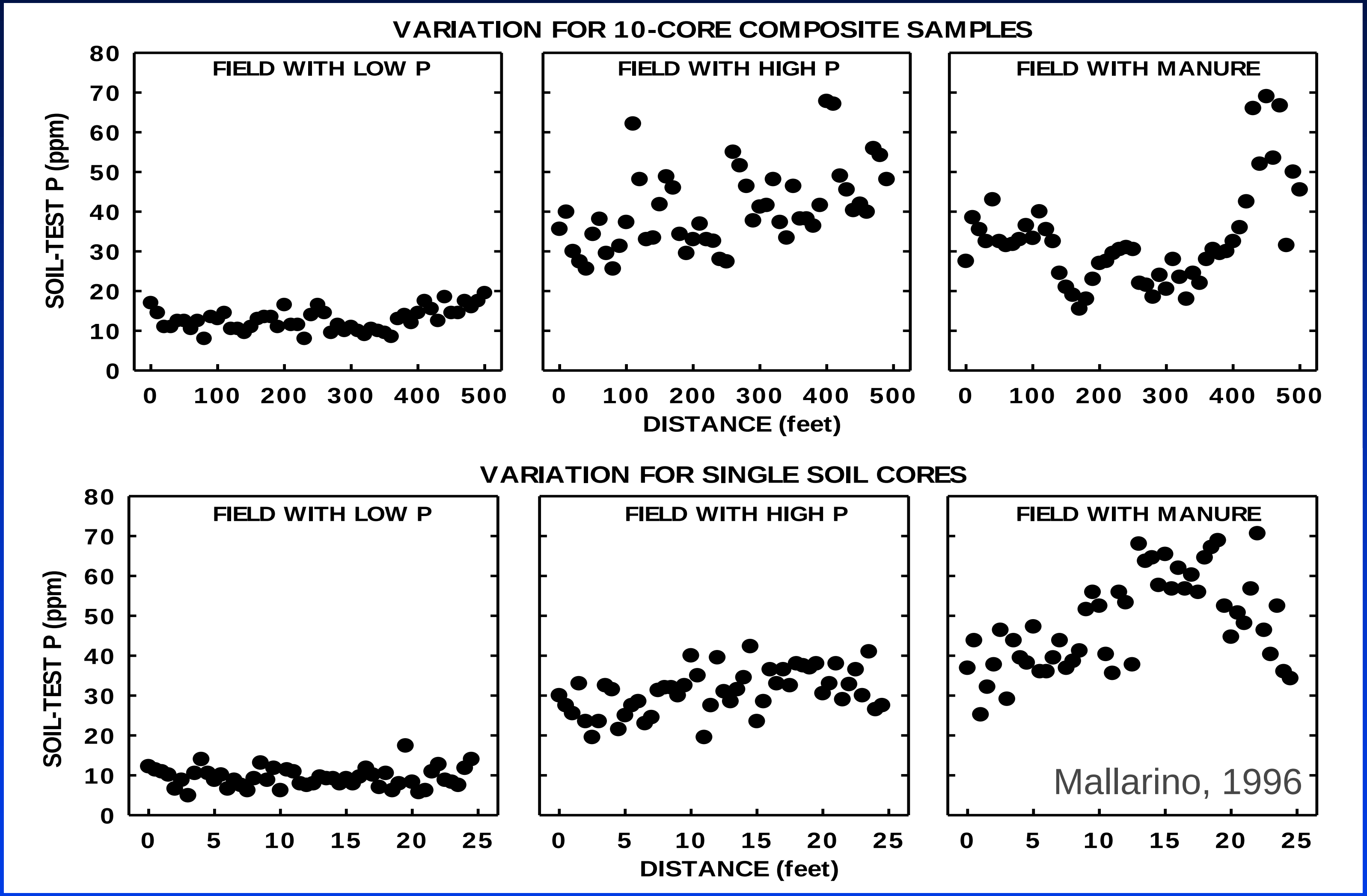


Large Systematic Variabilty

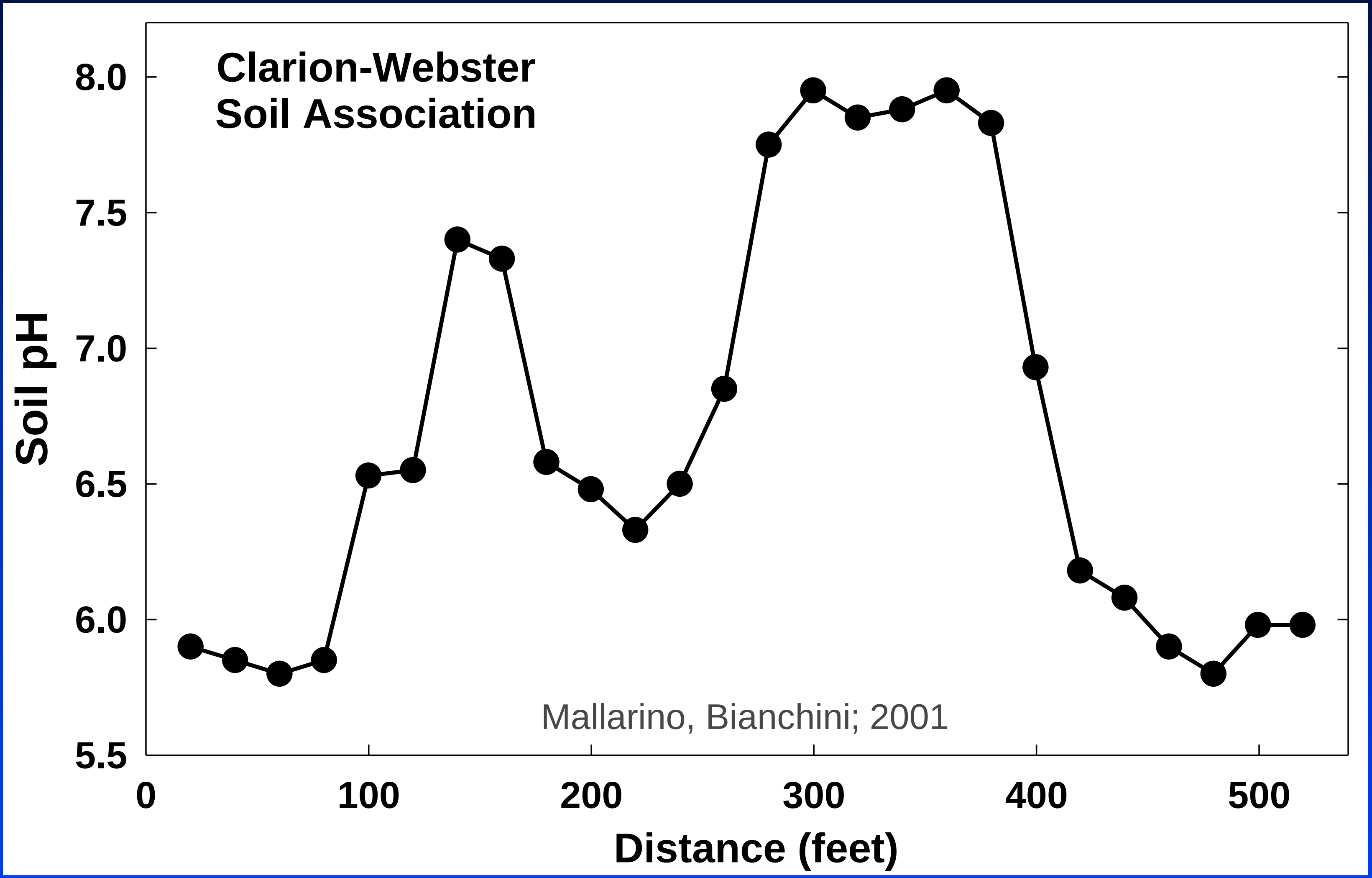


Mallarino, 1996

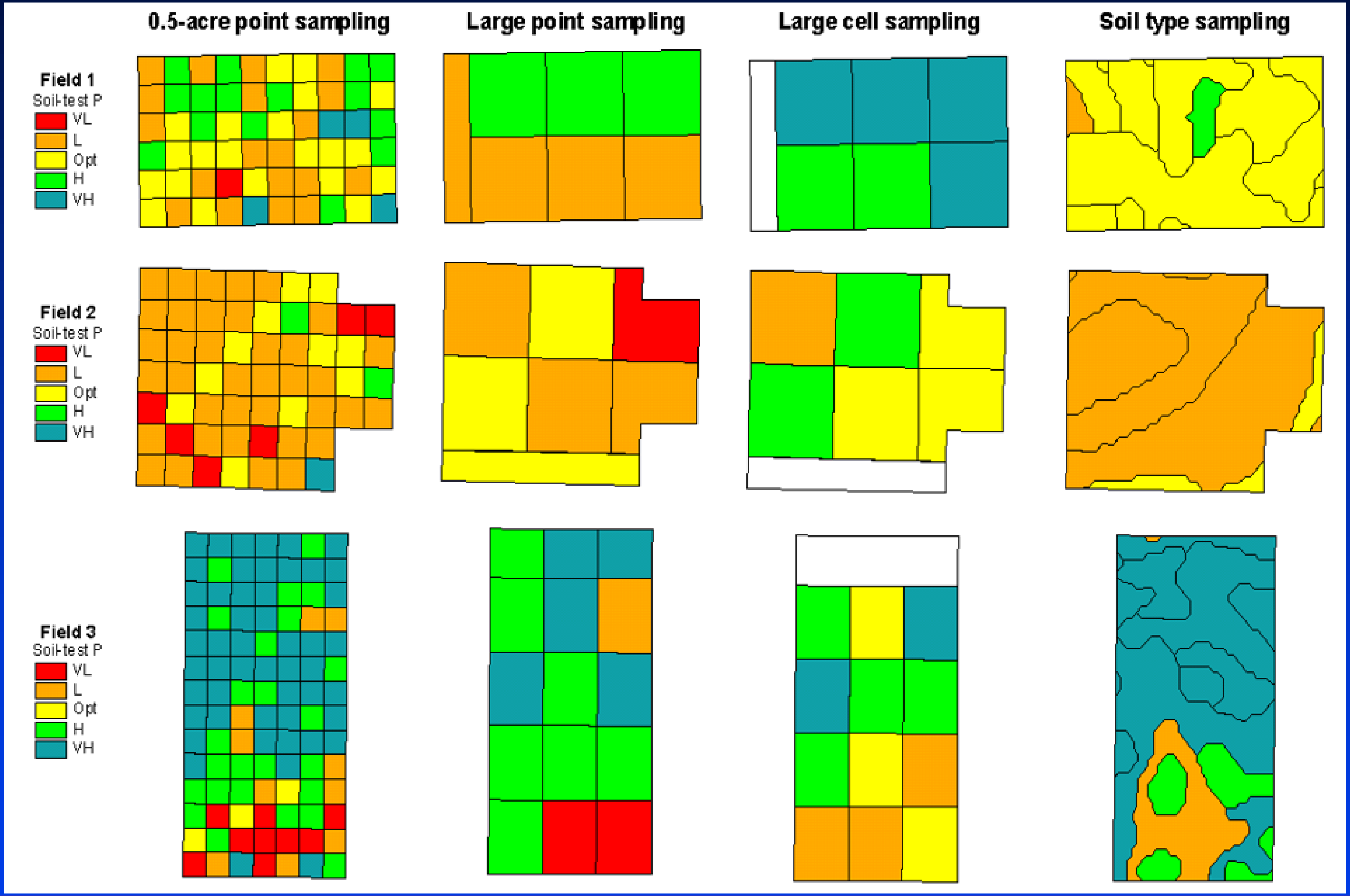
Large-Scale and Small Scale Variation



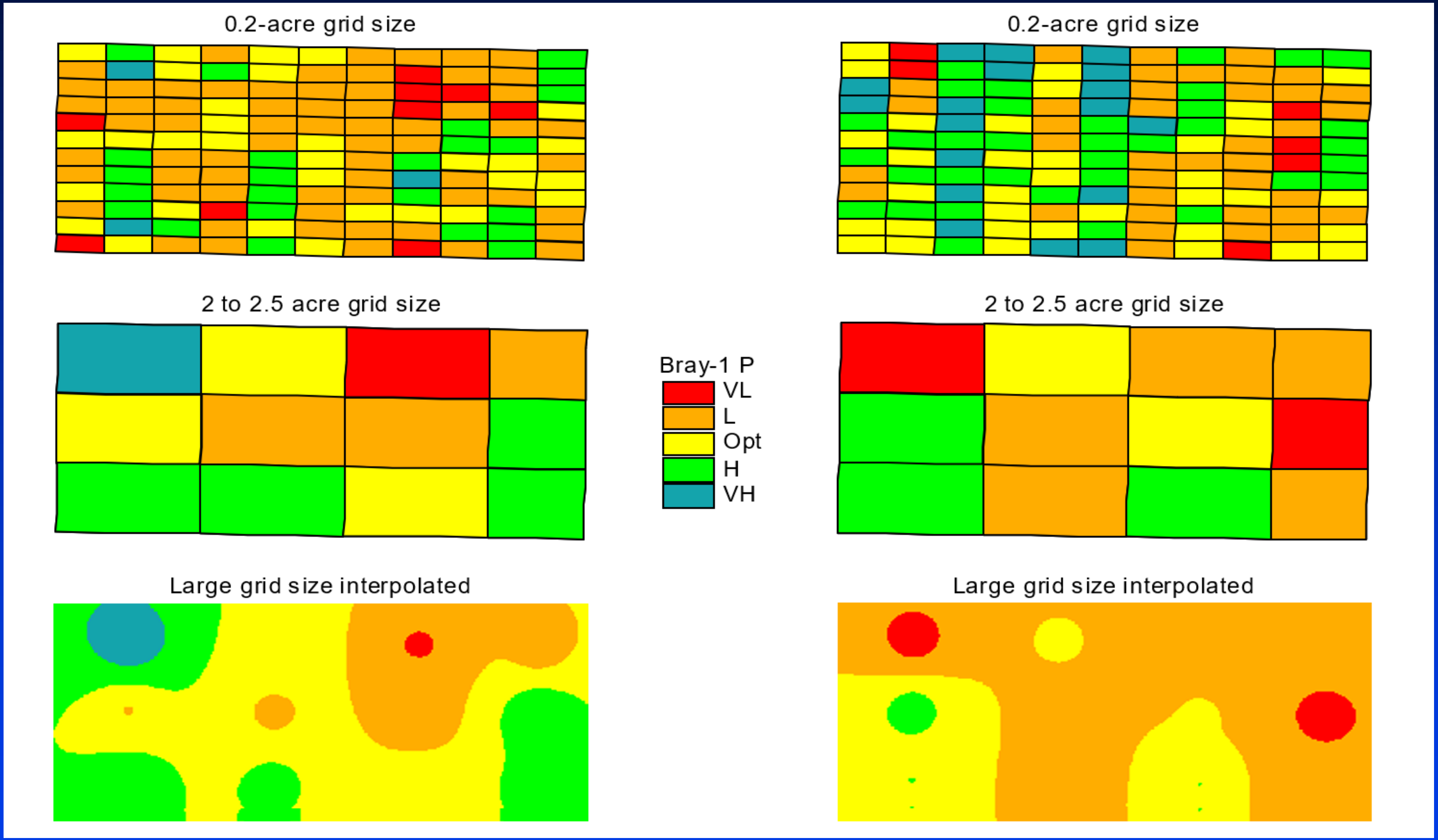
Small Scale pH Variation



Sampling Method and Soil-Test P



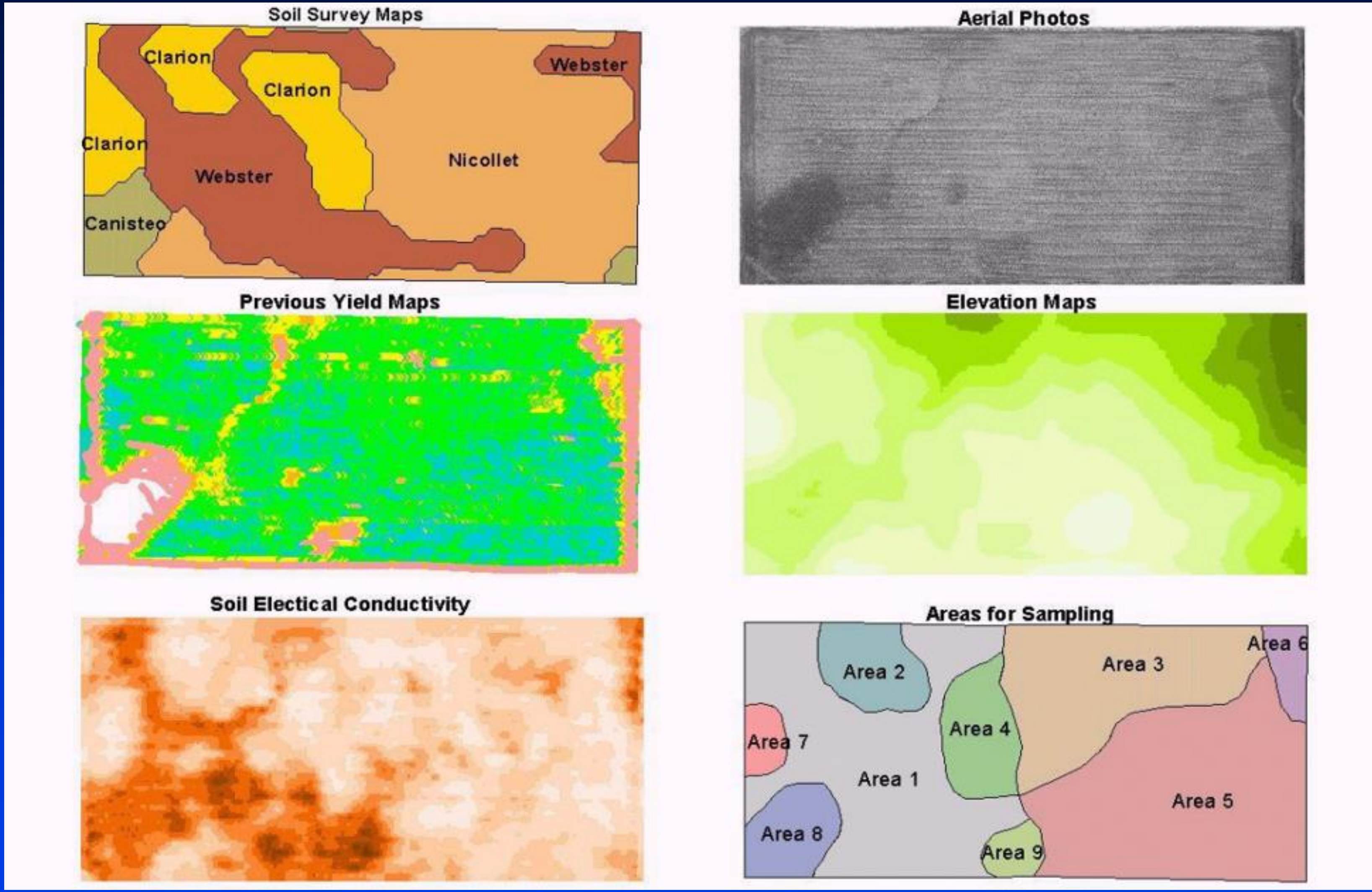
Grid Cell Size and Interpolation



Management Zones Sampling

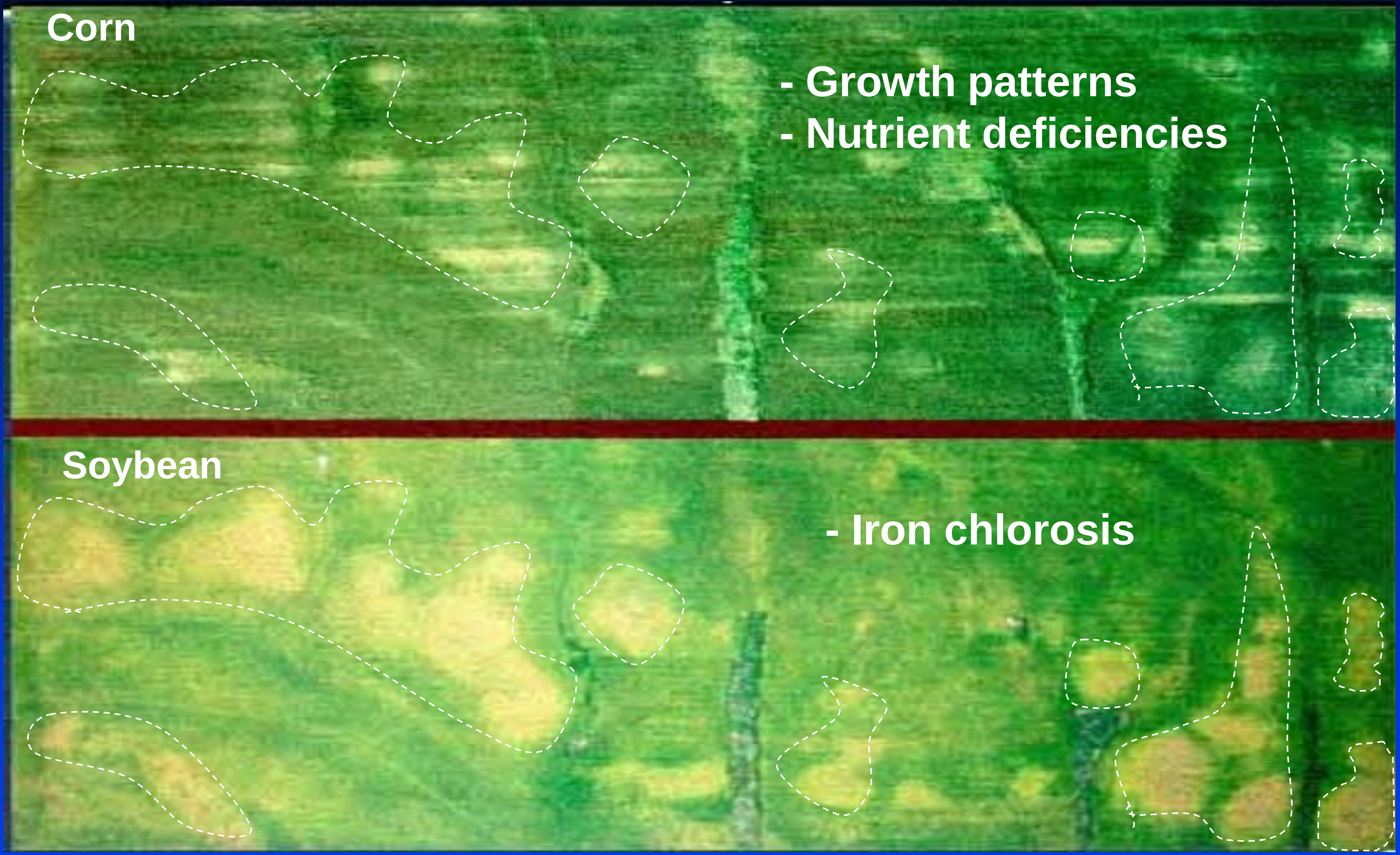
- Improve the sampling by soil type method and provide an alternative to a blind and costly grid sampling
- Delineate sampling areas based on many information layers: aerial photos, maps of soil, topography, yield, electrical conductivity, etc.
- Assumes that these factors are the cause or are related to different nutrient availability or crop needs

Management Zones Sampling



Overlay Layers of Information

Identifying Calcareous Field Areas



A. Blackmer & N. Rogovska, ISU

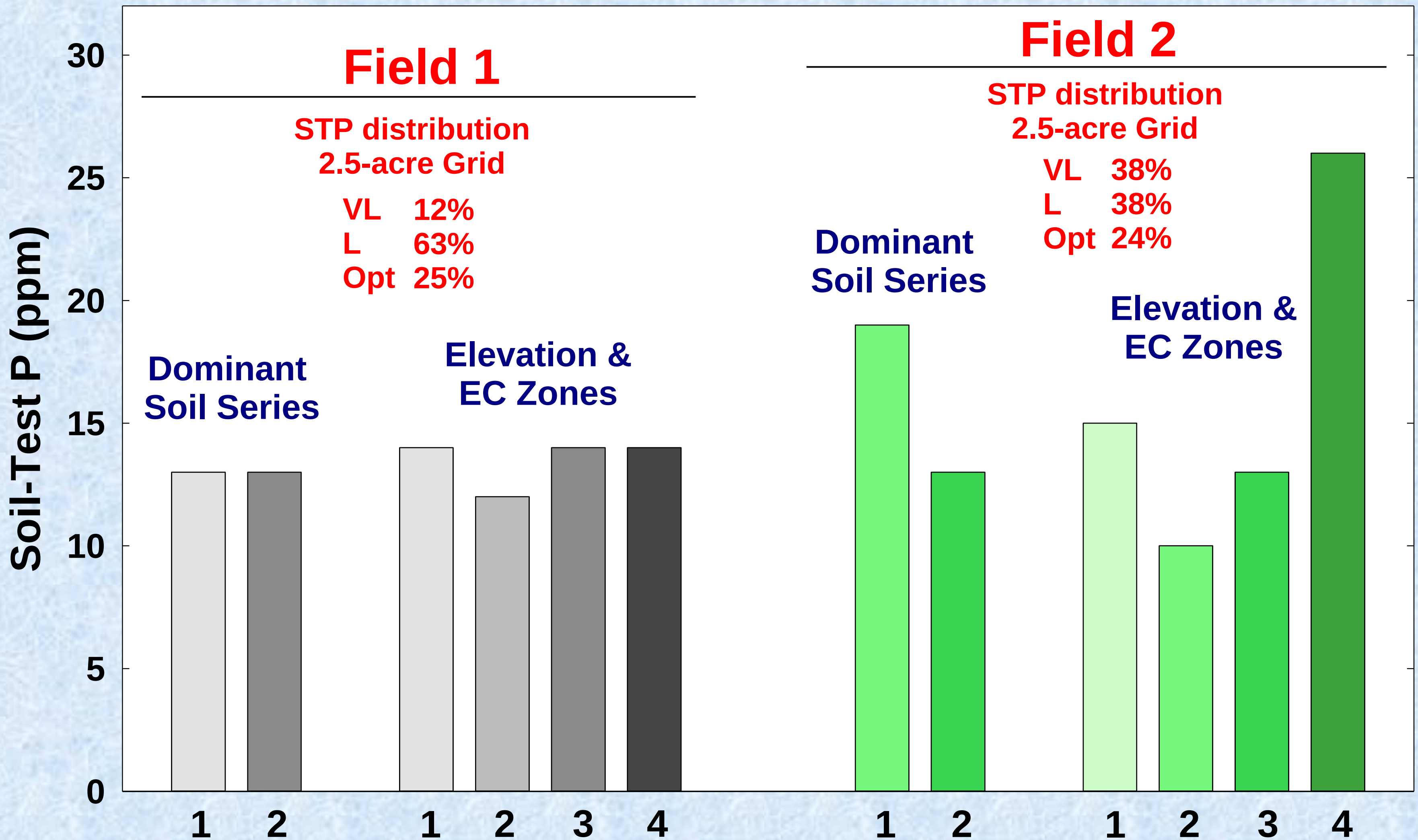
Efficacy Based on Crop Response

- Strip trials, P and K, corn and soybean
- Dense grid sampling 0.3 to 0.5 acres
- Simulated less dense sampling
  - 2.5 acre grid-cell sampling
  - Soil survey map zones
  - Zone sampling based on
    - elevation
    - electrical conductivity (EC)
    - elevation and EC combined

Yield Response & Sampling Method

- Research across 28 crop-years
- Efficacy Index: Capacity of a sampling method to identify field areas with different crop response:
  - Dense 0.3 to 0.5 acre grids: 100
  - 2.5 acre grids: 50
  - Zone sampling: 39
  - Sampling by soil type: 22

Zone Approaches and Average STP

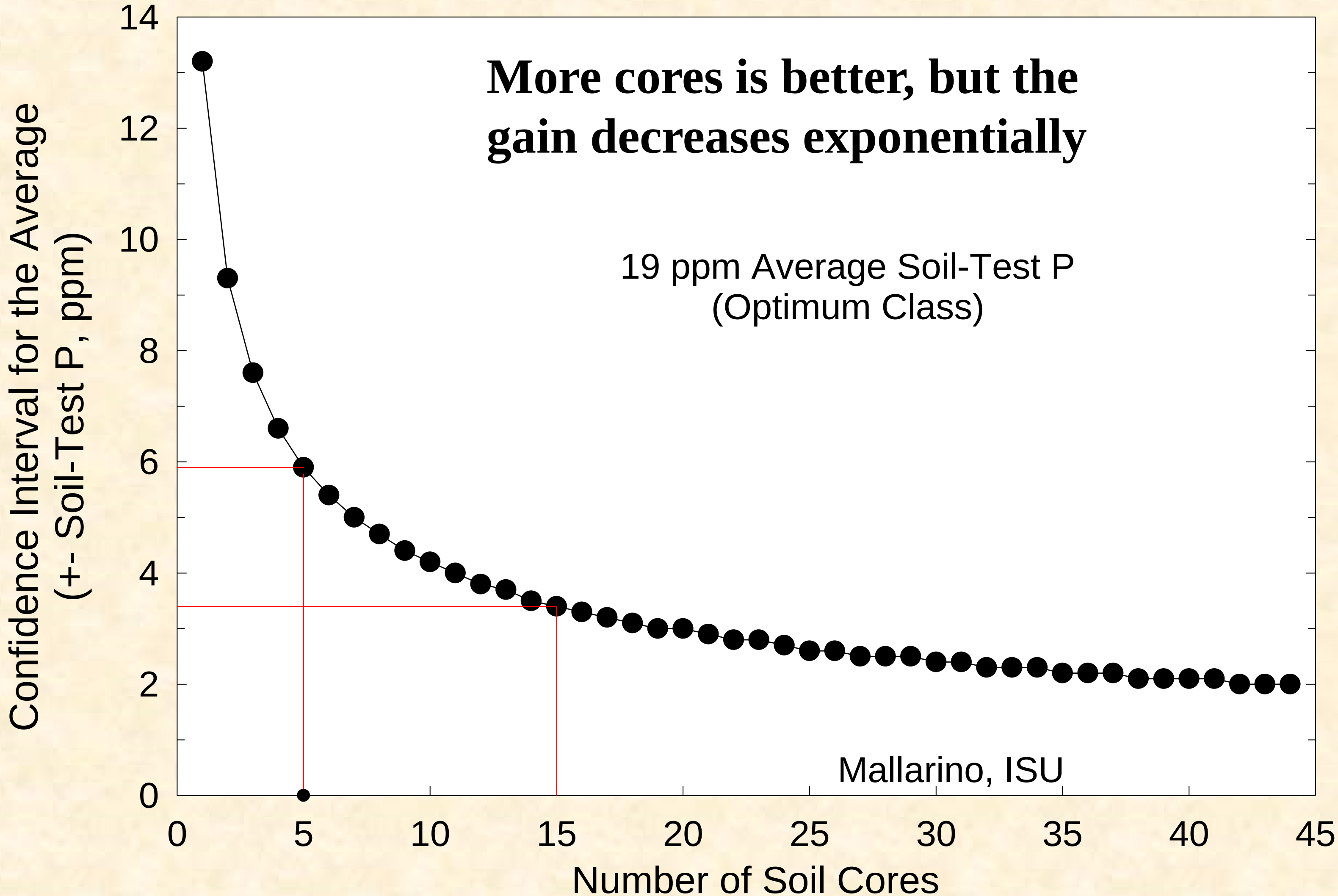


Mallarino and Sawchik, ISU

Why Isn’t Zone Sampling Better?

- Long histories of fertilization for originally low-testing soils mask soil properties effects on P and K variation
- Within-field yield variation has to be large and consistent over time to clearly influence soil P and K levels
- Results should be better in fields or regions with more contrasting soils and/or shorter fertilization histories

Need Many Cores Even with Grid Sampling



New Automated Soil Samplers

Taking Many Samples with Many Cores Can be Easy (but costly?)

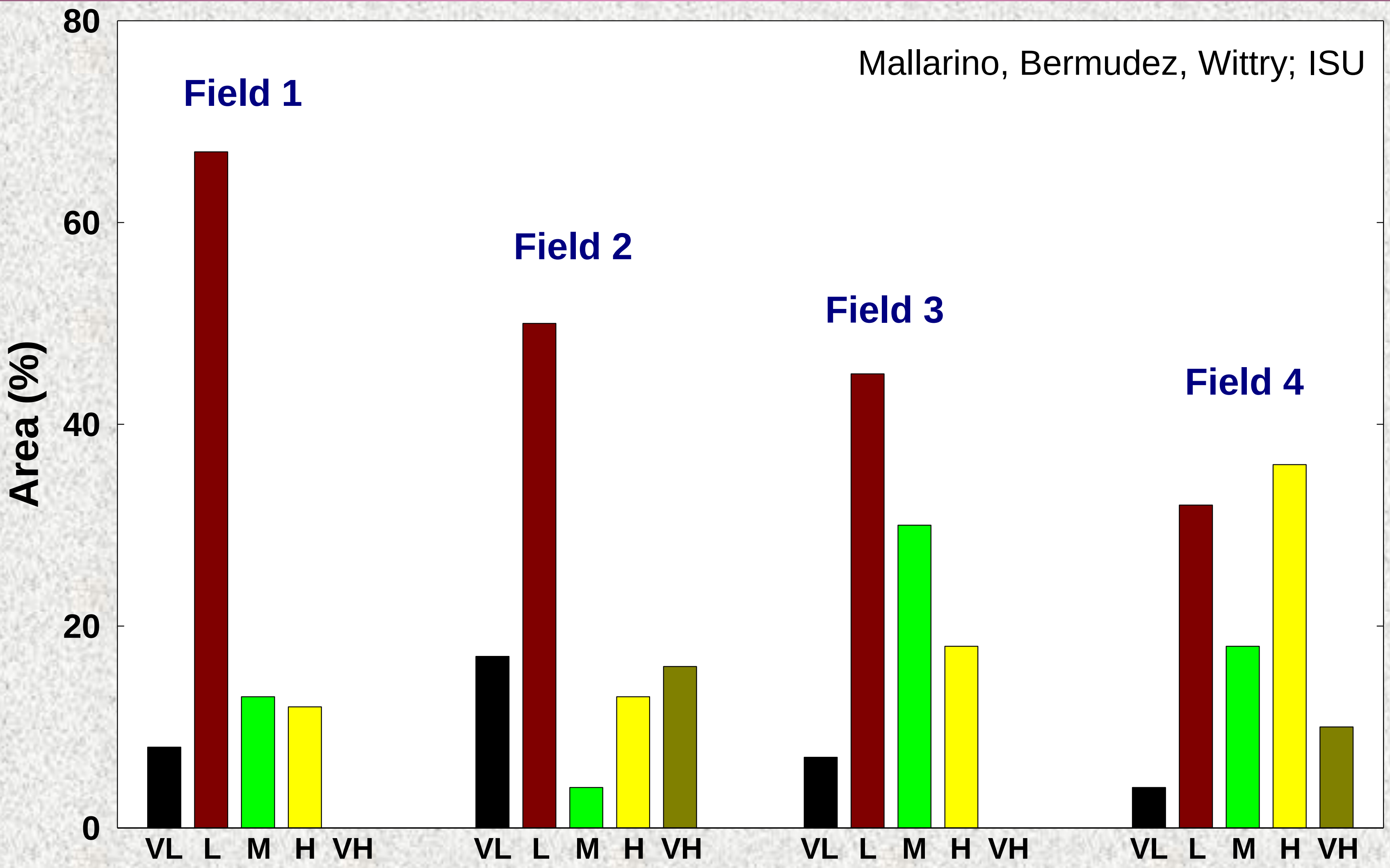
AutoProbe™, courtesy Jeff Burton, AgRobotics Inc.

Falcon Soil Sampler, courtesy Jerry Romine

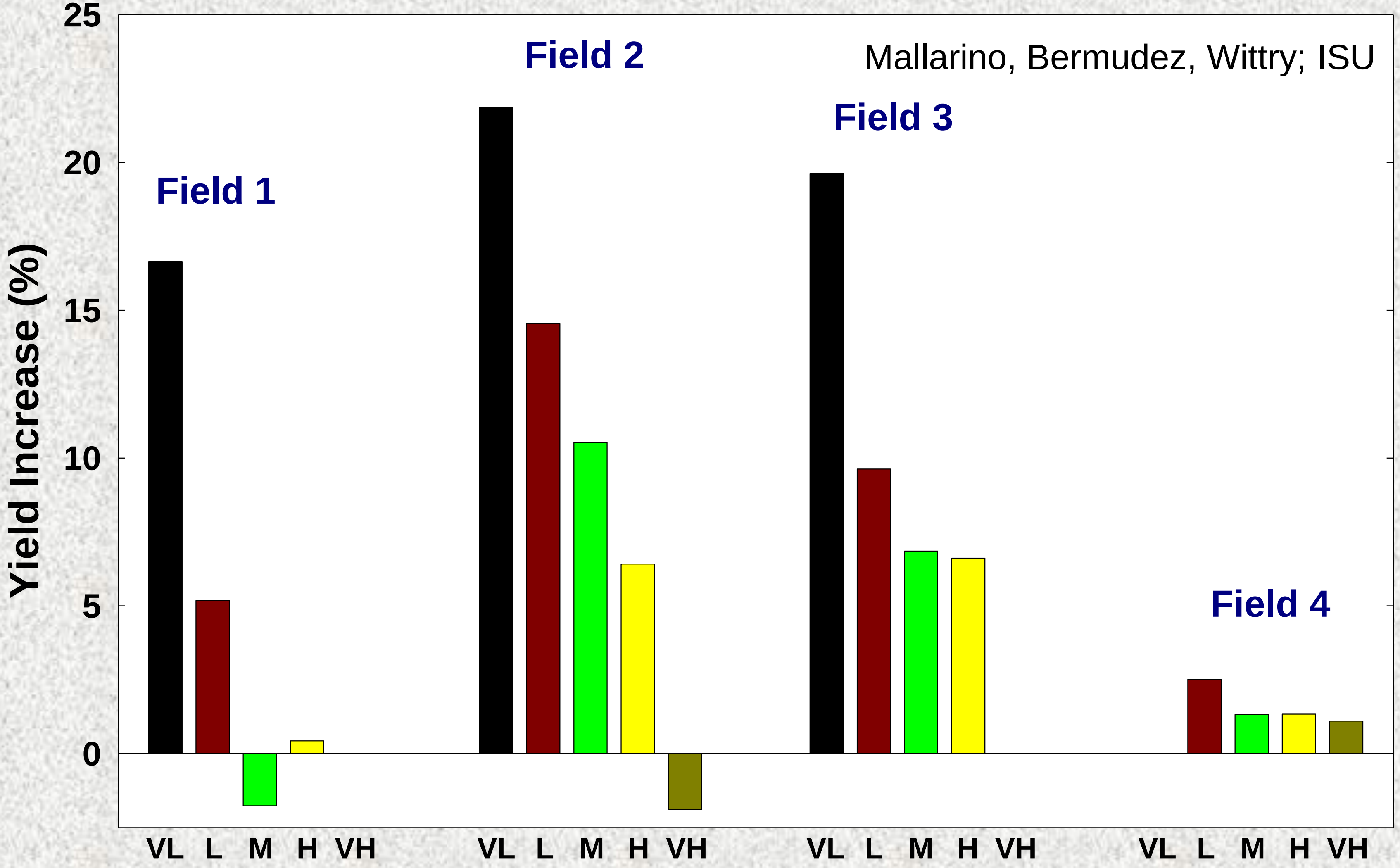
Variable-Rate for P, K, and Lime

- More clear justification than for N
- Based on what sampling method?
- Do better sampling and management increase yield enough to pay for the increased costs?
- What about benefits for water quality?

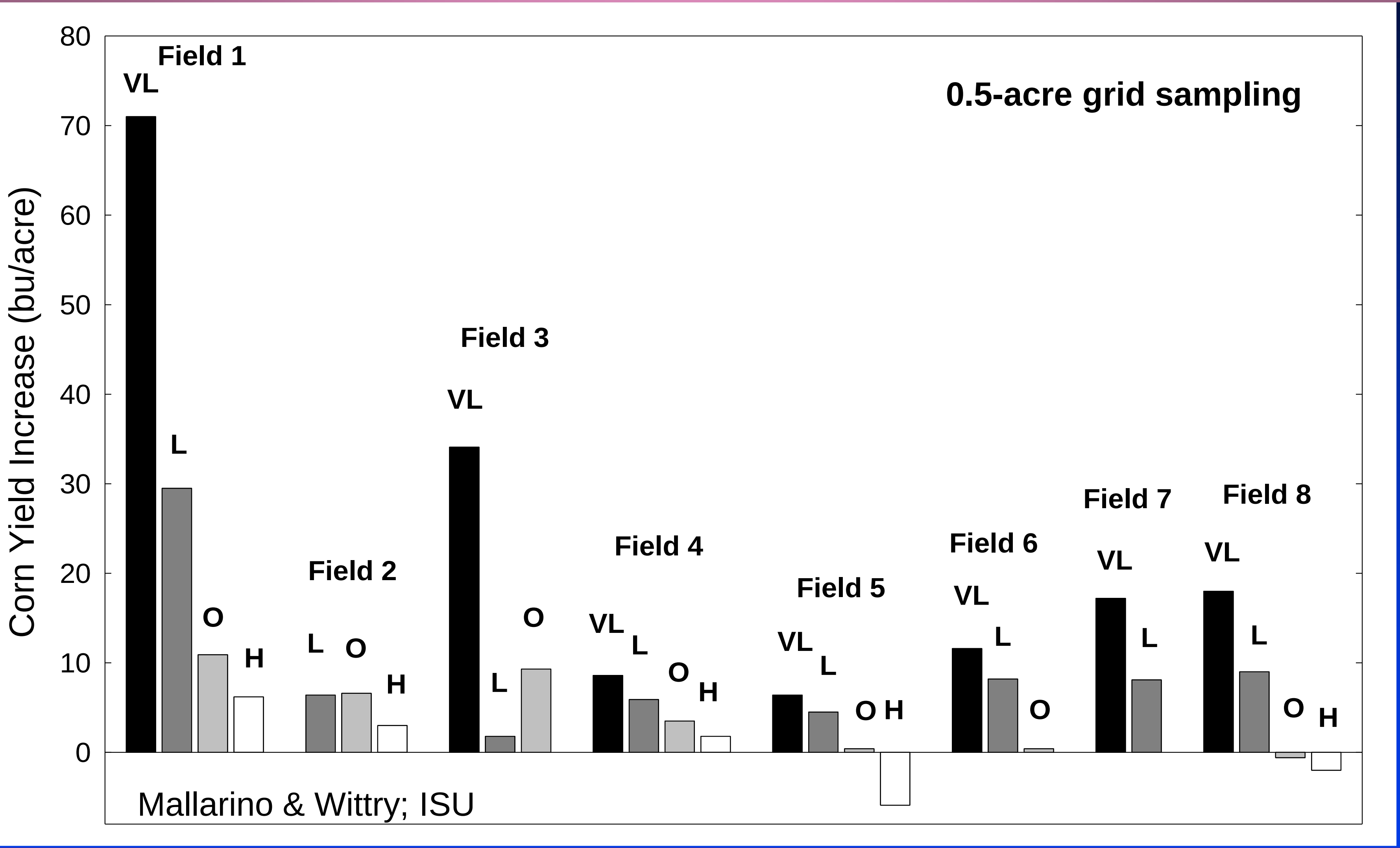
Within-Field STP Variation



Yield Response to P Variation

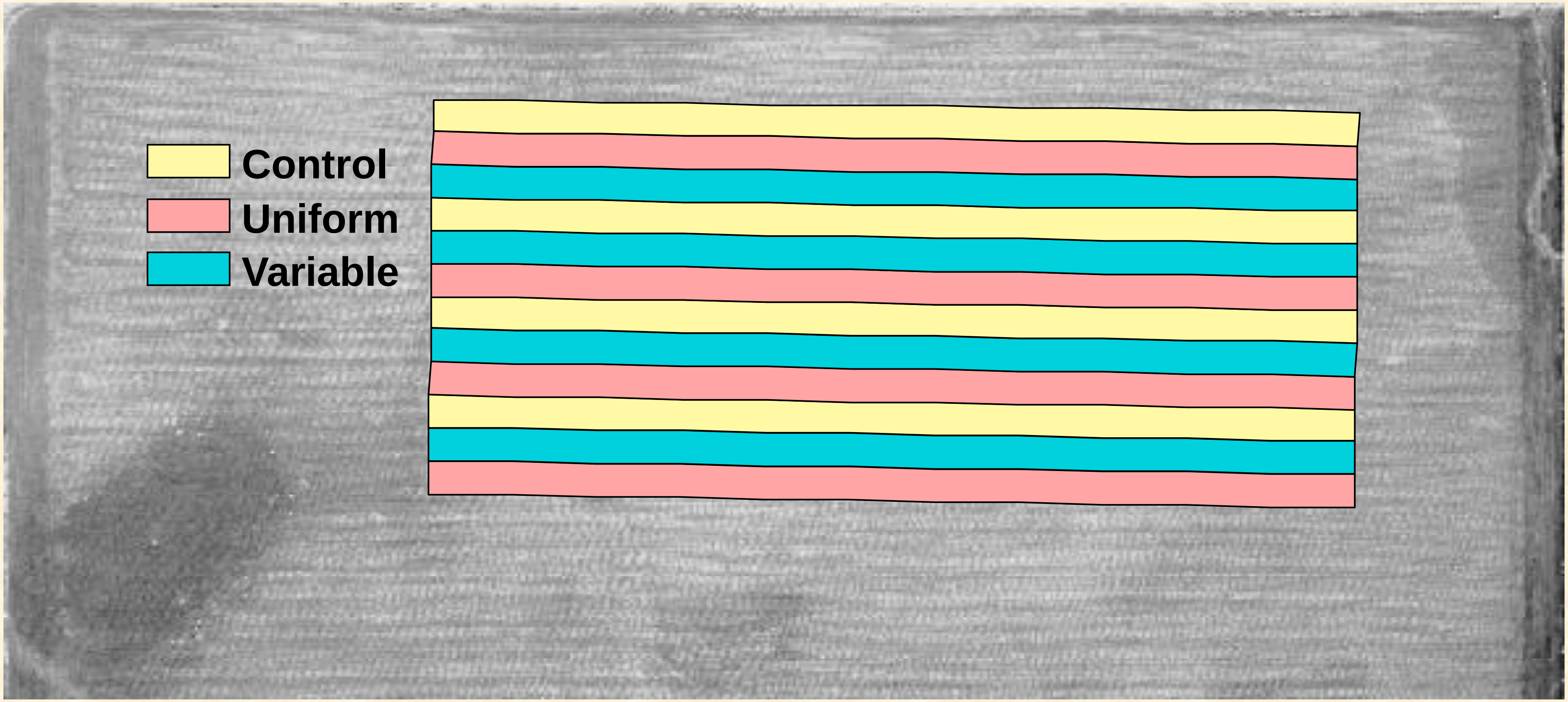


Within-Field STK and Yield Response



On-Farm Research: Uniform vs Variable

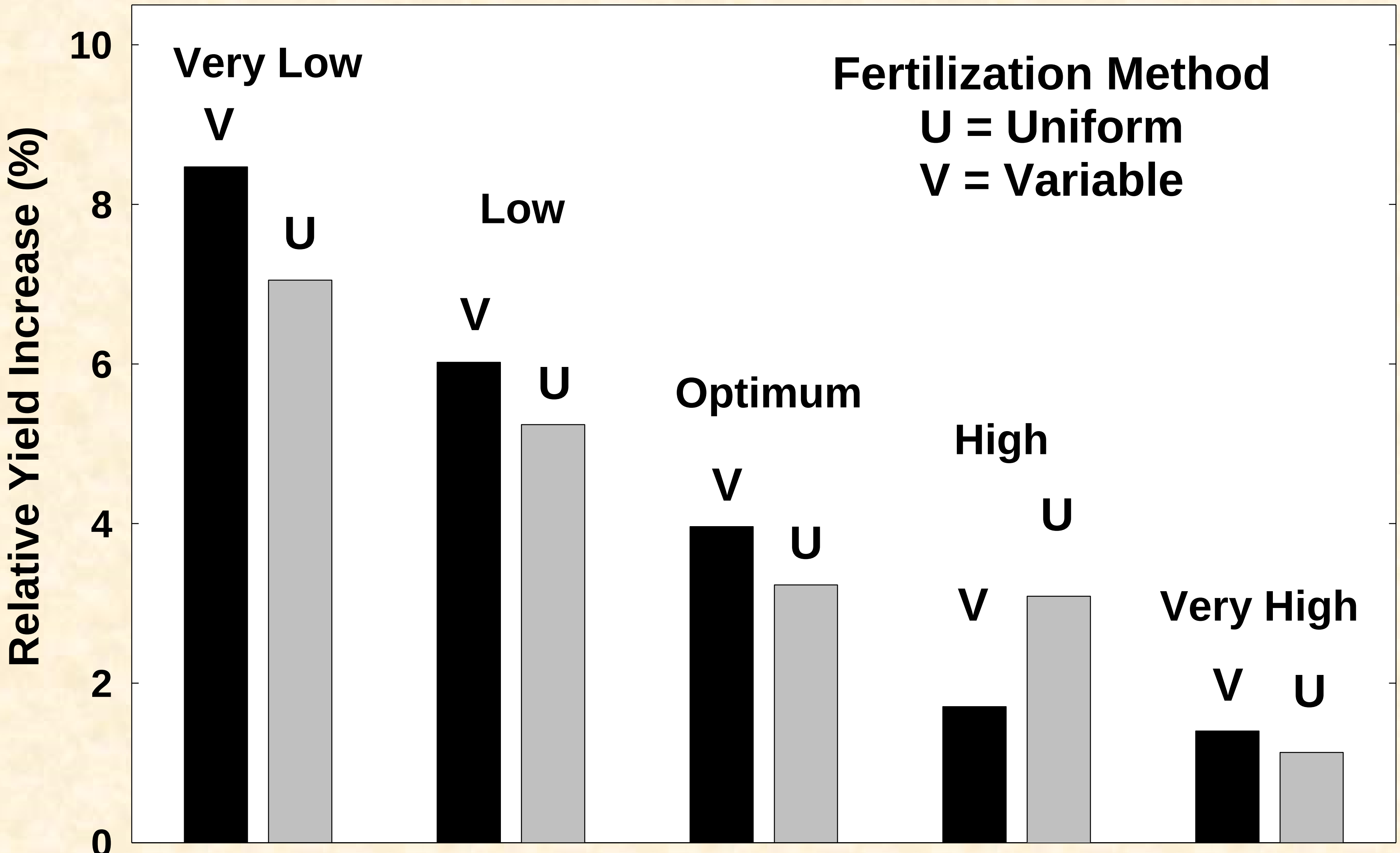
70 trials over the years, collaboration with coops
Corn and Soybean, P, K, or lime
Dense grid sampling, yield monitors, and GIS



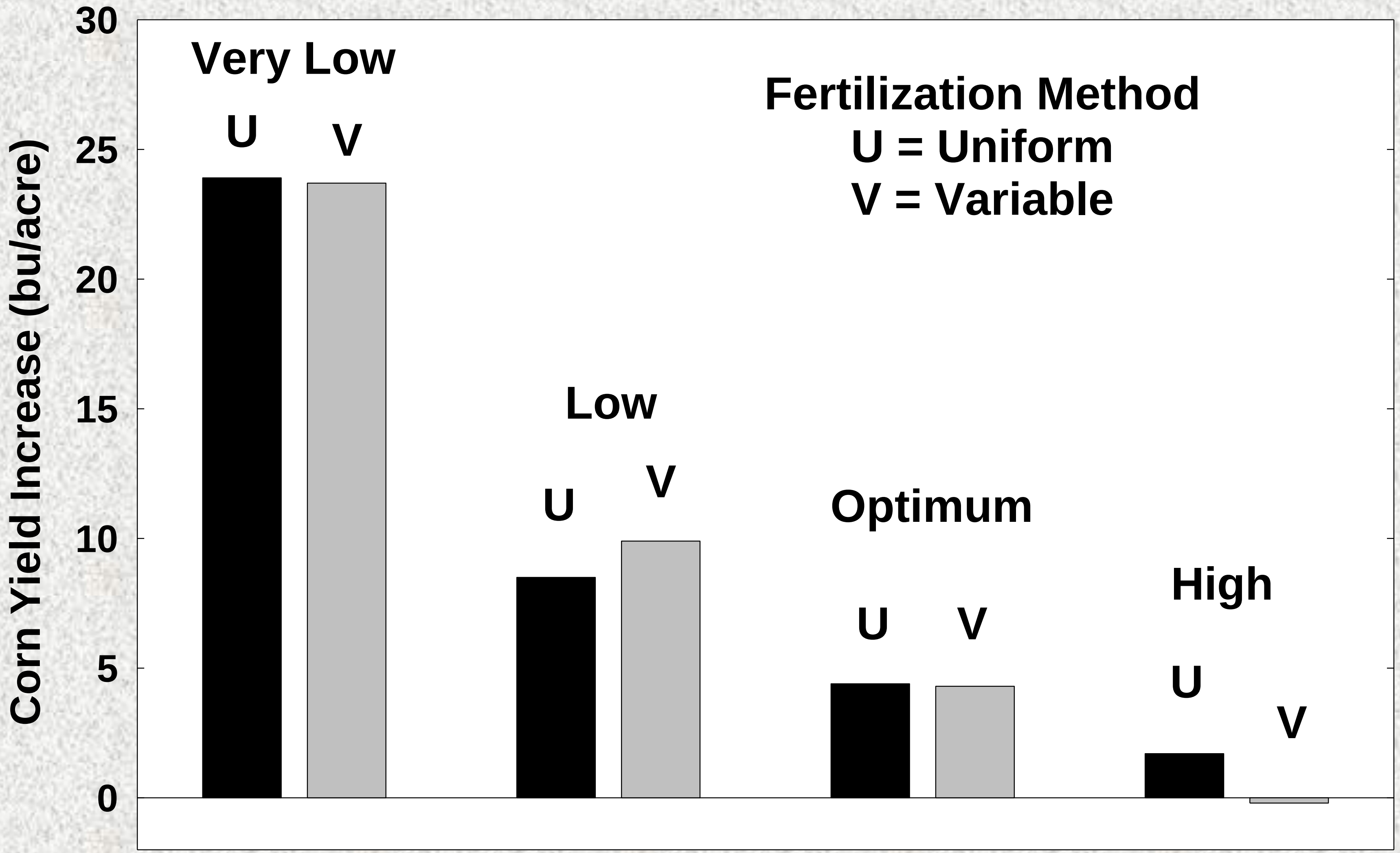
VRT Doesn't Always Increase Yield

- Most farmers are maintaining soil-test values at or above optimum levels
  - Small low-testing areas or do not exist
- Sometimes high small-scale variability
  - How representative are test values?
- Rates for low-testing soils are designed to get maximum yield, so additional P or K applied with VRT to low-testing areas may will not increased yield further

Example 1: Response by Test Class



Example 2: Response by Test Class

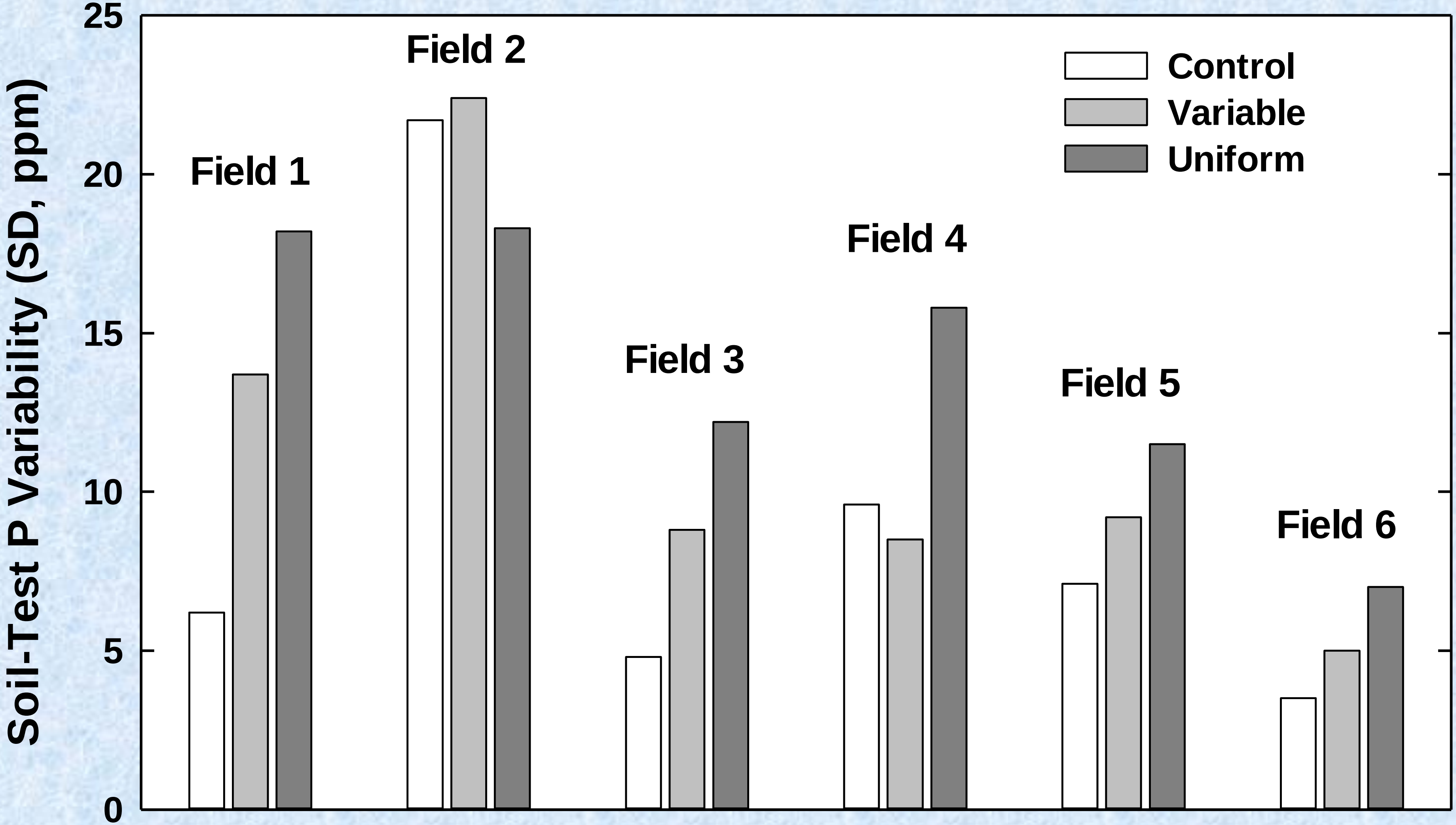


Mallarino &Bermudez, ISU

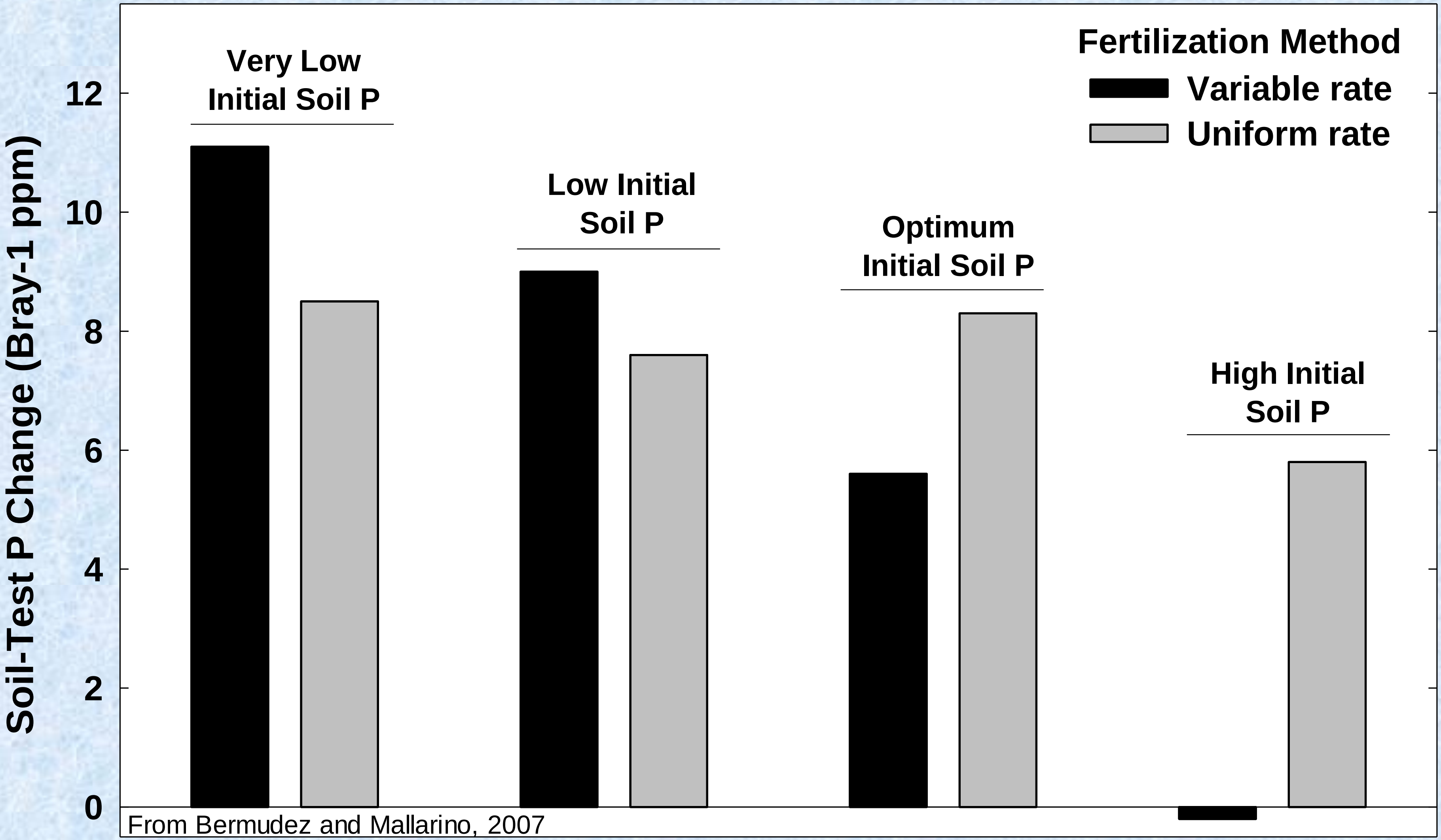
Fertilizer and Lime Applied

- **Difference Variable - Uniform application across all fields and years:**
  - **P_2O_5/acre: -52 to 71 lb, on average -9 lb**
  - **K_2O/acre: -67 to 9 lb, on average -15 lb**
  - **Lime ECCE ton/acre: -0.5 to -1 ton**
- **Less product was applied with VRT, but varied greatly across fields according to soil-test values.**

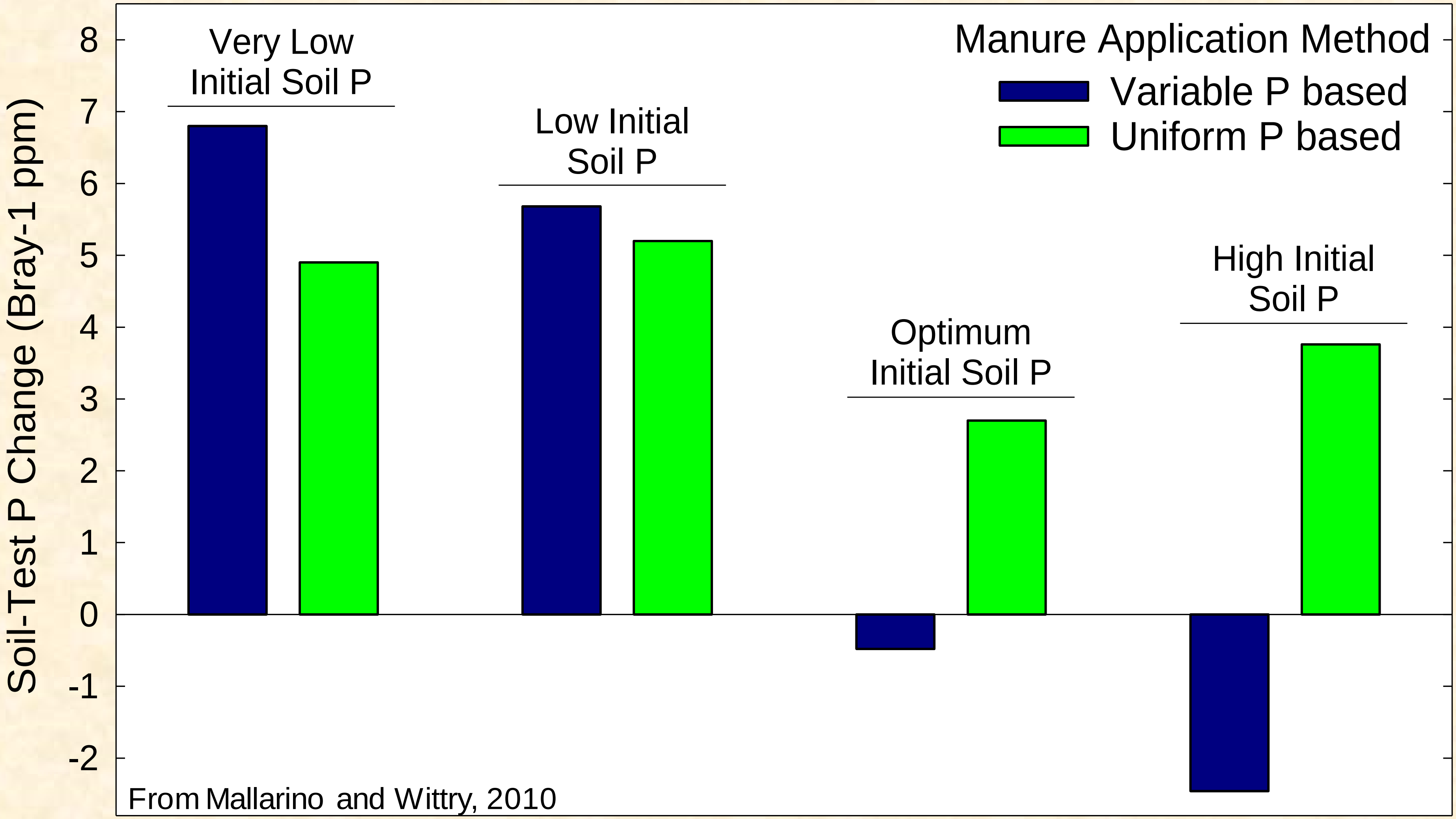
VRT Reduces Soil Test Variabilty



Variable Rate P Fertilizer and STP Change



Variable Rate Manure P and STP Change



Better Management with VRT

- Benefits from VRT and grid sampling increases with high soil-test variation and unfavorable price ratios
  - slowly buildup in low-testing field areas to reduce risk of yield loss
  - don't apply to high-testing field areas
  - combine with yield maps/removal
  - reduce soil-test variability
- A good technology used with wrong nutrient recommendations will not work


Soil Fertility Web Site
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