Fertilizer, Aglime, & Pest Mgt. Conf.
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In-Field Measurement of Soil Quality & Sustainability

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Sustaining Earth
and Its People

“Worldwide changes are transforming American agriculture into an endeavor focused not only on *efficient food and fiber production* but also on delivering

***improved public health, social well-being, and a sound environment*”**

(FRONTIERS IN AGRICULTURAL RESEARCH: Food, Health, Environment, and Community, NRC, NAS, Washington, D.C.2002)

Need Soil Management to economically meet food production needs and maintain quality of essential soil, water, and air resources

Renewable Agriculture & Food Systems

SUSTAINABLE AGRICULTURE

An agriculture that can EVOLVE toward:

- Greater human UTILITY
- Greater EFFICIENCY of RESOURCE use
- Favorable BALANCE with the ENVIRONMENT

(Richard Harwood, MSU, 1990)

Sustain. Strategies & Indicators

- Conserve soil organic matter
  Change in time/space (Color chart/Density)
- Minimize soil erosion
  Infiltration/compaction/runoff (Ring & Probe)
- Balance production with environment
  Seasonal soluble N & P, leaching and loss of greenhouse gases (EC probe & Strips)
- Better use of renewable resources
  EC, pH, Nitrate, Respiration/temperature

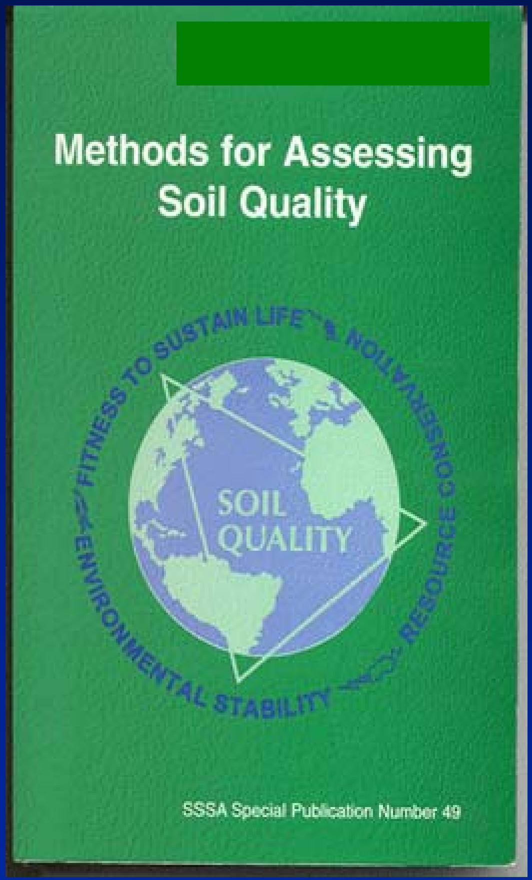
USDA Soil Quality Test Kit

"Helped <u>translate science into practice</u>."


“Test kit has facilitated partnerships between
farmers and ag specialists”

Methods for Assessing Soil Quality

Edited by: J.W. Doran and A.J. Jones



Soil Science Society of America, Special Pub. No. 49

(Harvey Gaynor- Australian Cotton Producer)

"I need help from *Scientists* with TOOLS for MANAGEMENT

more than

INDICATORS of SOIL QUALITY"

We need PARTNERSHIPS to get KNOWERS working with DOERS

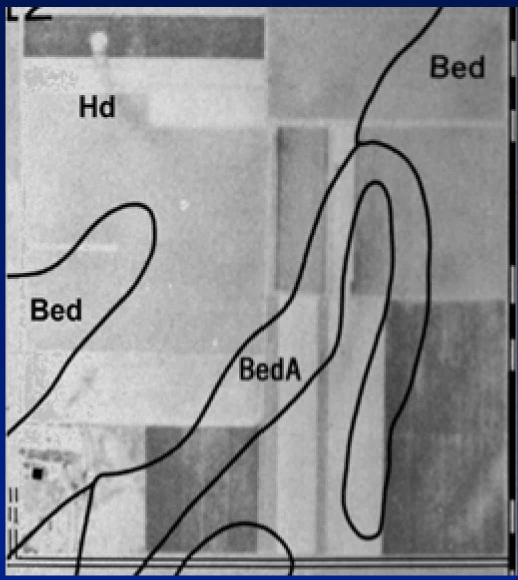
Measuring Agricultural Sustainability at the Farm Level

Farmer/Society Needs	**Resource/Environmental Conservation**
Acceptable	Adequate/Acceptable
• Yields	• Soil organic matter
• Profits	• Soil depth
• Risk	• Soil cover
• Energy($) Ratio Output/Input	• Leachable Salts (NO_3) Electrical Conductivity

(After Gomez et al., 1996)

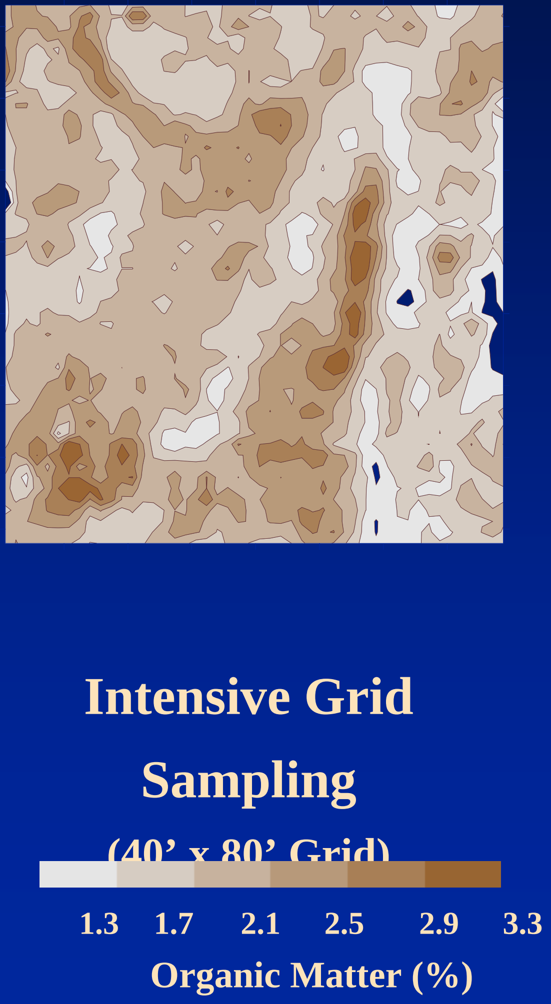
Intensive Soil Quality Assessment on a Field Scale

Irrigated Field Near Gibbon, in Central Platte Region of Nebraska



Soils Map

Aerial Photograph



Intensive Grid Sampling

(40’ x 80’ Grid)

Breaking New Ground C management at the Farm Scale

SQ Vest- Ring of many uses

Infiltration

Soil Compaction

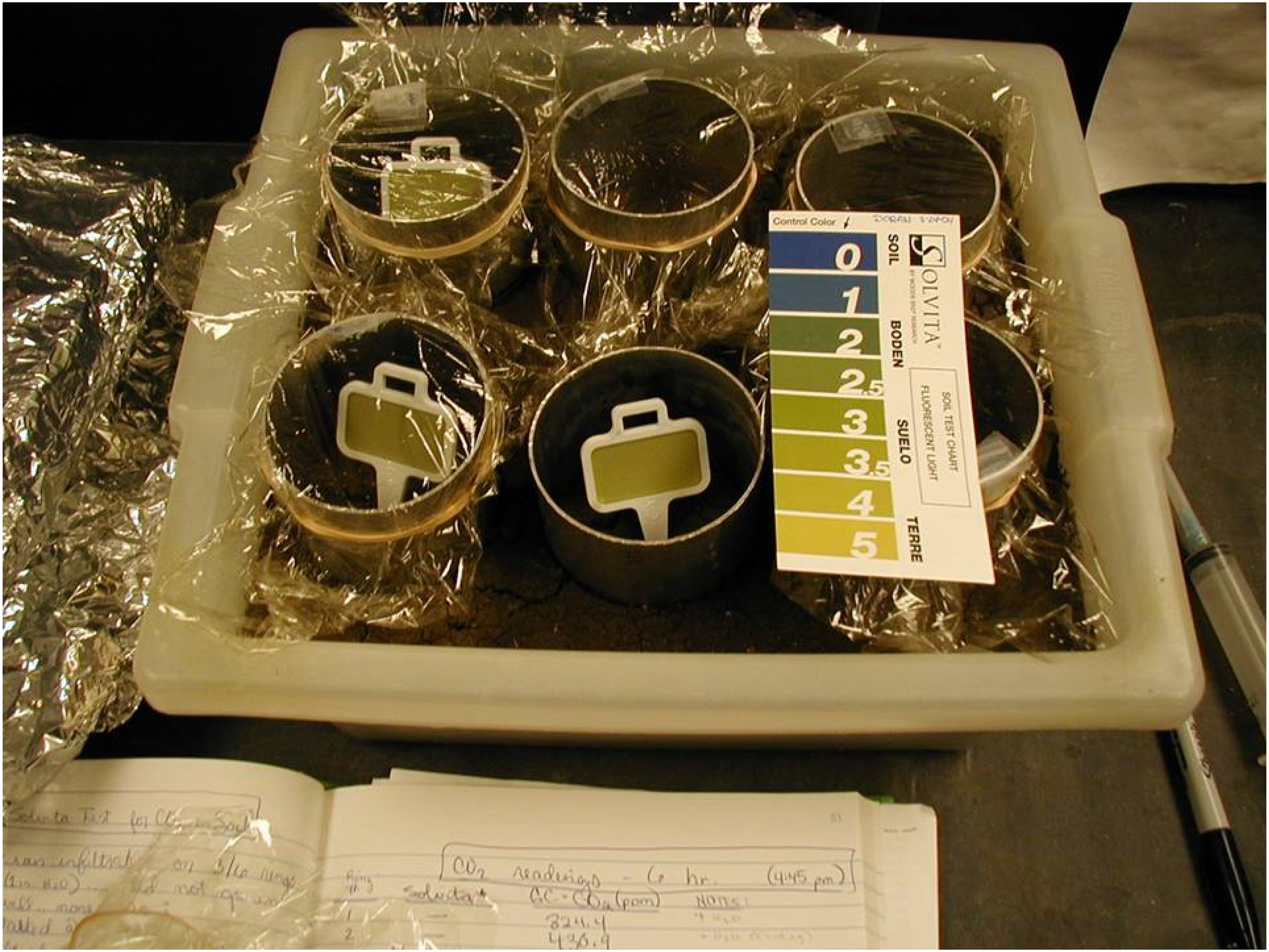
Water-holding Capacity

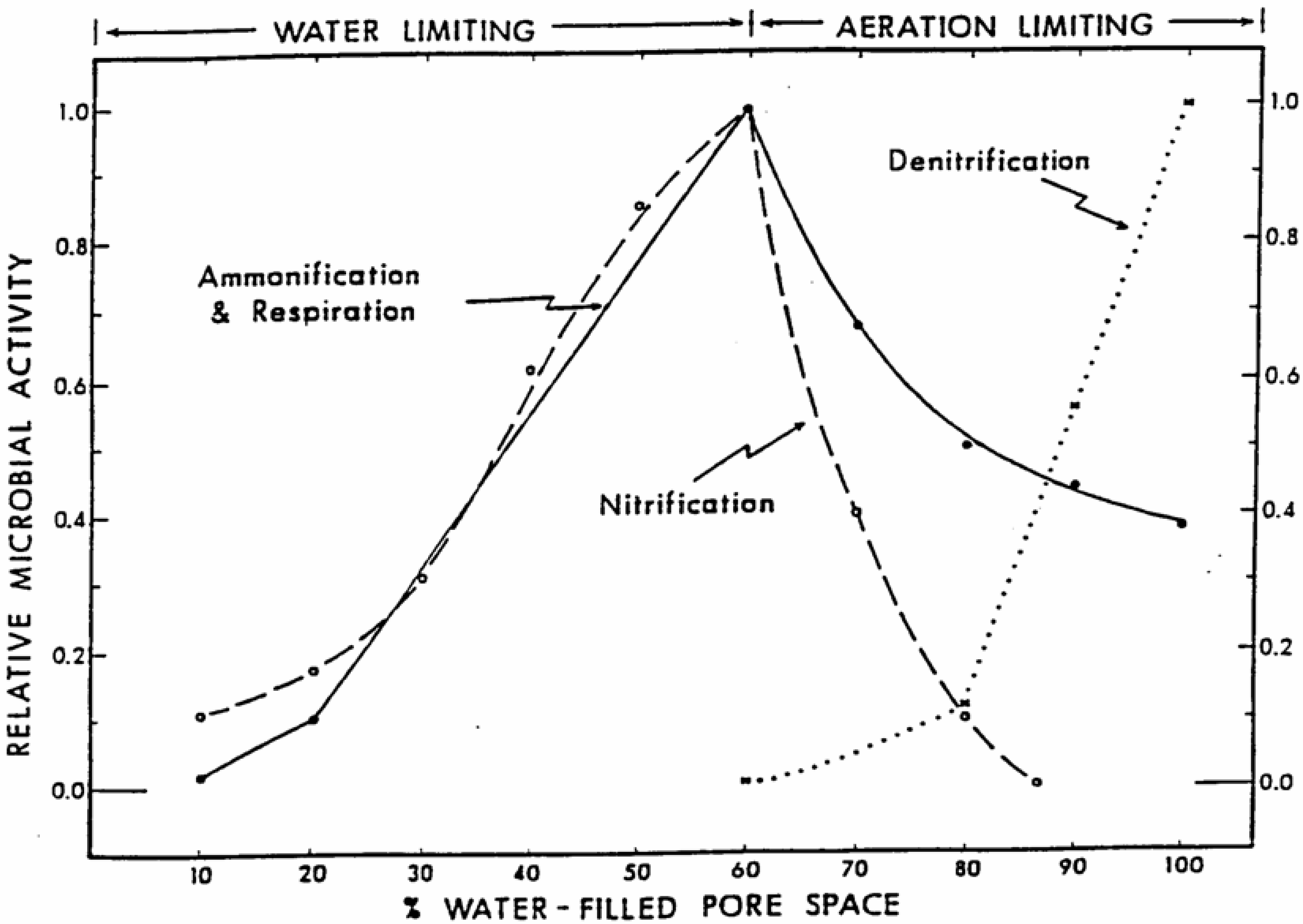
Bulk Density & WFPS

Respiration (3h Solvita)

(field temp. & WFPS)

Potential N Mineralization


Control Color
SOIL
BODEN
SUELO
TERRE
0
1
2
2.5
3
3.5
4
5
SOLVITA
SOIL TEST CHART
FLUORESCENT LIGHT
CO2 readings - 6 hr. (4:45 pm)
Solvita
CC-CO2 (ppm)
NOTES
824.4
430.9



WATER LIMITING
AERATION LIMITING
RELATIVE MICROBIAL ACTIVITY
1.0
0.8
0.6
0.4
0.2
0.0
Ammonification
& Respiration
Nitrification
Denitrification
10
20
30
40
50
60
70
80
90
100
% WATER - FILLED PORE SPACE

Soil Electrical Conductivity (EC) : Indicator of Soil Health and activity of Plants, Microorganisms, and Nematodes;

Range of units (dS/m) in wet soil:

0 to 1 units: best soil health

1 to 2 units: Caution, problem for:

- **Sensitive plants** (d.e. bean, cowpea, pepper, orchardgrass, berseem clover, and potatoes)
- **Nitrogen bacteria** (more Nitrous Oxide evolved offsets benefits of tie up of atmospheric CO_2 in SOM; 1 N_2O + 300 CO_2)
- **Plant parasitic nematodes** (may have a selective advantage at EC>1)

Rapid estimator of Soil Nitrate-N

(low lime soils, pH < 7.2)

140 X EC <= ppm Nitrate-N

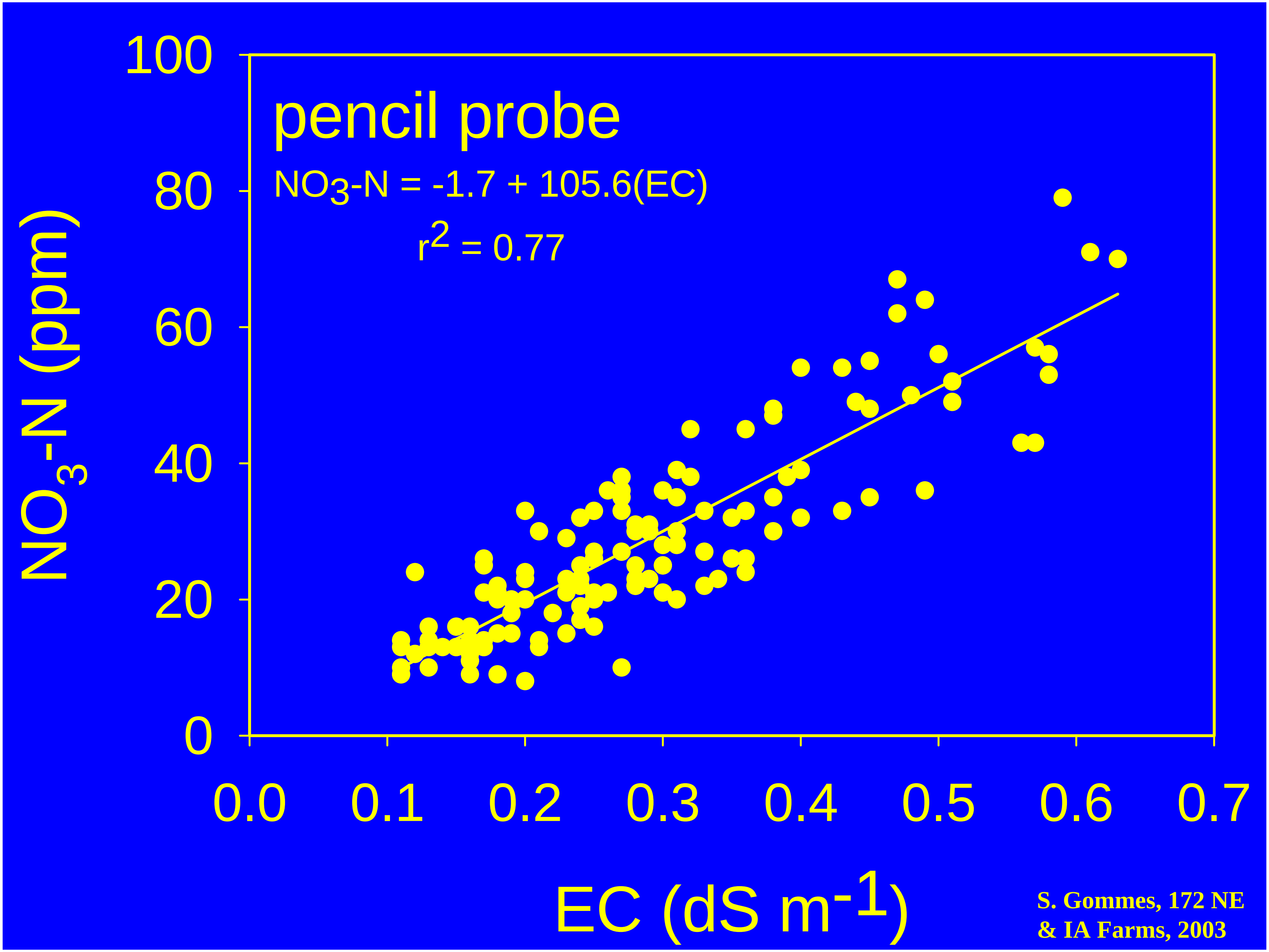
Spring Nitrate-N Test for non-limited corn yield

(Early June, top 12" soil, corn 12" tall 4-6 leaves)

EC differential of 0.15 units (21 ppm nitrate-N) in fertilized corn or 0.10 units (14 ppm nitrate-N) with manure or after soybean or alfalfa.

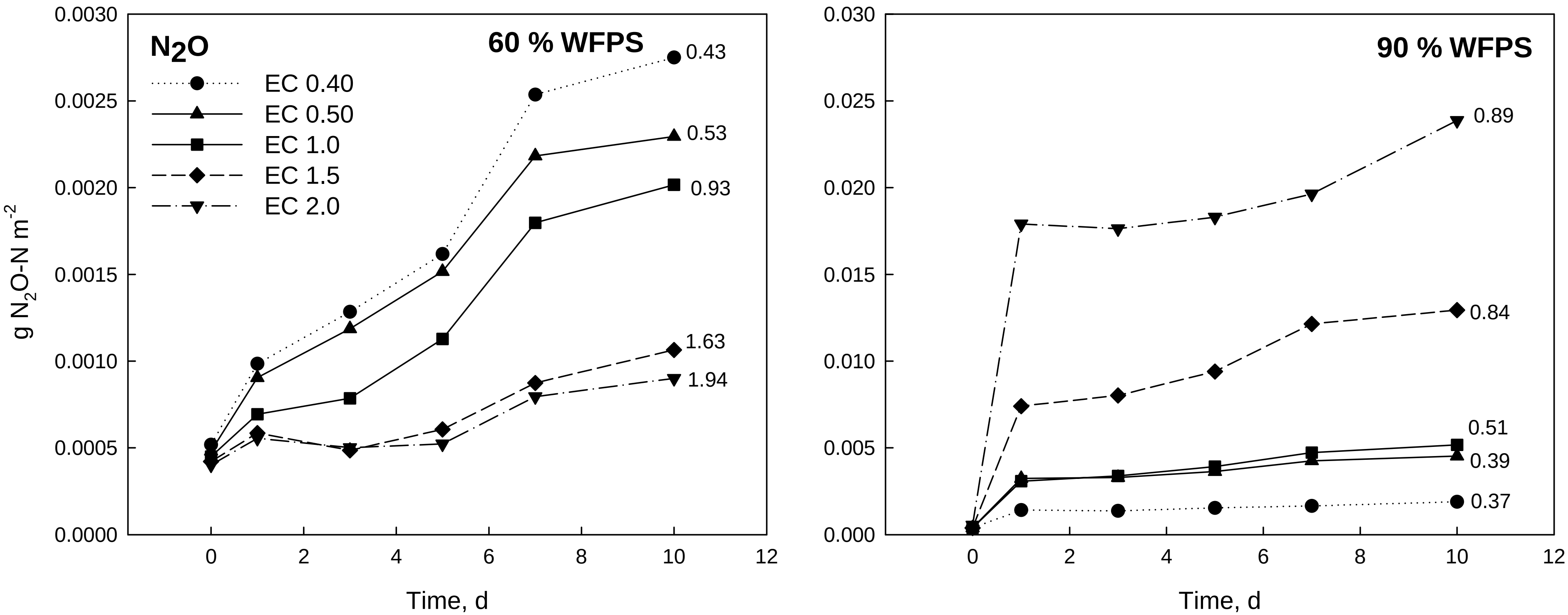
Nitrate loss after heavy rain and water logging

If soil EC is 0.01, the Nitrate-N content is < 1.4 ppm



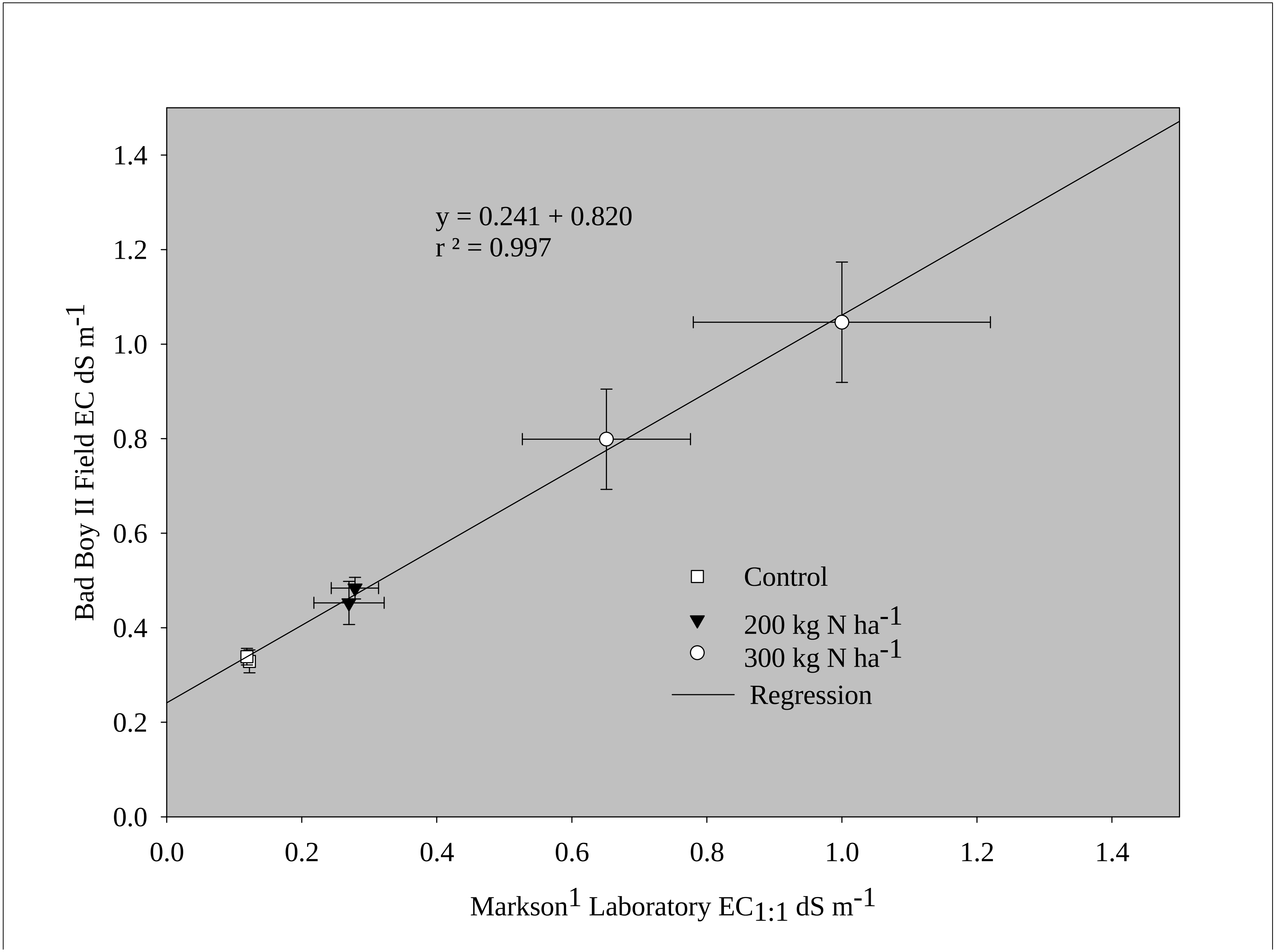
S. Gommes, 172 NE & IA Farms, 2003

Lincoln EI CC-M2 soil

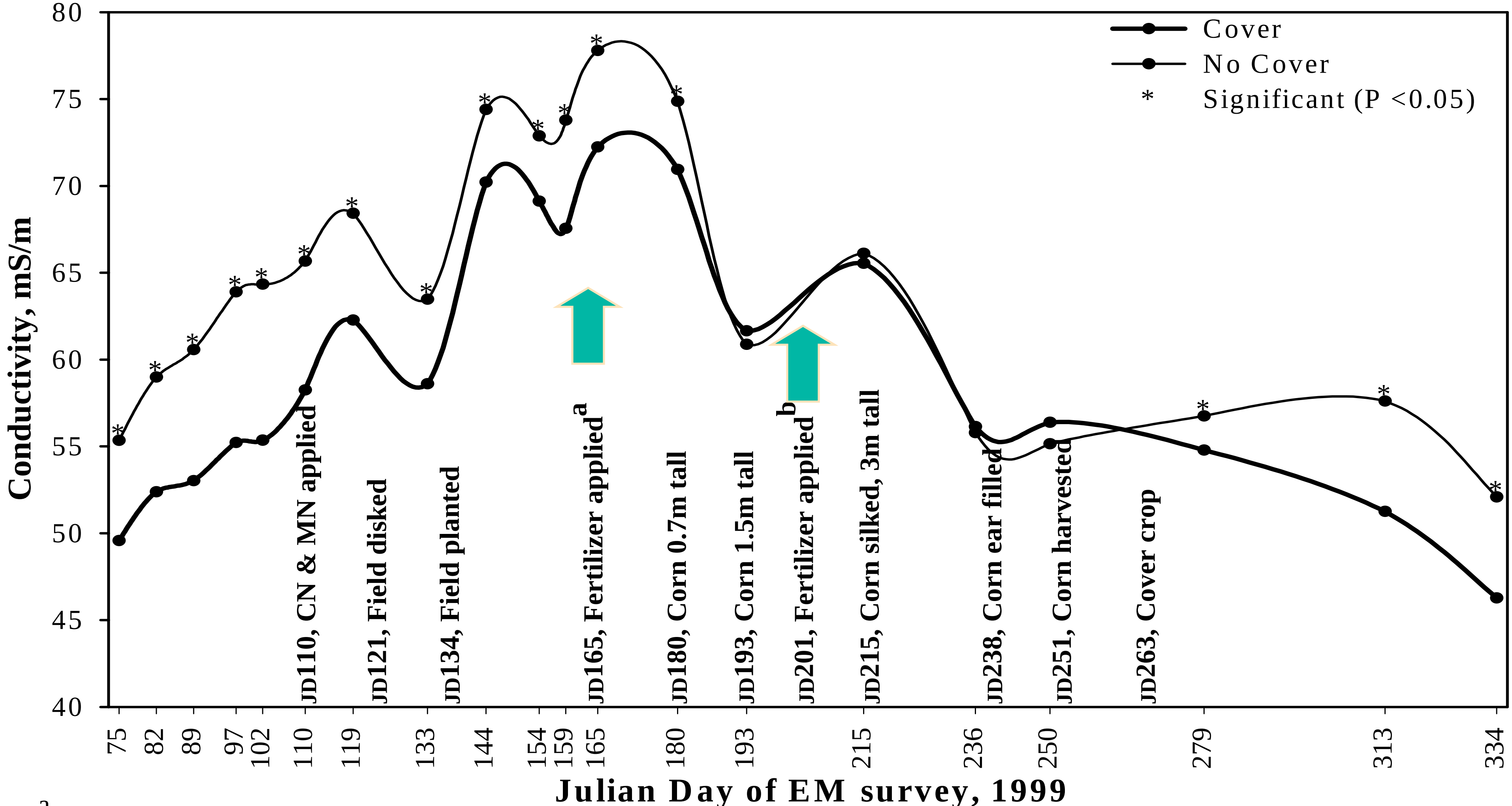


EC_0	Nitrate-Nitrogen, ppm day 0	day 10
0.38	27	60
0.53	27	50
1.02	27	1
1.54	27	1
2.04	27	1

EC_0	Nitrate-Nitrogen, ppm day 0	day 10
0.38	27	0
0.53	27	0
1.02	27	1
1.54	27	0.5
2.04	27	1


y = 0.241 + 0.820
r ² = 0.997
Control
200 kg N ha-1
300 kg N ha-1
Regression
Bad Boy II Field EC dS m-1
Markson1 Laboratory EC1:1 dS m-1
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4

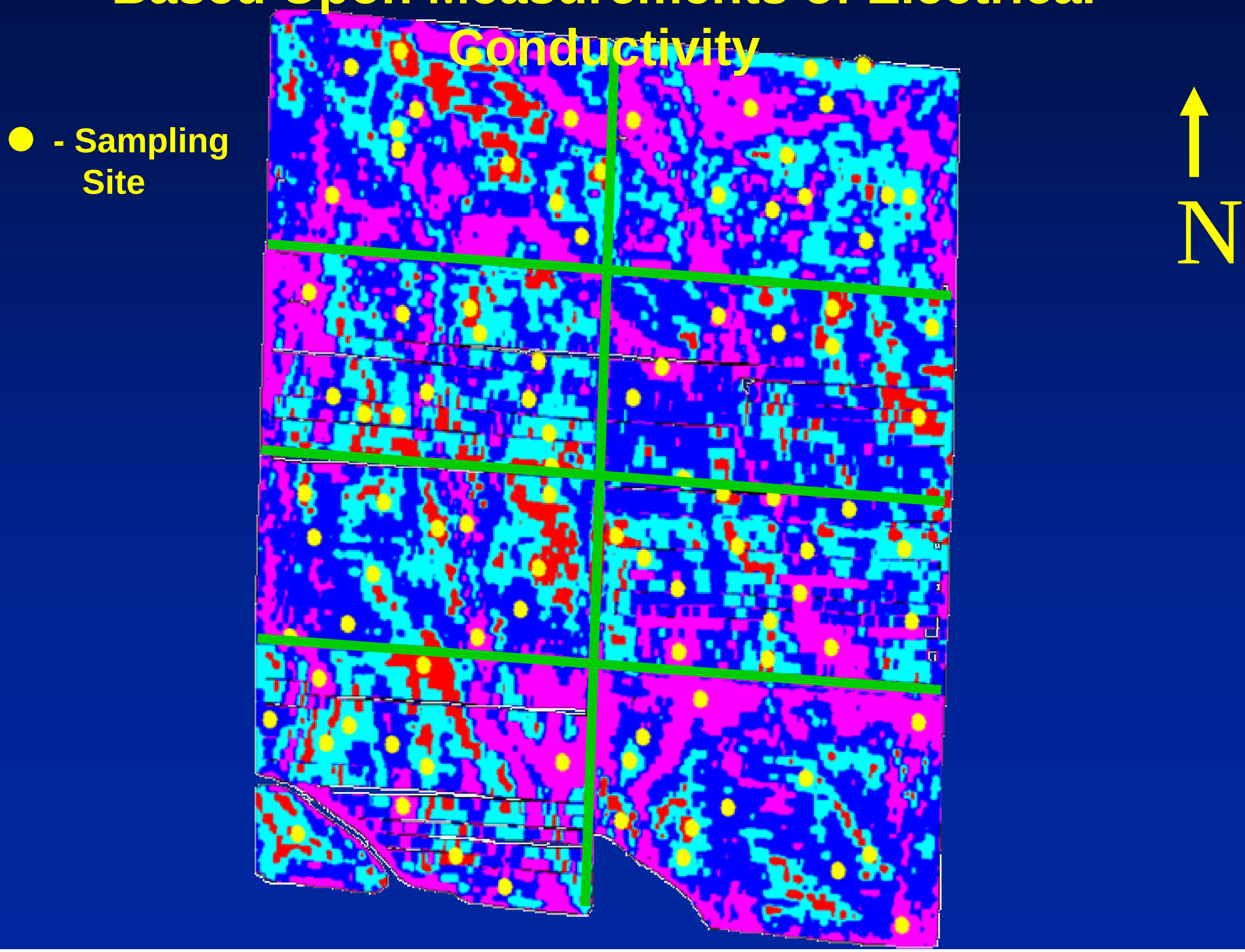
Electrical Conductivity



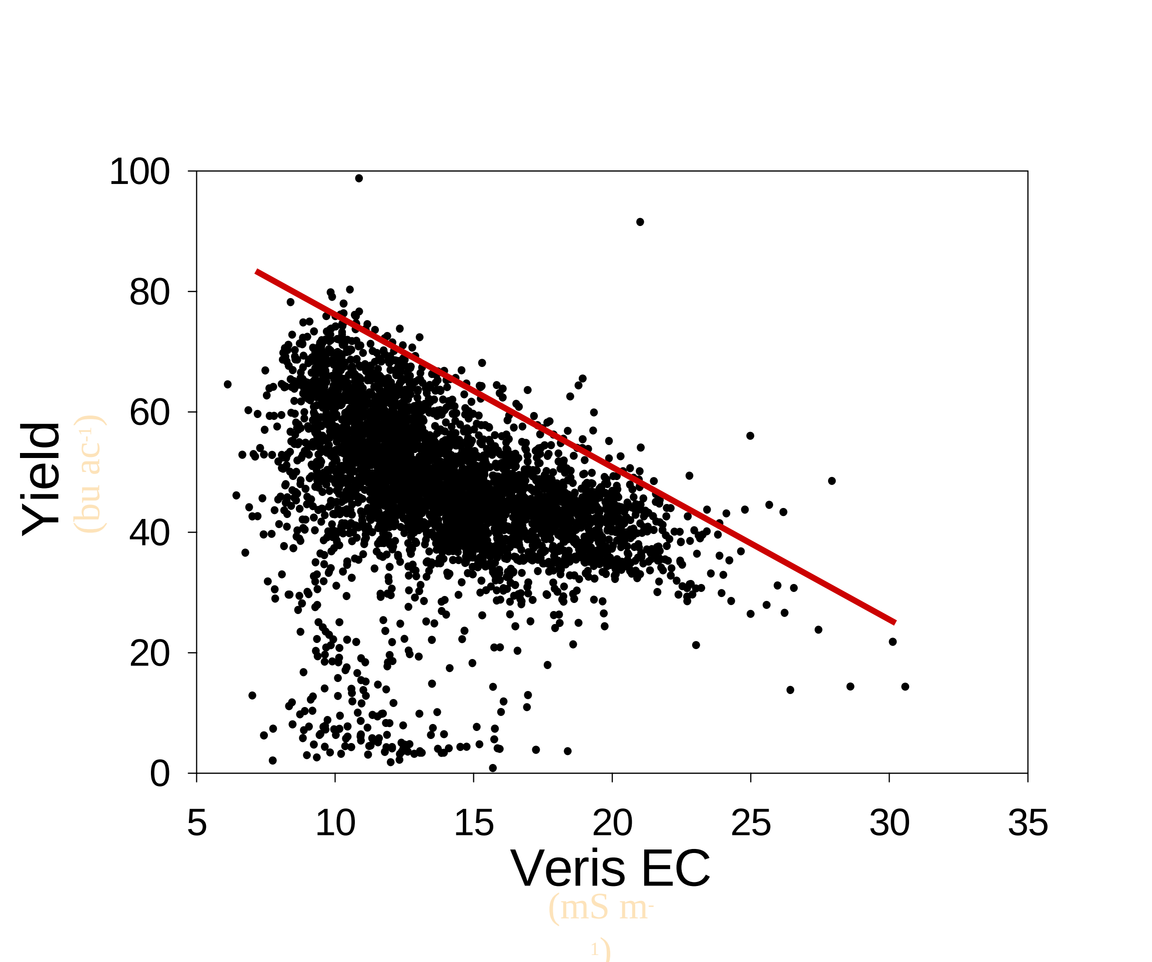
[a] Fertilizer applied to NCK plots only

[b] Fertilizer applied to NCK, CP and MP plots

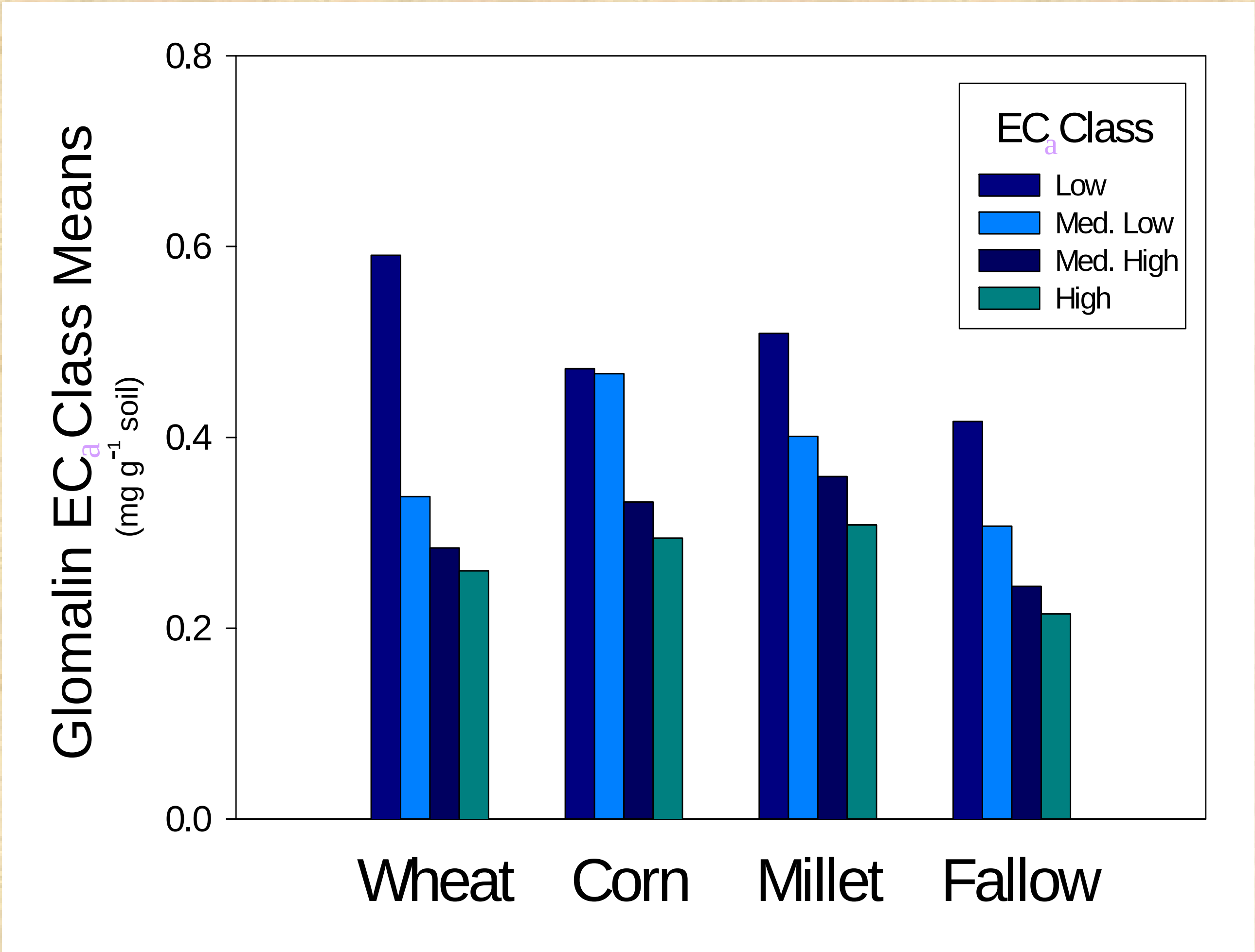
Soil Sampling Map of a Full Section in NE Colorado Based Upon Measurements of Electrical Conductivity



1999 Wheat Yields vs. EC_a



Glomalin



Glomalin EC_a Class Means
(mg g^{-1} soil)
0.8
0.6
0.4
0.2
0.0
EC_a Class
Low
Med. Low
Med. High
High
Wheat
Corn
Millet
Fallow

SQ INDICATORS for PRODUCERS

- **Direction of CHANGE in SOIL OM with TIME**
  Visual or Remote Sensing of Soil Color, Soil Analysis
- **Visual : DUST, RUNOFF, RILLS, SEDIMENT**
  Soil Properties: Depth, OM, Texture, % Cover, Infiltration
- **CROP and VEGETATION Characteristics**
  Yields, Color, N content, Rooting (Visual/Remote Sensing)
  Soil Physical State / Compaction (Dig a Hole)
- **Input / Output Ratios of COSTS and ENERGY**
  Soil & Water Nitrate Levels to indicate Efficient N Use
  Soil Acidification (leaching with inefficient N fertilizer use)

Single Most Valuable Soil Quality Indicator


Post-Millennium Agriculture
"Returning to Basics"
Thank You for Your Attention

OUR CHALLENGE

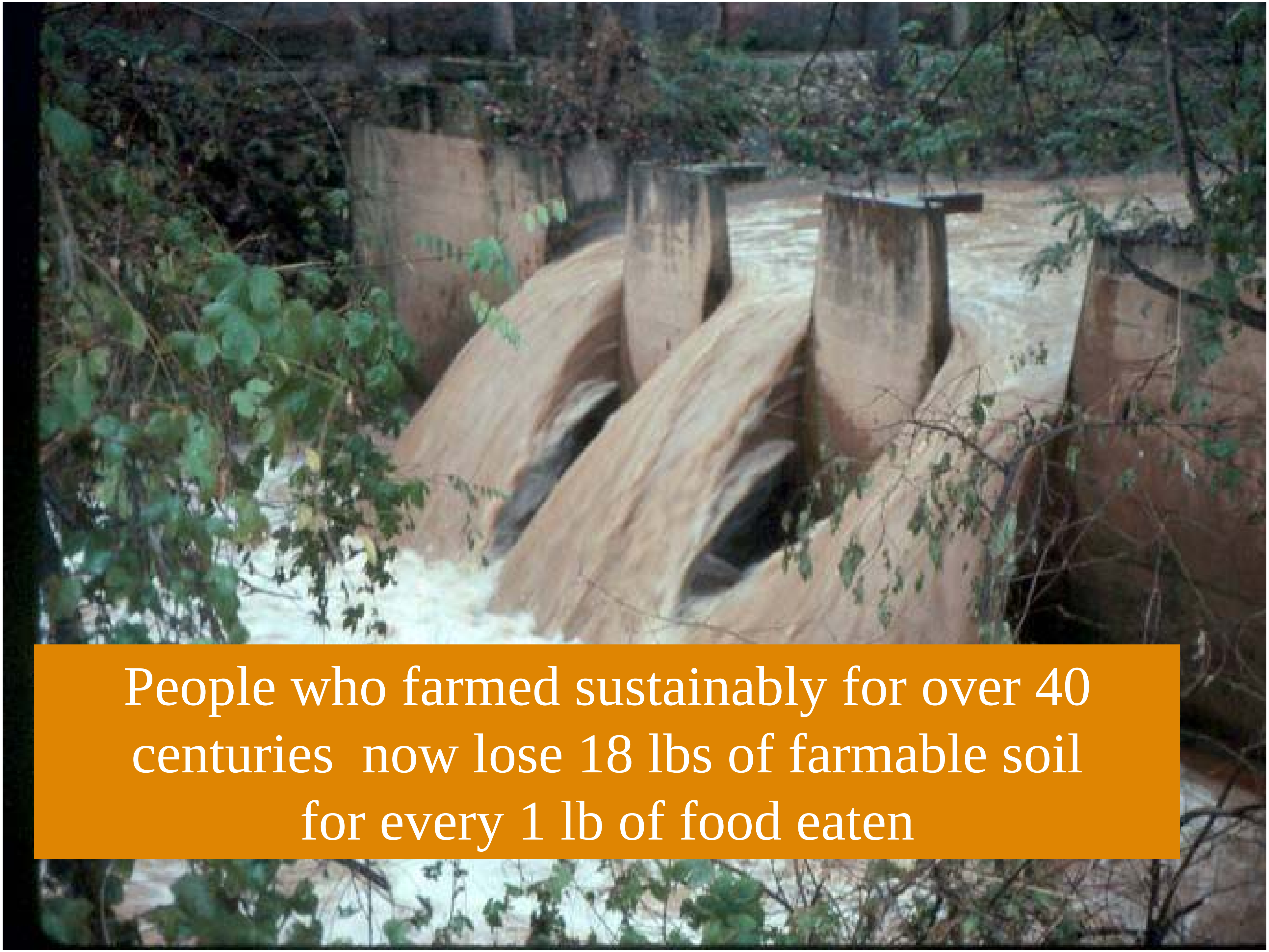
Charting a course

towards *Sustainability*

by

Translating Science into Practice

Early settlers plowing the prairie – To survive in a seemingly hostile environment



People who farmed sustainably for over 40 centuries now lose 18 lbs of farmable soil for every 1 lb of food eaten

For the first time since the dawn of civilization we now have the technological capacity to change the global environment

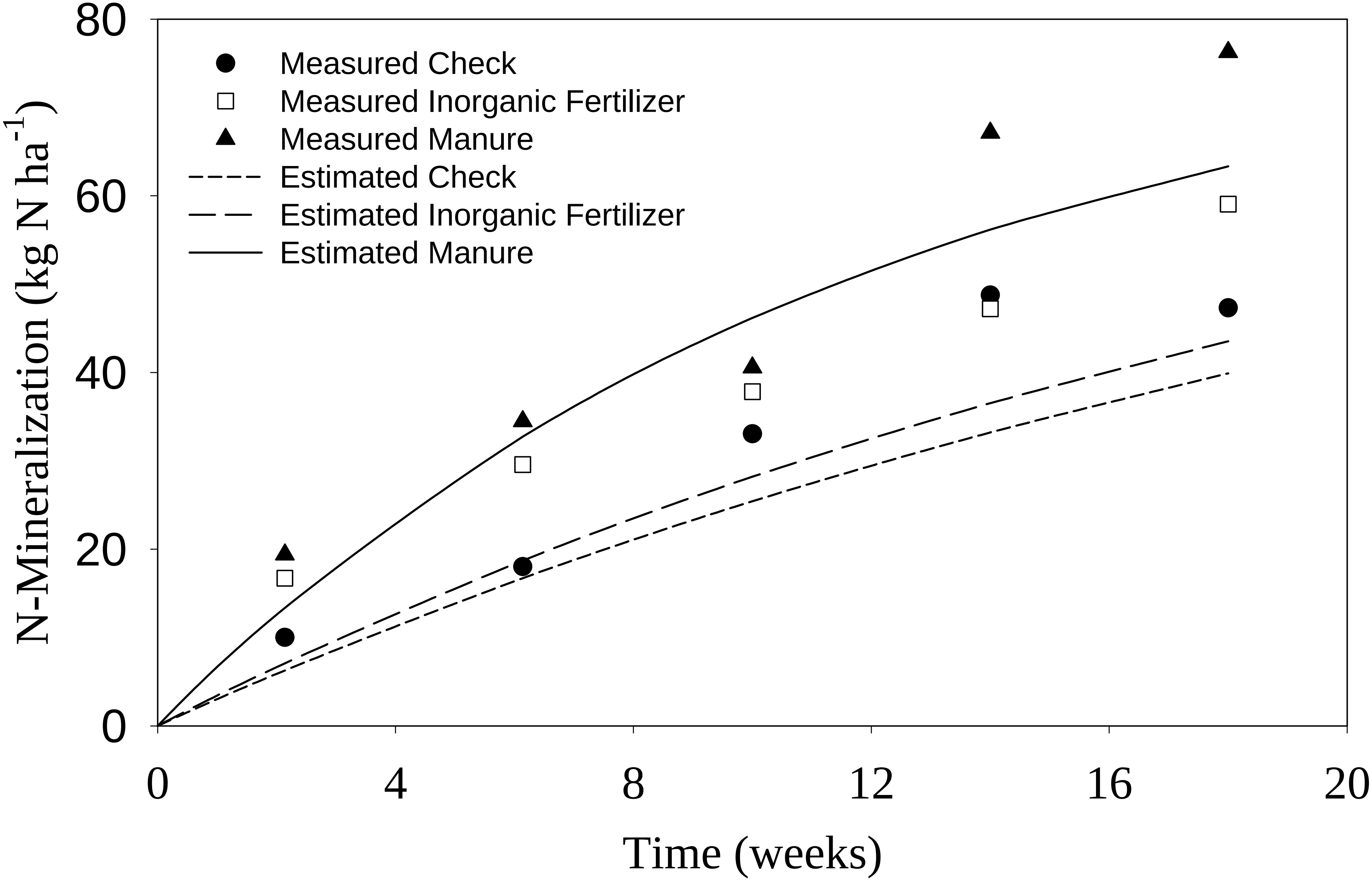


Figure 3. *In situ* N-mineralization and net mineralization predicted from Bulk Soil Electrical Conductivity.