USDA Agricultural Outlook Forum 2007

AGRONOMIC INPUTS USING PRECISION AGRICUTLURE ACROSS DIFFERENT LANDSCAPES

Kip Balkcom
Research Agronomist, USDA-ARS

Presented: Thursday, March 1, 2007

Precision Agriculture

An intensive management scheme that addresses variability and made possible through the integration of different technologies, which include:

- ✓ **Global positioning systems – GPS**
- ✓ **Remote imagery/sensors/point samples**
- ✓ **Geographic information systems – GIS**
- ✓ **Variable rate controllers**

Precision Agriculture

- **Site Specific Agriculture: method of production in which zones and soils are delineated within a field and managed according to their unique properties.**

- **Management Zones: field areas with a similar combination of potential yield-limiting factors.**

- **Ultimate Goal → delineation of management zones.**
  - **Reduce inputs**
  - **Optimize productivity within field**

Management Zones

- **Zones in fields which can be delineated , grouped and managed in a similar fashion to optimize inputs and/or optimize profits**
- **Delineation: 1) Remote sensing; 2)Topography; 3) Soil testing; 4) Soil Maps; 5) Yield map**
- **Evaluation accuracy of SSM:**
  - ✓ **Historical (yields previous/after)**
  - ✓ **Indirect (regression analysis)**
  - ✓ **Direct (multiple side by side comparison)**

(Plant, 2001; Bouma et al., 1999; Fleming et al., 1998; Doerge, 1999; Fraisse 1999; Pocknee & Kvien, 1999)

Soil Spatial Variability

- **Since fields contain a complex arrangement of soils and landscapes, extensive spatial variability in soil properties and crop yield is common.**

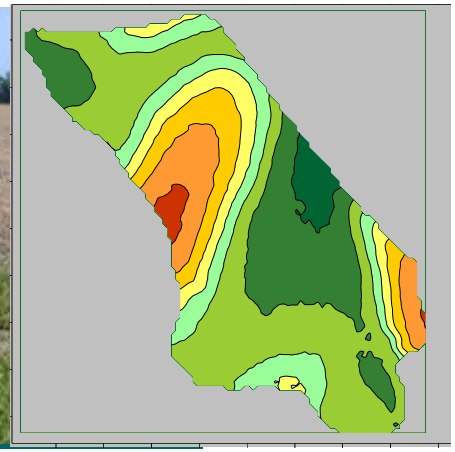
(Mulla & Schepers, 1997; Sadler et al., 1998; McBratney and Pringle, 1999)

Soil Spatial Variability

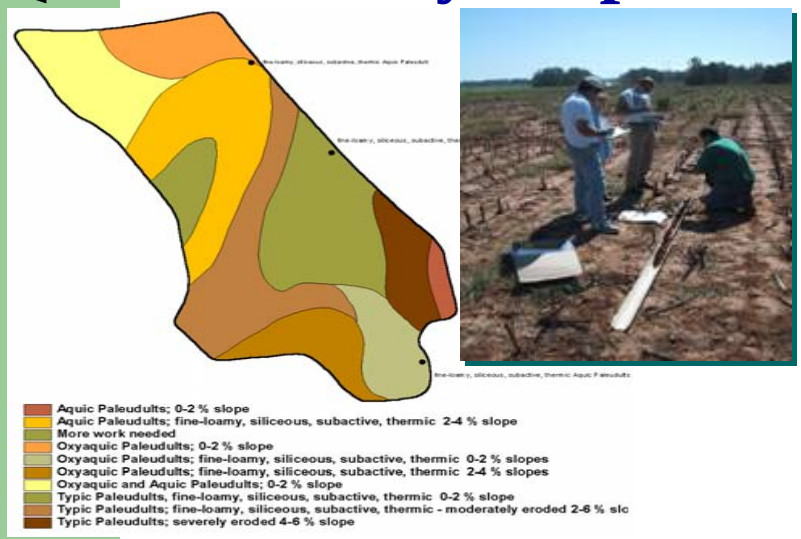
Management Zones Delineation

Temporally-Stable Zones

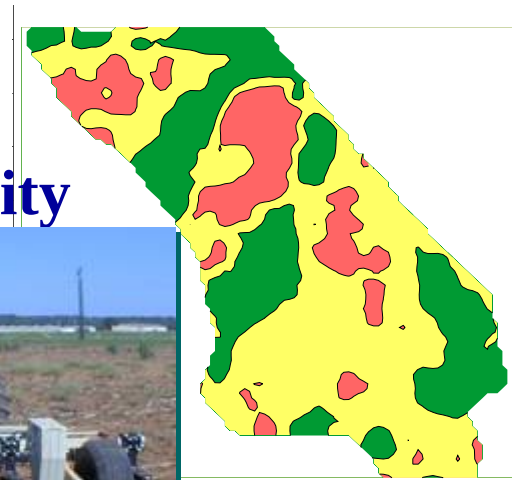
✓ **Terrain Attributes**



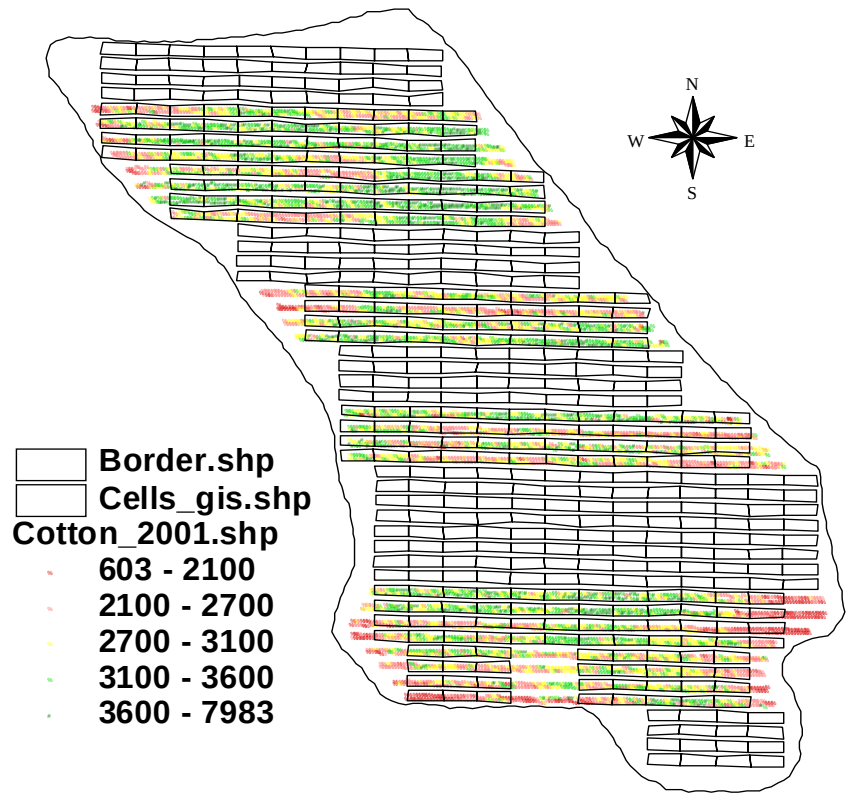
✓ **Soil Survey Map**



✓ **Electrical Conductivity**

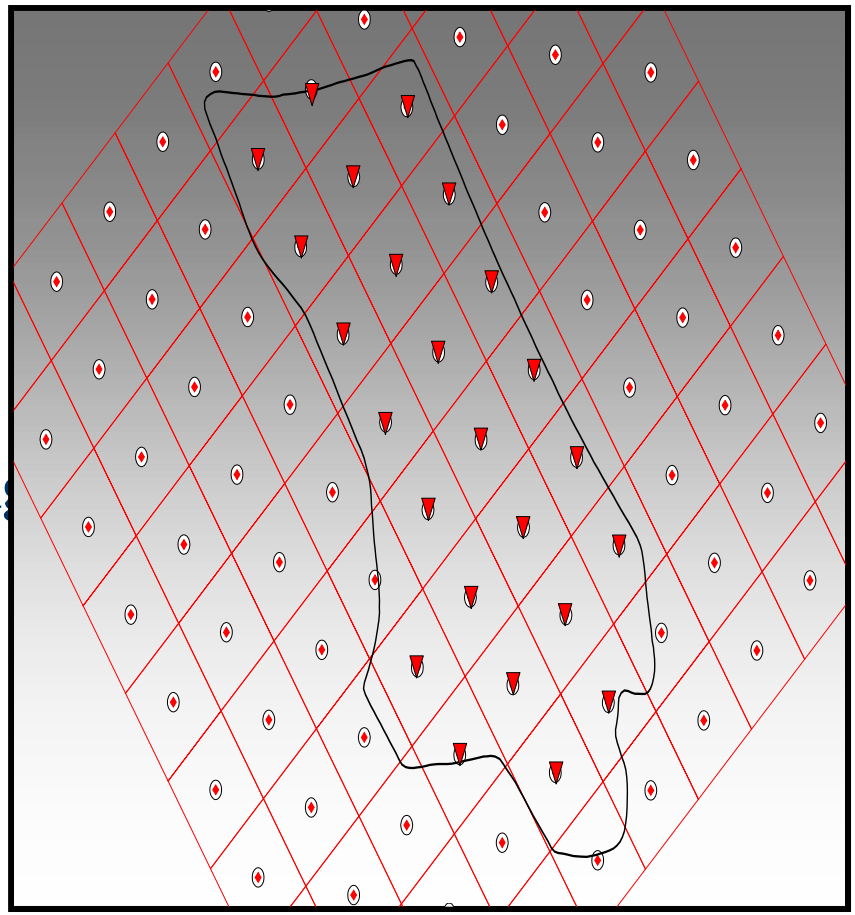


Yield Monitoring



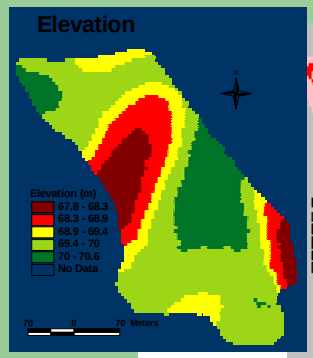
Site-Specific Data Analysis

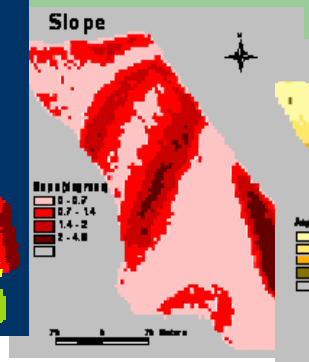
- Integrating point data with continuous data: Interpolating the point data.
- Interpolation Methods:
  - Nearest neighbor
  - Local average
  - Inverse distance weighting
  - Kriging
  - Monte Carlo simulation

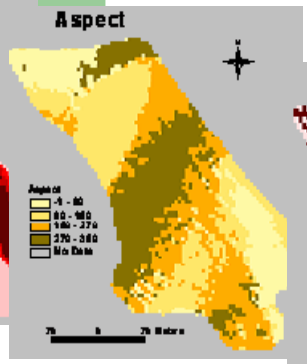


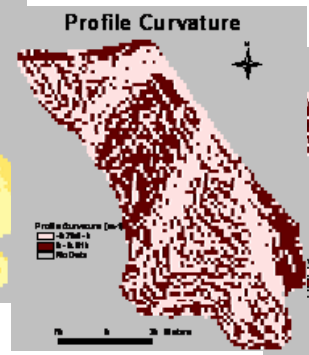
(Isaaks & Srivastava, 1989; Whelan et al., 1996; Wollenhaupt et al., 1997; Plant, 2001)

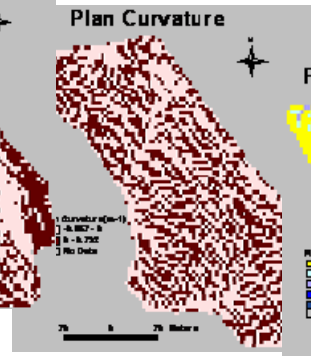
Info Overlay

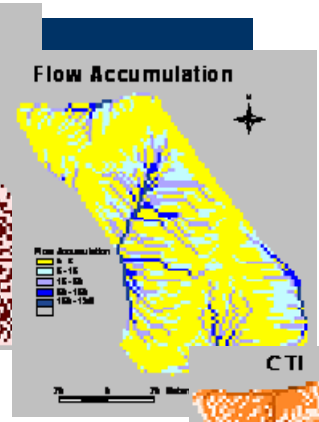


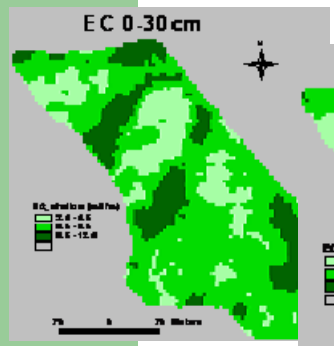


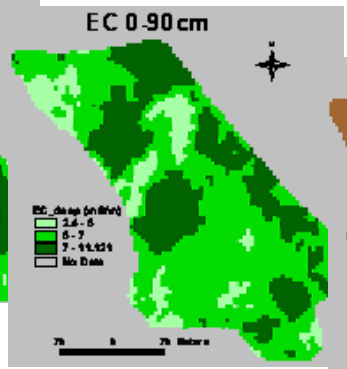


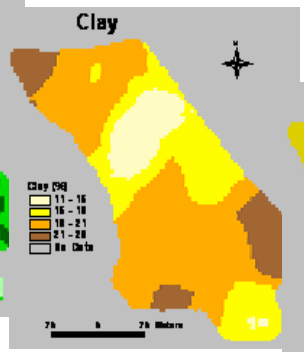


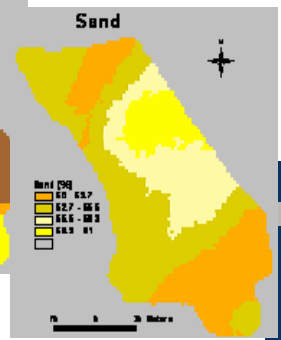


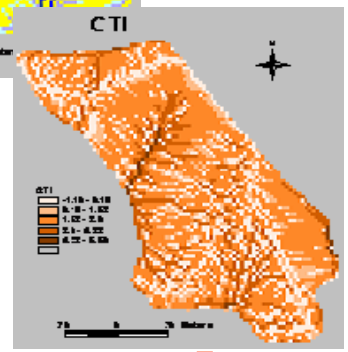


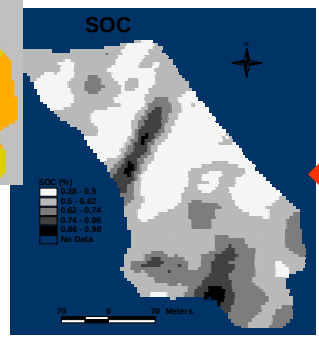


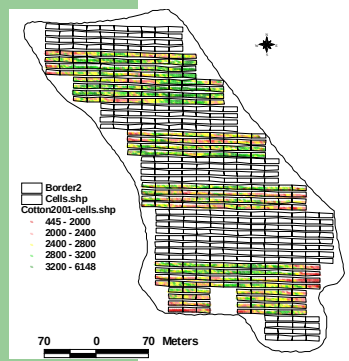


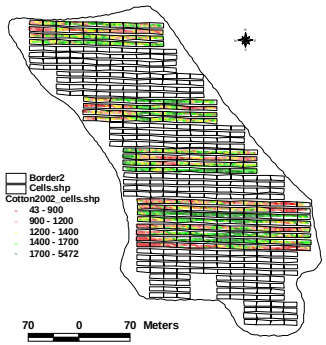


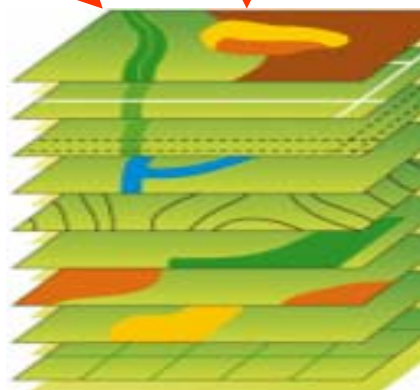












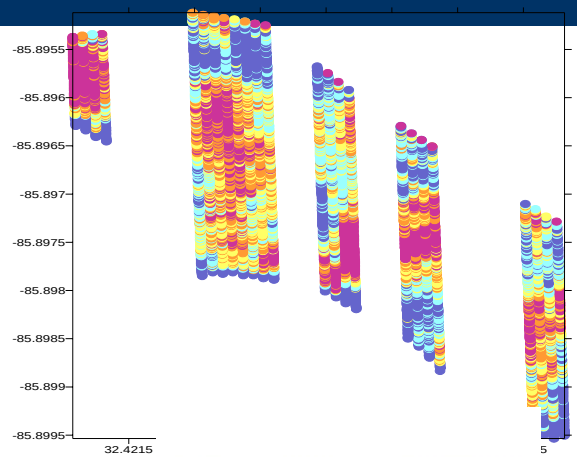
Agronomic Inputs

- Fertilizer/lime inputs
- Variable rate seeding
- Site-specific disease/insect/weed control
- Site-specific plant growth regulators
- Variable rate irrigation
- Site-specific tillage

Guidance System

Keys to Success

- Information
- Technology
- Management



(Mulla & Schepers, 1997; Plant, 2001)

Variable-rate

“adoption of variable-rate N and variable-rate seeding in maize have been similar; the technology to vary these inputs likely exceeds the knowledge of how to best use it.”

Doerge, 2005

Precision Conservation

Introduced by Berry et al. (2003).

Utilizes all the tools and technologies related to precision agriculture, but is much broader because it addresses aspects related to soil and water conservation in agricultural and natural ecosystems.

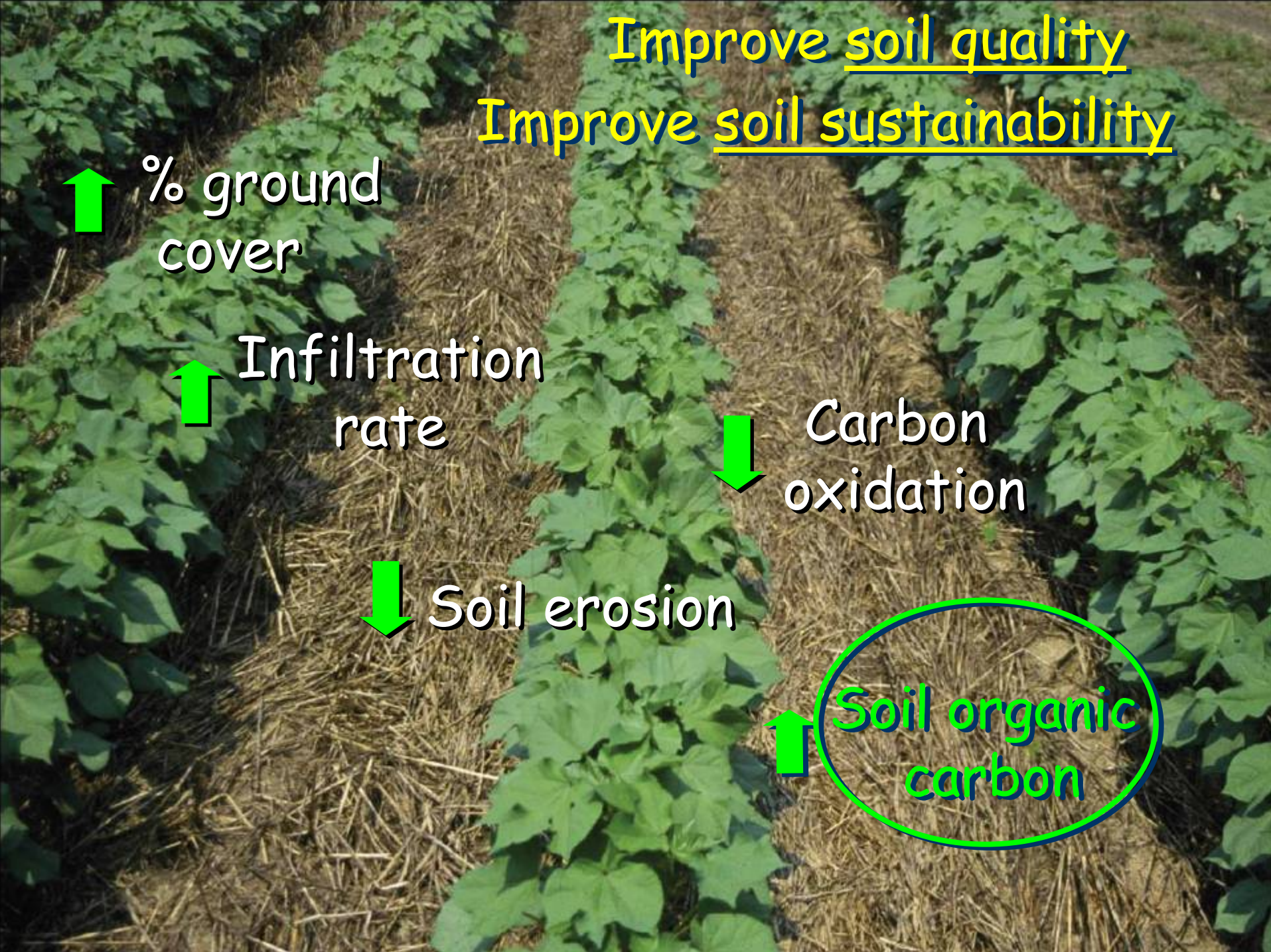
Special Issue:
Journal of Soil and Water Conservation
Volume 60 November/December, 2005

Precision Conservation

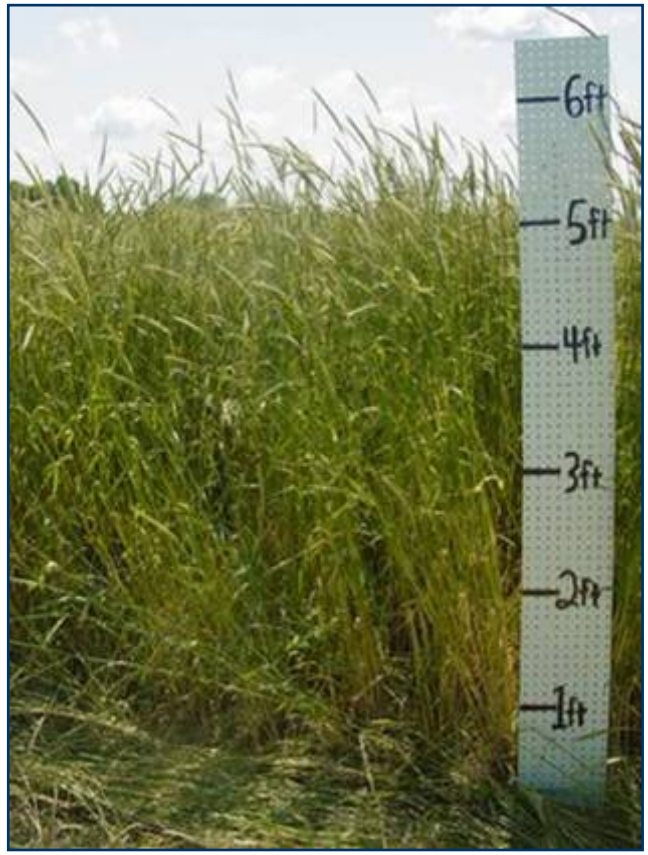
Utilize conservation practices across the landscape to

- ✓ **Increase C sequestration.**
- ✓ **Reduce soil erosion and off-site transport.**
- ✓ **Reduce nitrate leaching.**
- ✓ **Optimize yields.**

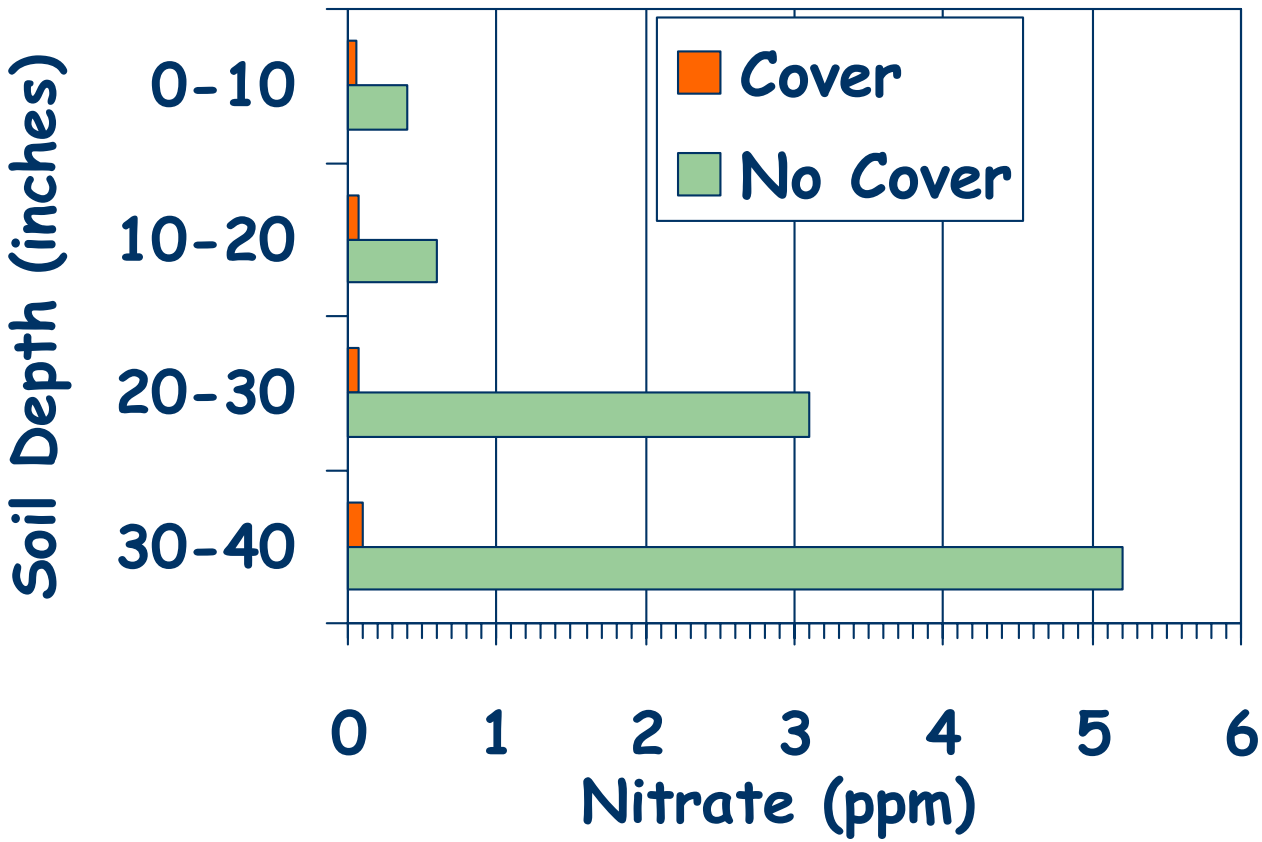
(JSWC, 2005)


Improve soil quality
Improve soil sustainability
% ground cover
Infiltration rate
Carbon oxidation
Soil erosion
Soil organic carbon

Cover Crop- Key Component

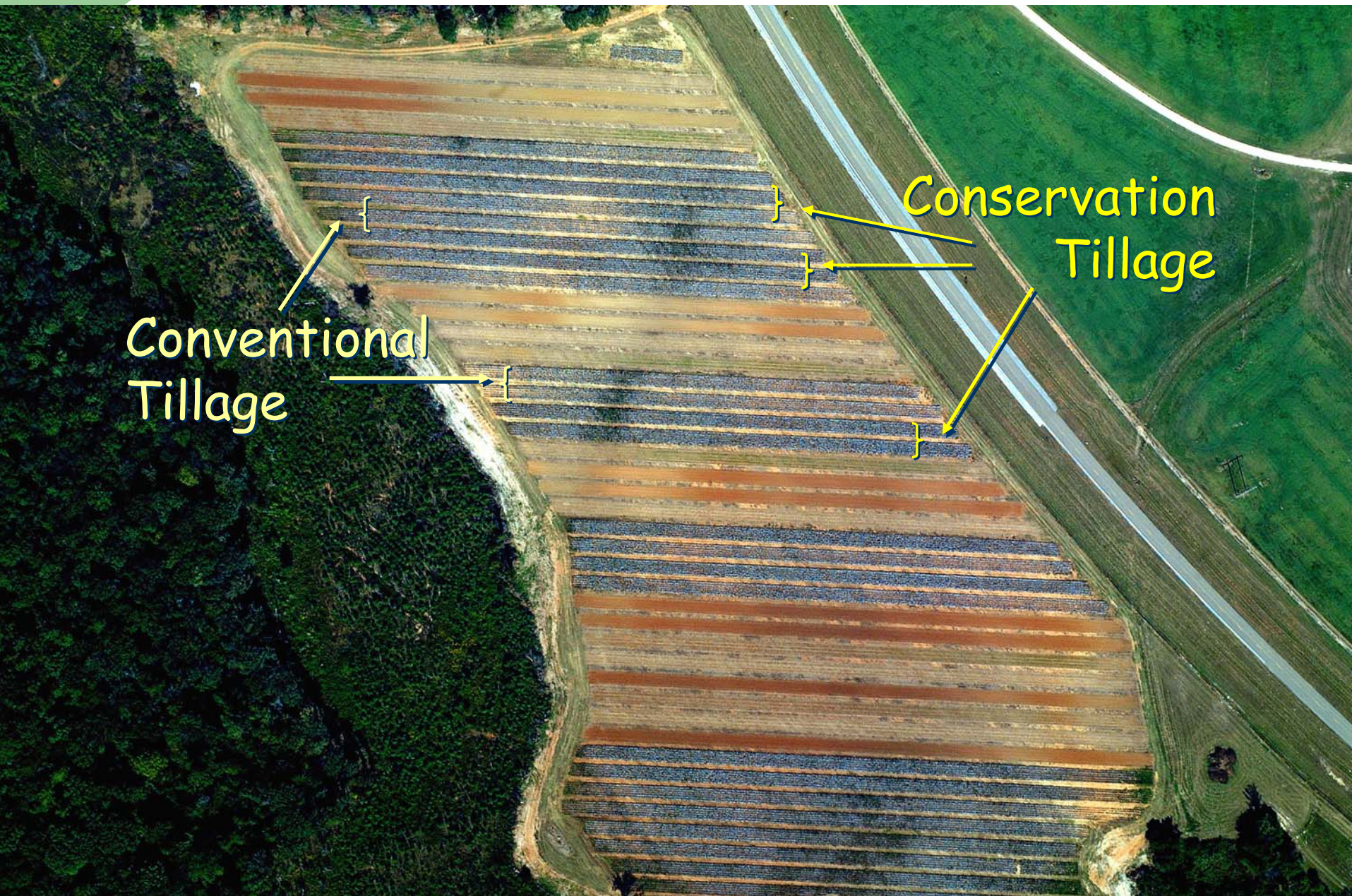


Leaching of Nitrogen



•Hemphill and Hart 1993

Field Scale Research



Conventional

SLOPE POSITION

Conservation

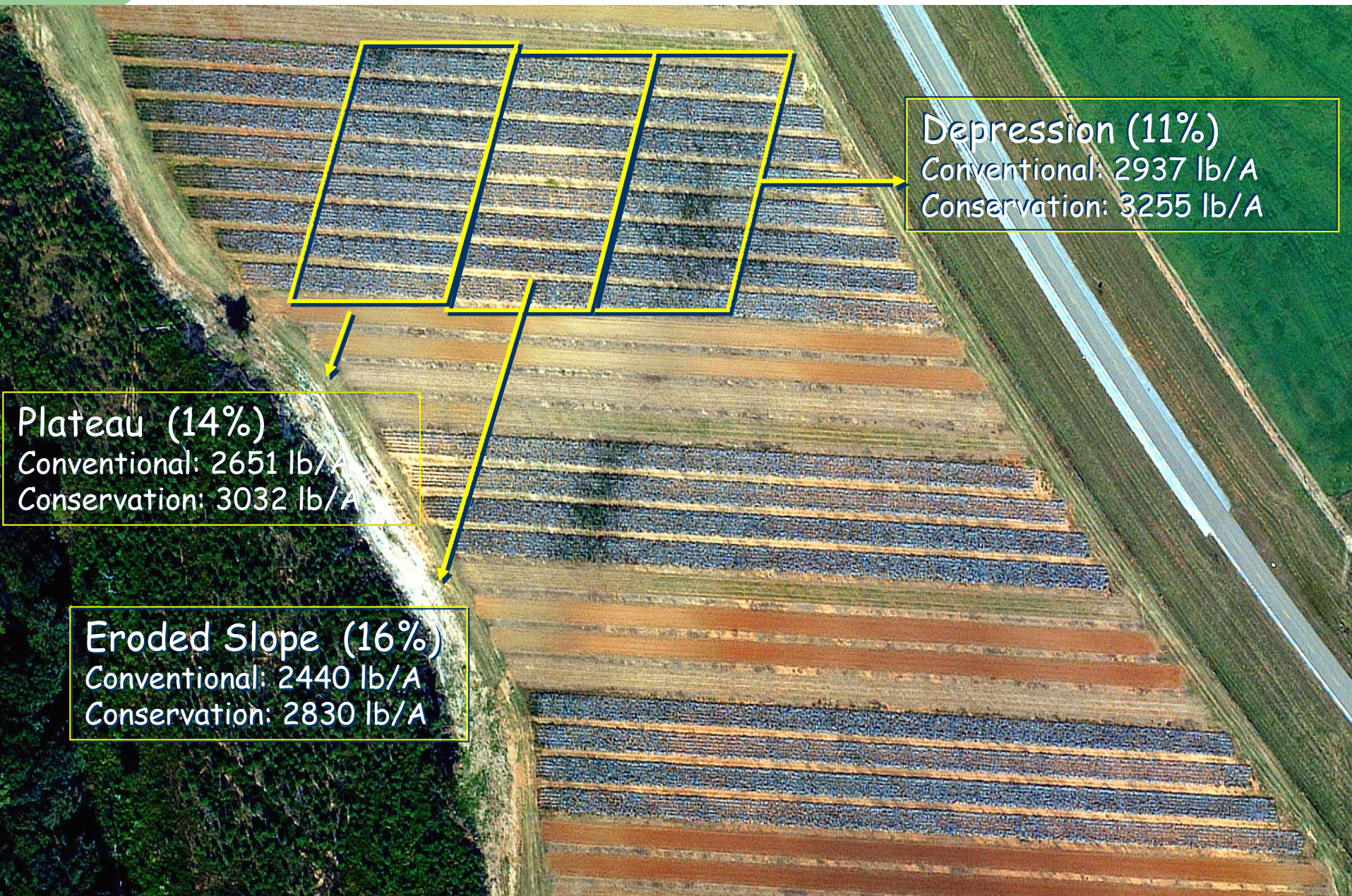
Shoulder

Backslope

Footslope

Toeslope

Field Scale Research



Precision Agriculture or Conservation

- **Potential to improve profits and reduce environmental pollution.**

- **Technology is expensive and not easily manageable by farmers for which it is designed to help.**

- **Precision agriculture and conservation will be part of American agriculture in the future:**

  - **How?**
  - **Which ones?**
  - **What extent?**

Sadler et al., 2005