Converting Colorful Maps into Useful Info - Normalizing years of geo-referenced soil and yield data to strategize next year's management

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Variability

Spatial

Temporal

Dynamic Prop.
(within the year-
soil water content
nitrates)

Static Properties
(soil texture, pH etc..)

Variation
(from year to year)

Yield Map

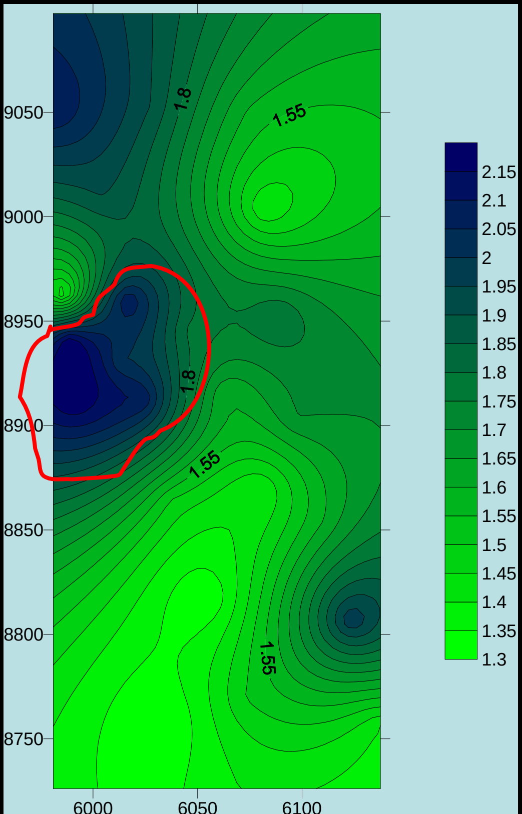
Spatial variability is the norm rather than the exception in most fields.

The success of Precision Agriculture depends on:

- how accurate is the assessment of variability
- adequacy of inputs recommendations
- the degree of application control

Management Zones

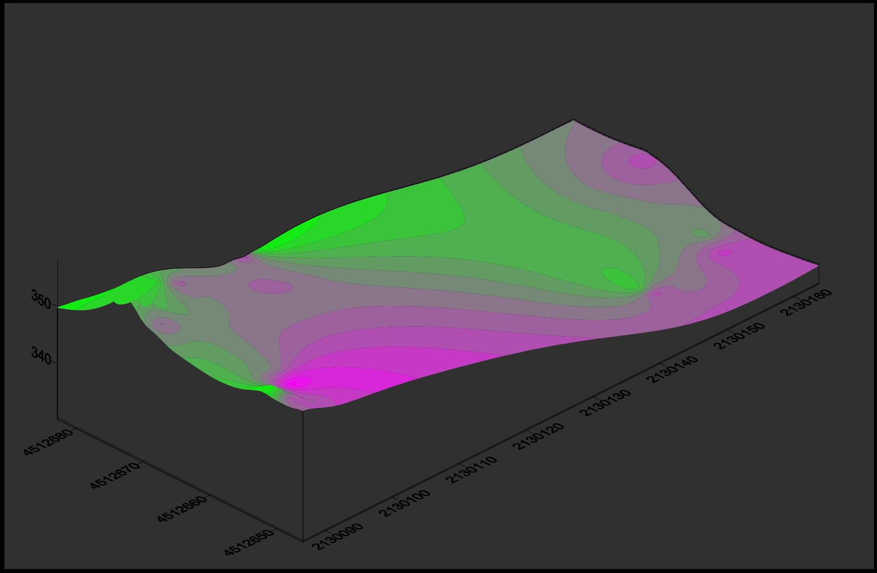
A management zone for variable rate technology (VRT) can be defined as a sub-region of a field that expresses a near-homogeneous combination of yield limiting factors for which a single rate of a specific crop input is appropriate



Management Zones Delineation

Various authors have proposed criteria for the delineation of management zones based on:

- **Topography, landscape position**
- **Soil Type**
- **Nutrient levels**
- **Yield**
- **EC**
- **Remote sensing and aerial photos**
- **Producers experiences**



(Fiez et al.,1994; Ostergaard, 1997; Franzen et al., 2001; Basso et al., 2001; Johnson et al., 2003; Ferguson et al., 2004; Schepers et al., 2004, Chang et al., 2004; Fleming et al.,2004; Inman et al., 2005)

Precision Agriculture – 4 R

..is the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production for the purpose of improving crop performance and environmental quality.

...applying the <u>Right input</u>
in the <u>Right amount</u>
at the <u>Right time</u>
in the <u>Right place</u>

Pierre Robert

1990 - 2015

Precision Agriculture

1990 vs 2015

1990

- **Technology Enabled**
  - **- immature, limiting**
- **Within Field Variability**
  - **Recognized but difficult to map**
- **Apply whole field principles to site-specific management**
- **Environmental Benefits assumed – *win-win***

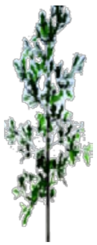
2015

- **Core Technologies Mature**
  - **– New technologies**
- **Sensing variability**
  - **– Null Hypothesis – Temporal >> Spatial**
- **Real time management**
  - **– Lack of SS production functions**
- **Ecosystem services are expected**
  - **– Change in management scale is required**

(Photo sources F.J.Pierce)

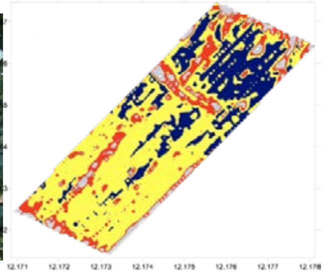
Precision Agriculture Scales of Application

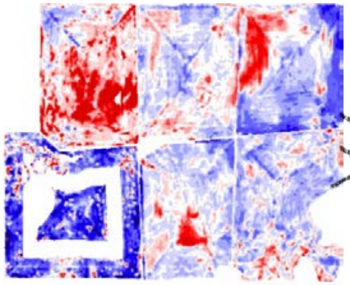
Plant -- Landscape

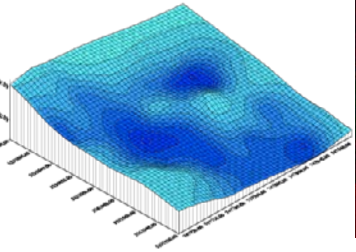

Plant

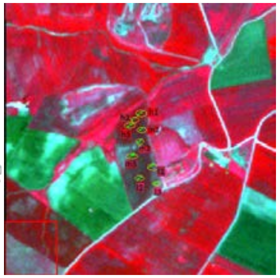

Trunk


Tree

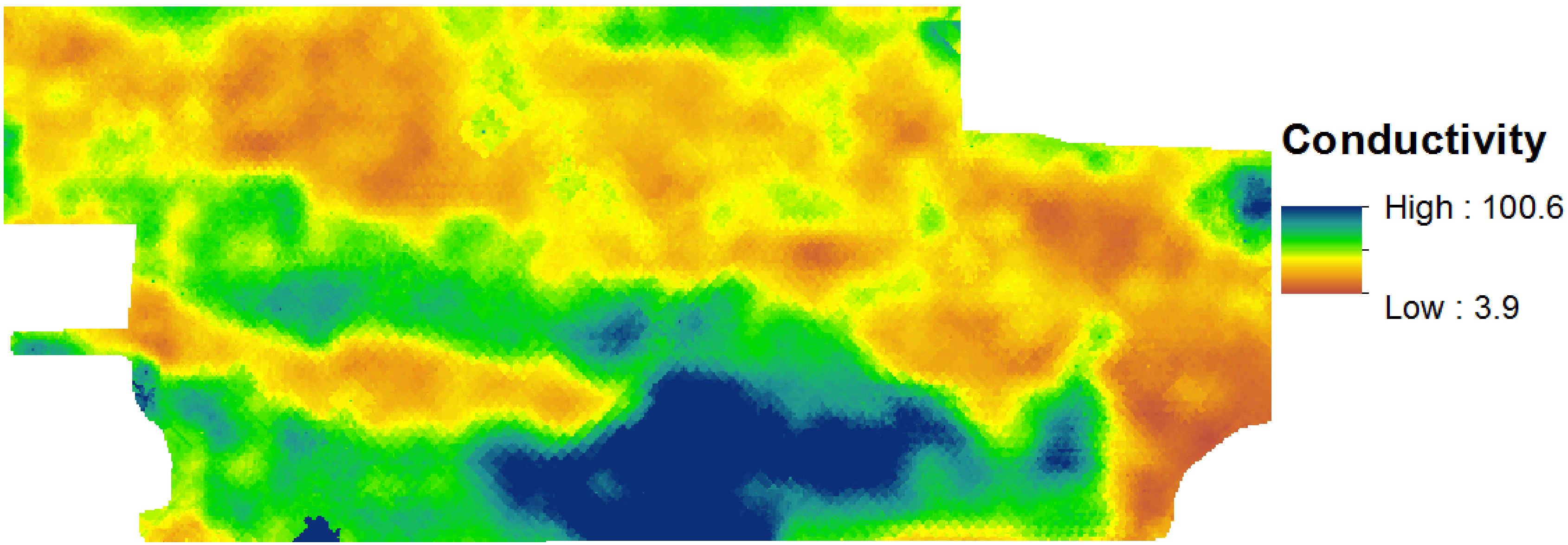

Field


Farm

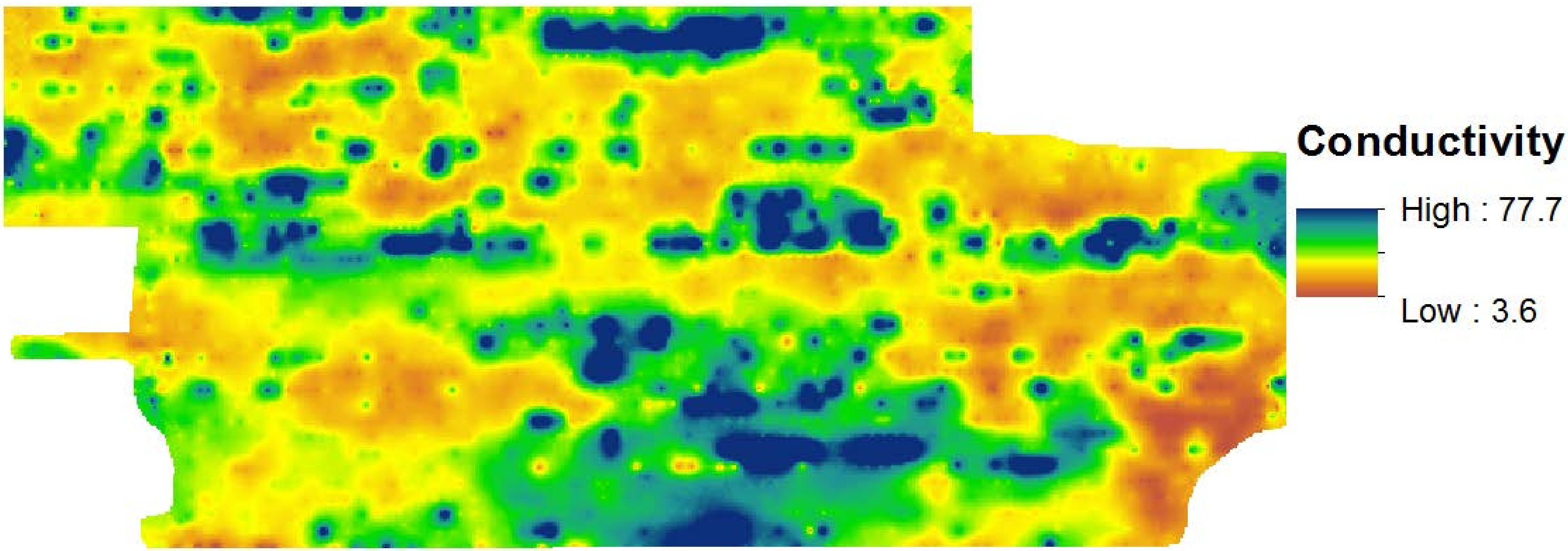

Catchment


Landscape

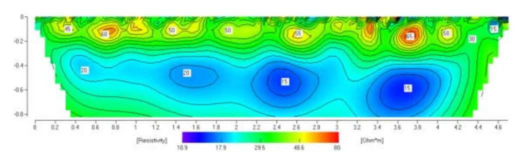
Veris Soil Conductivity Map: Shallow

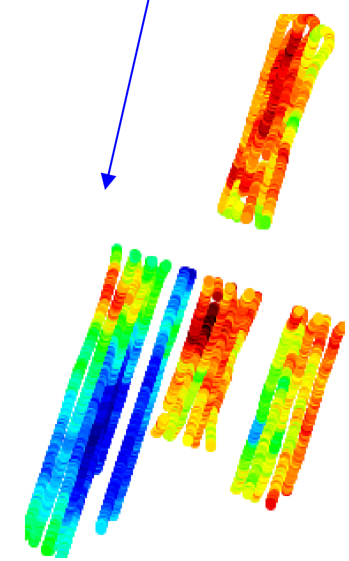


Veris Soil Conductivity Map: Deep



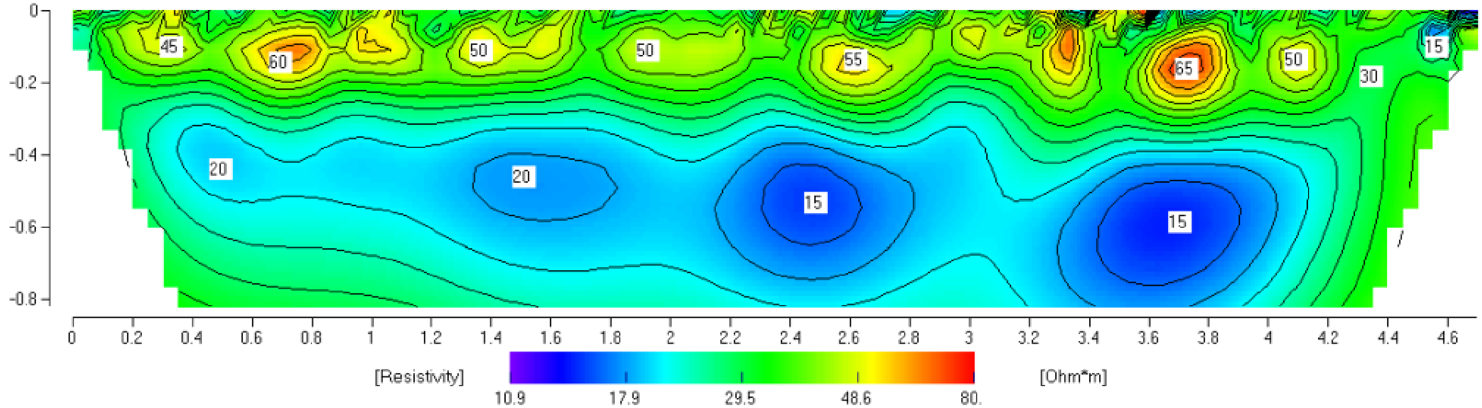
High-resolution 2-D resistivity tomography



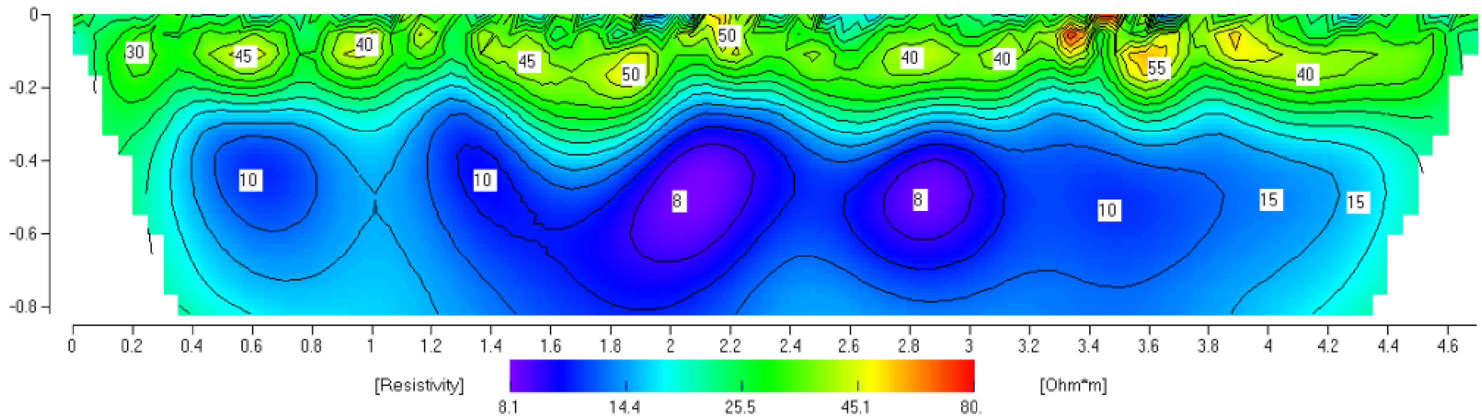


High-resolution 2-D resistivity tomography

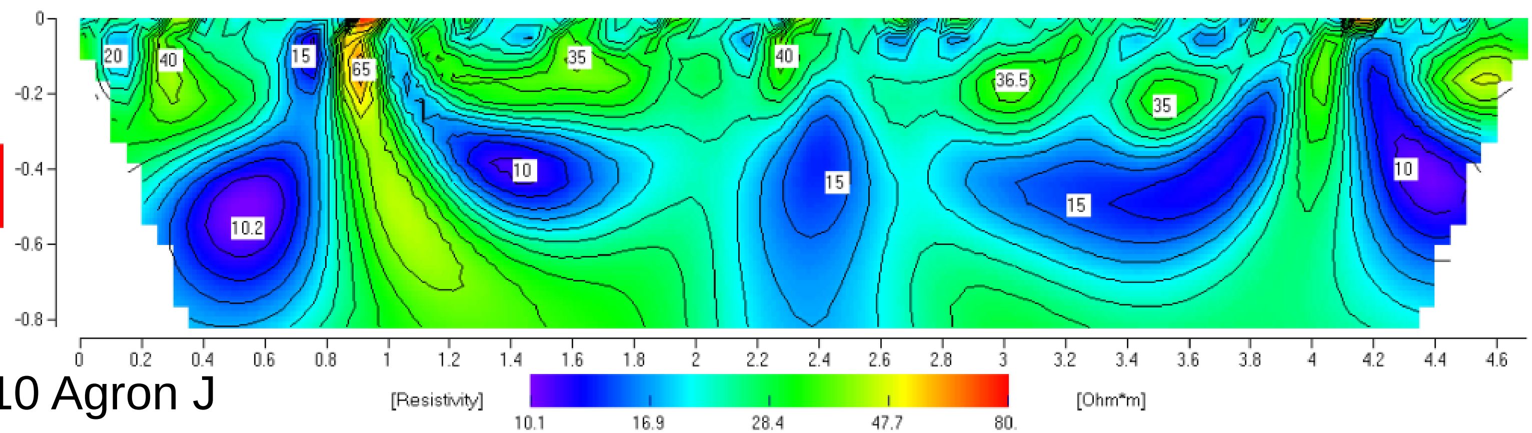
Conventional Tillage



Minimum Tillage

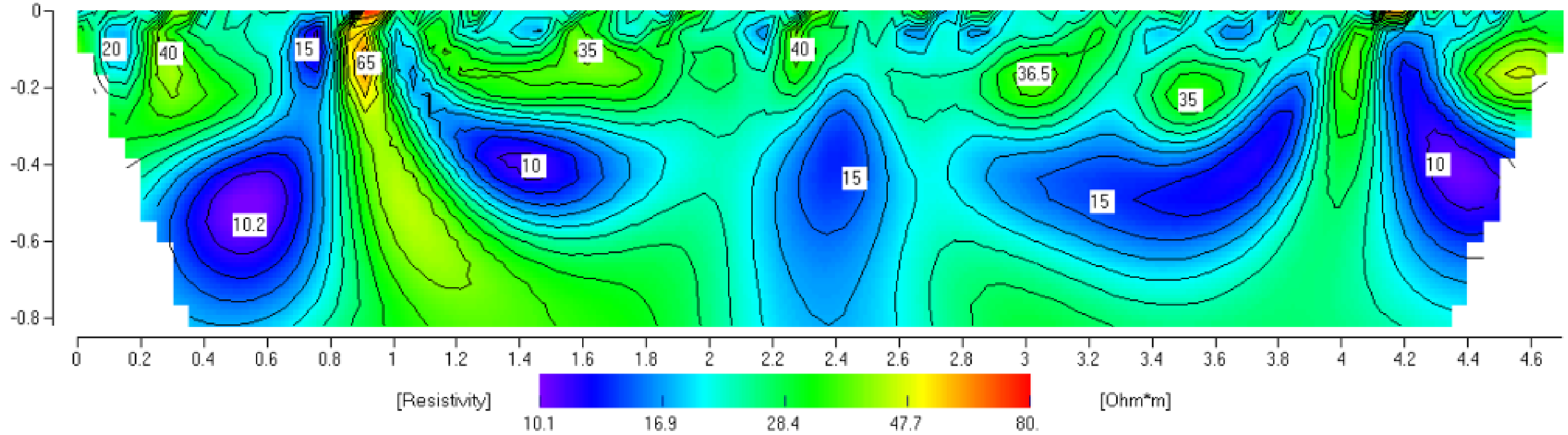


No Tillage

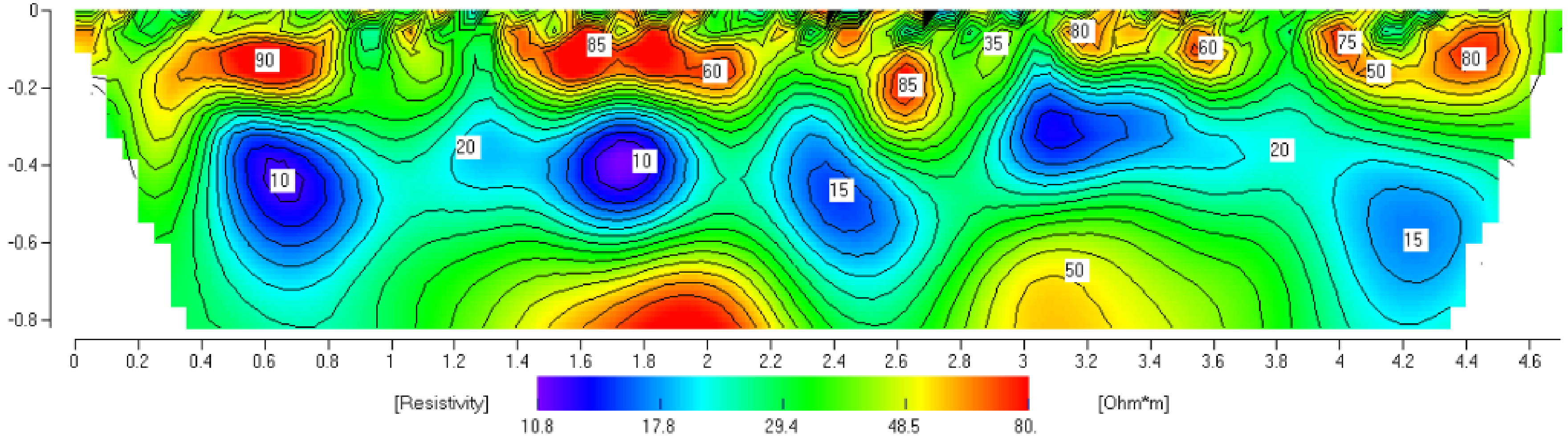


Basso et al., 2010 Agron J

No Tillage

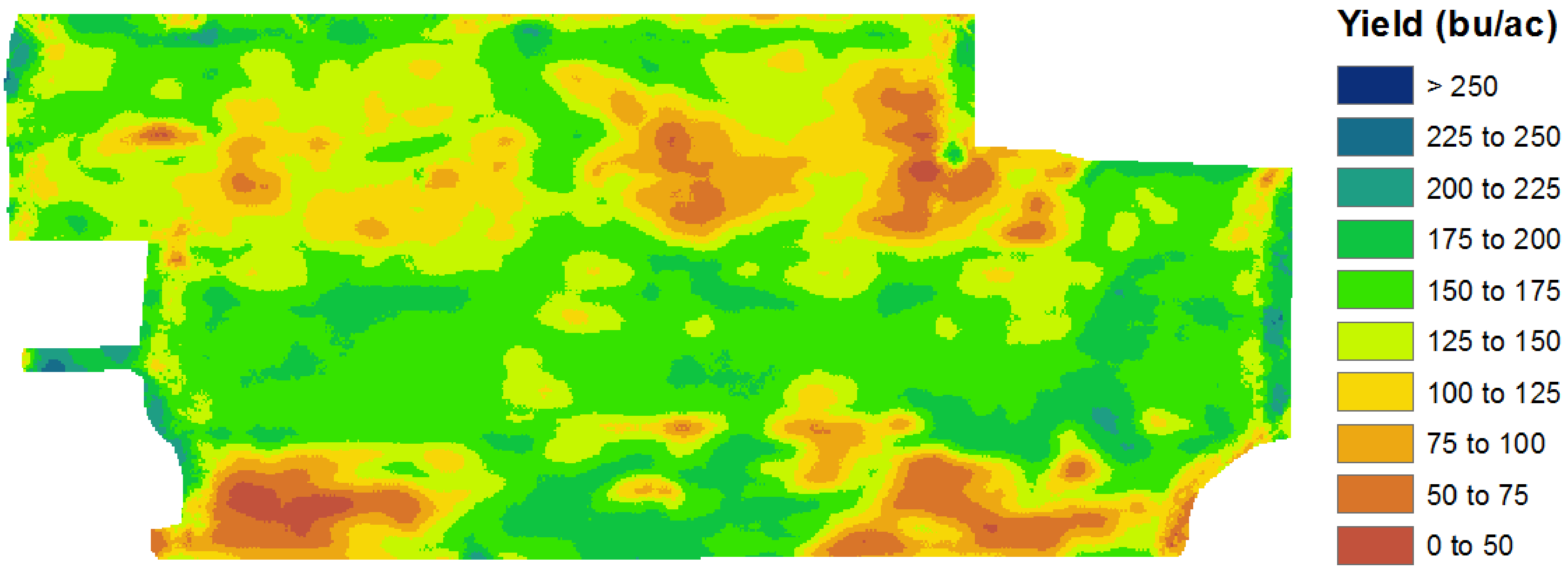


No Tillage plot right after a tillage event

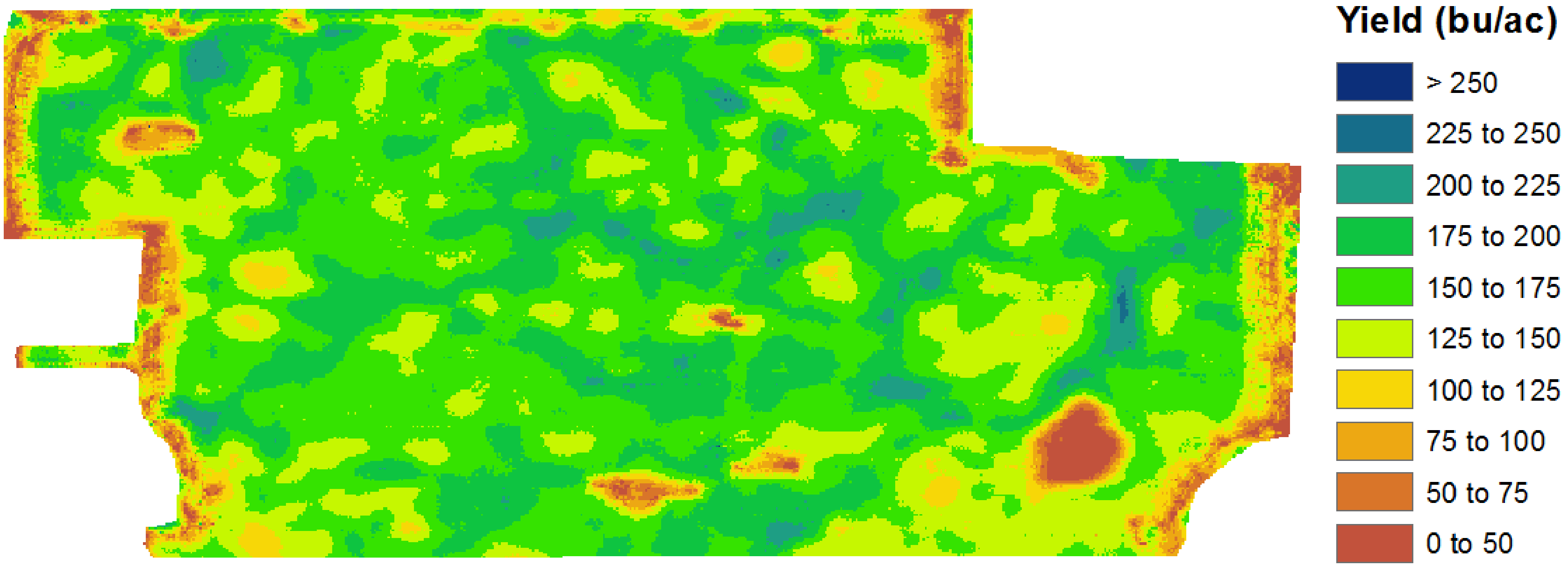


Basso et al., 2010 Agron J

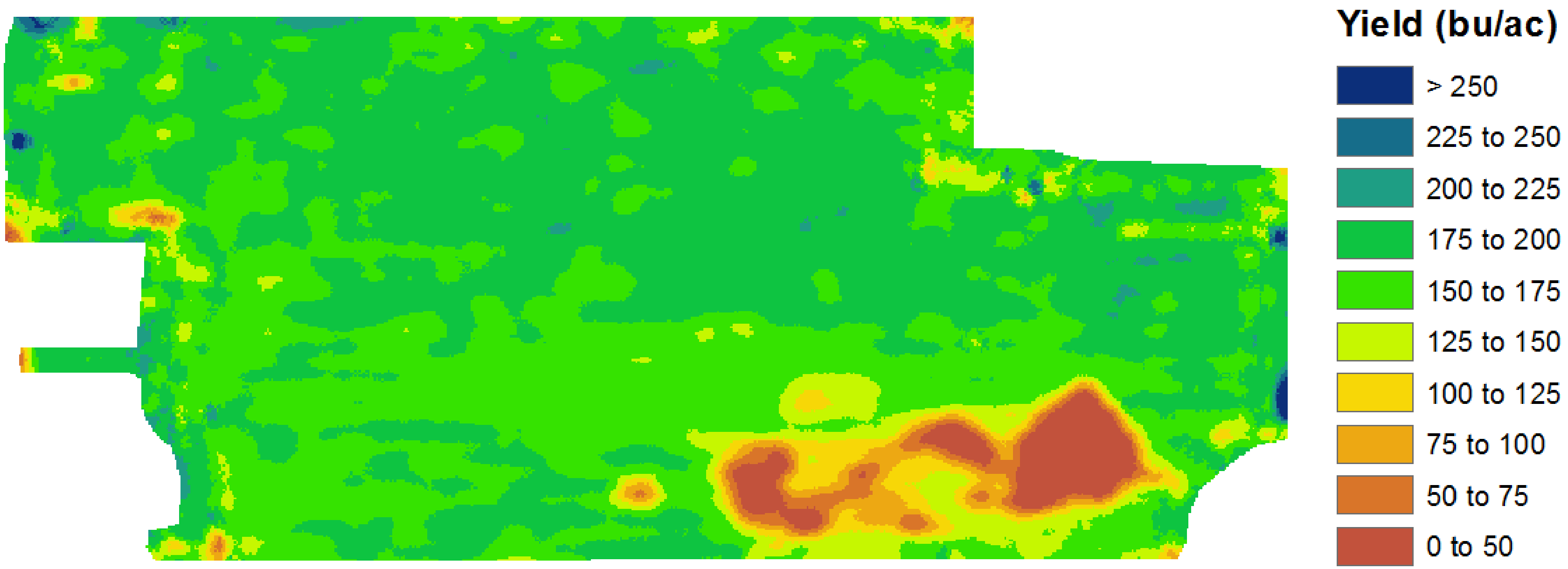
2006 Yield Map



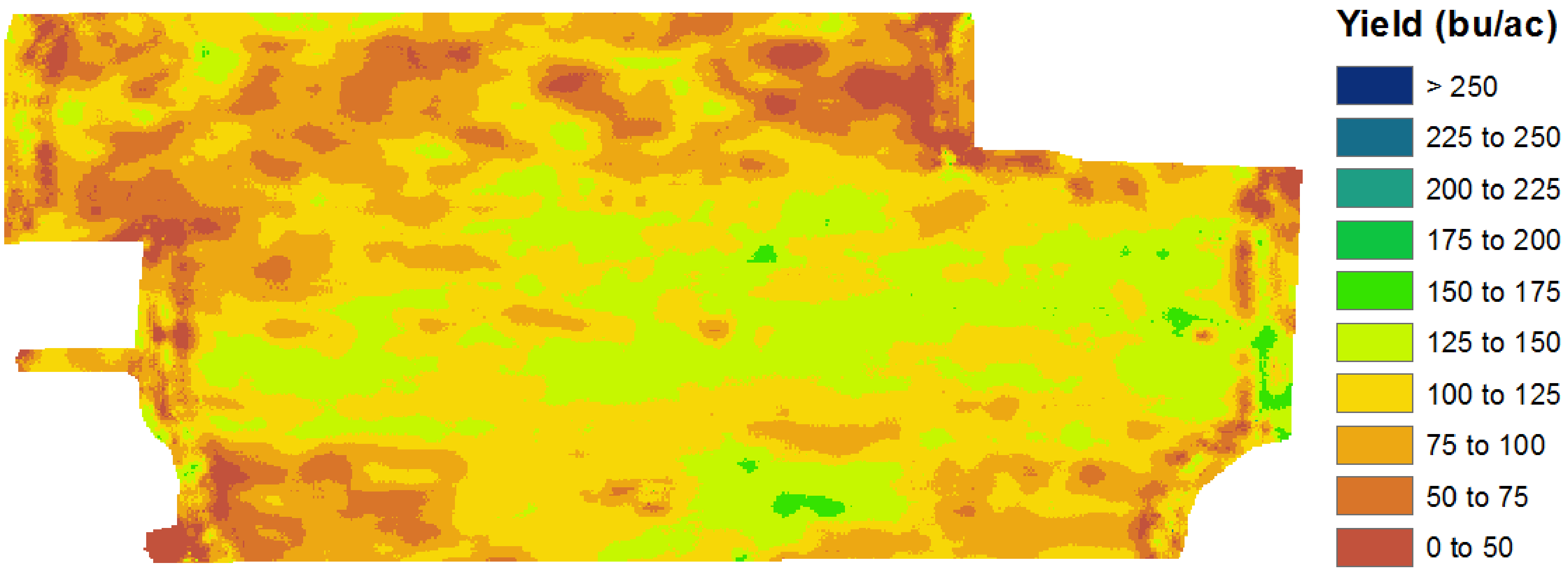
2008 Yield Map



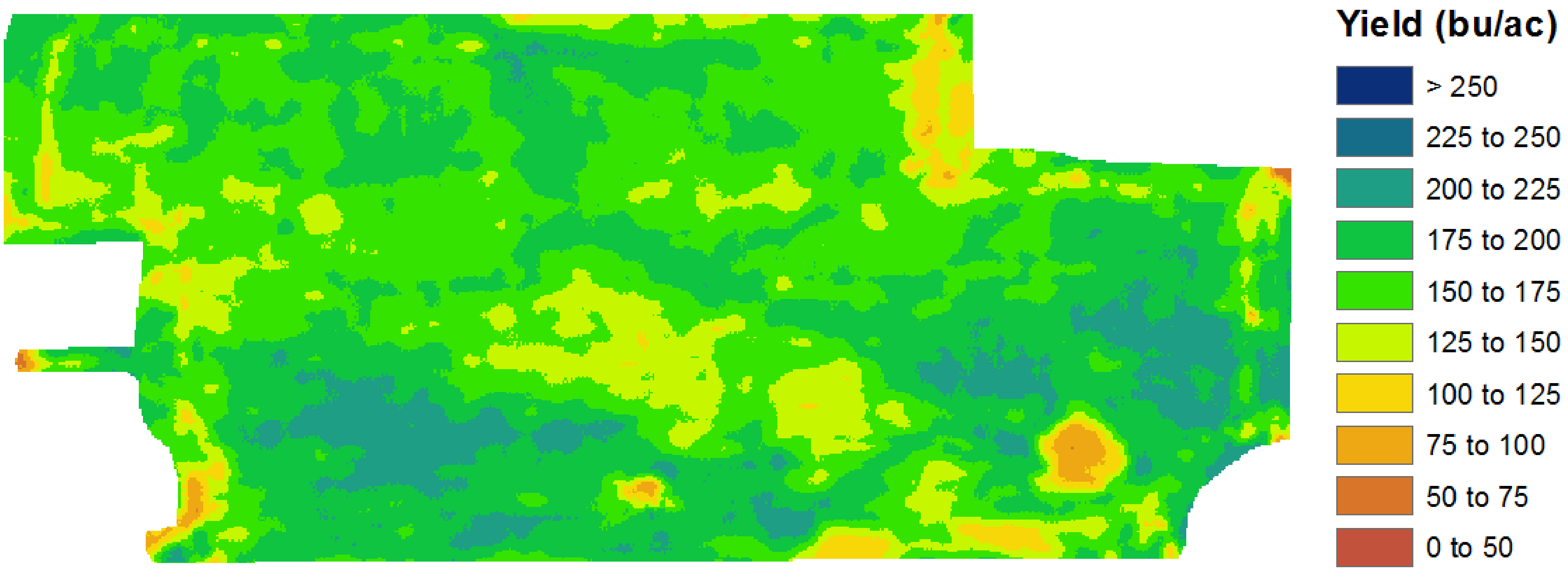
2010 Yield Map



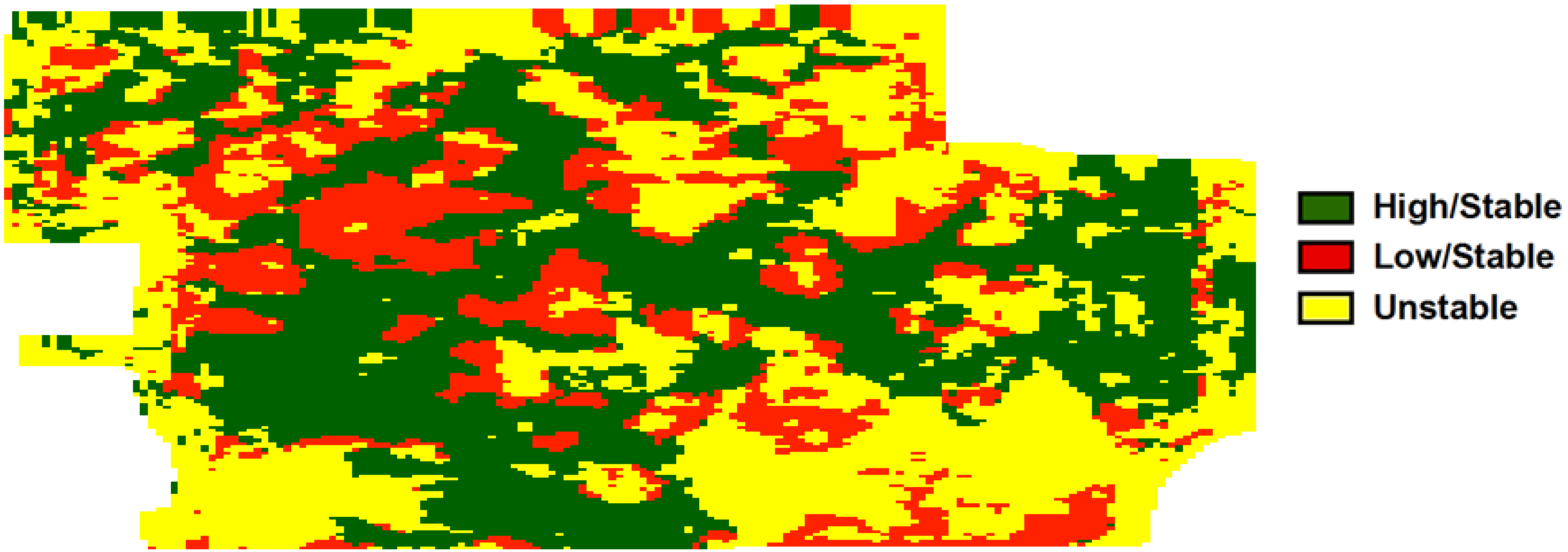
2012 Yield Map



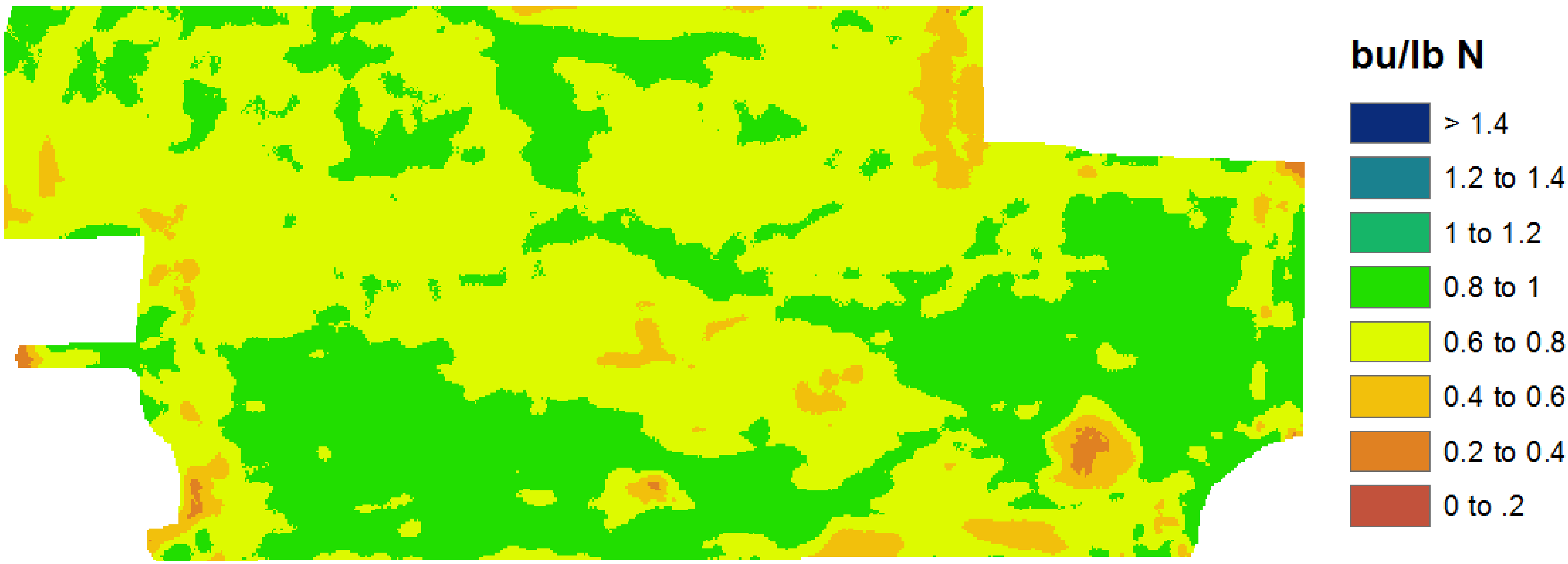
2014 Yield Map



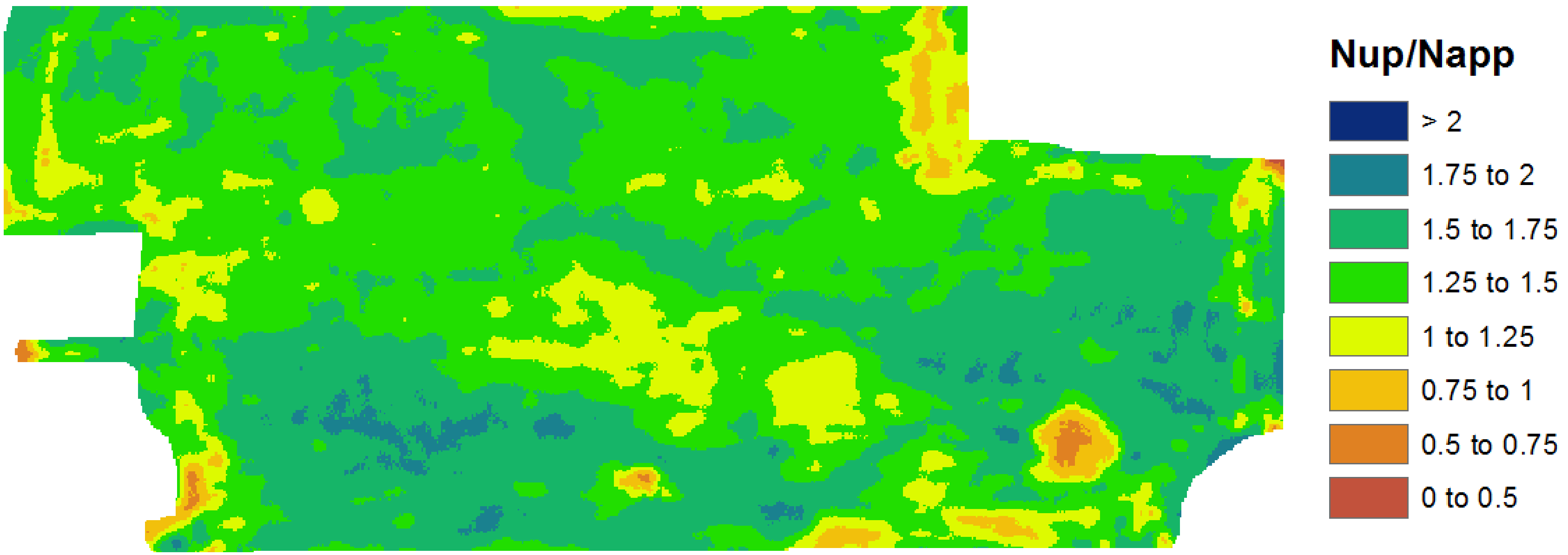
Stability Map



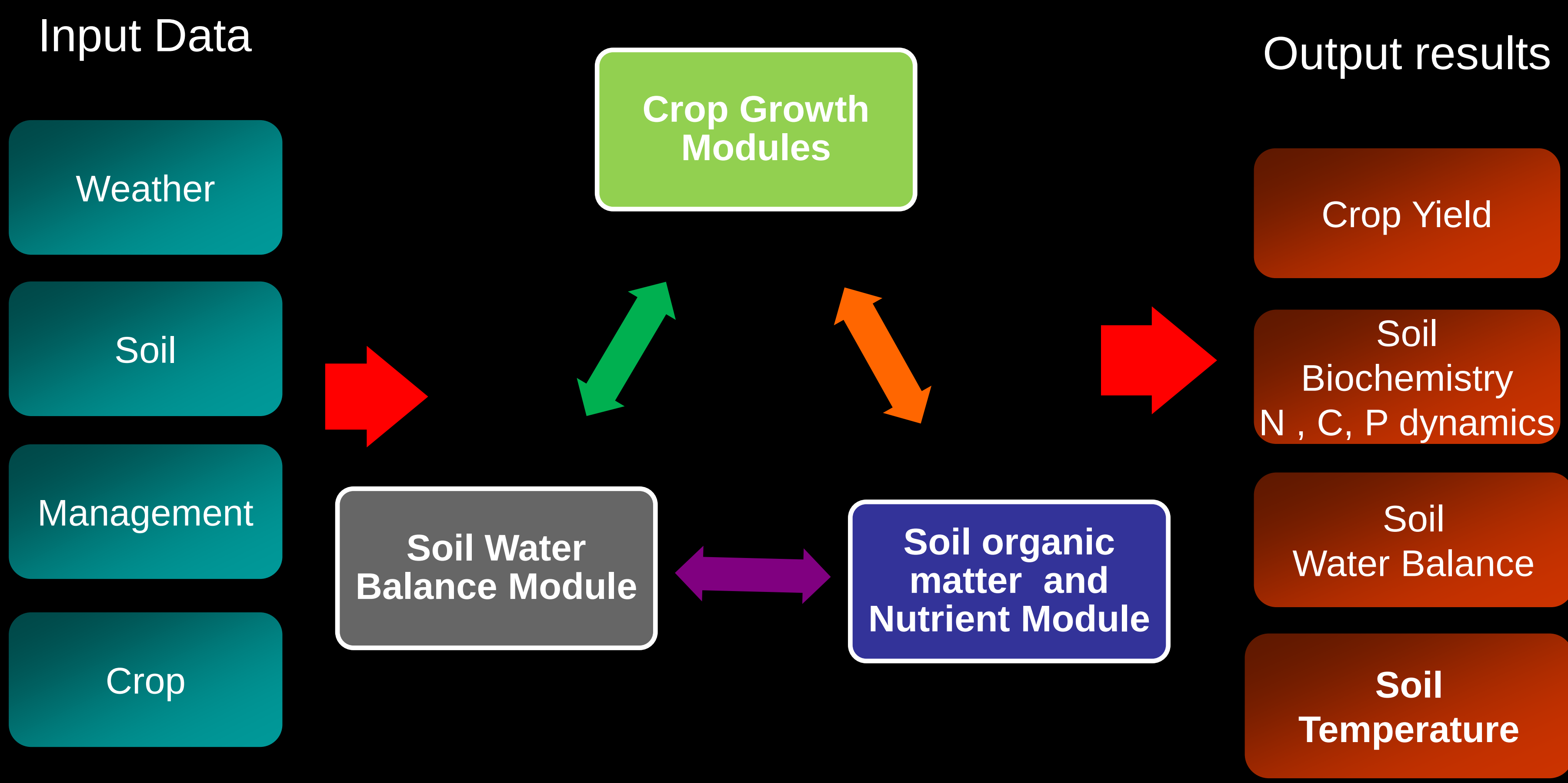
2014 Nitrogen Use Efficiency



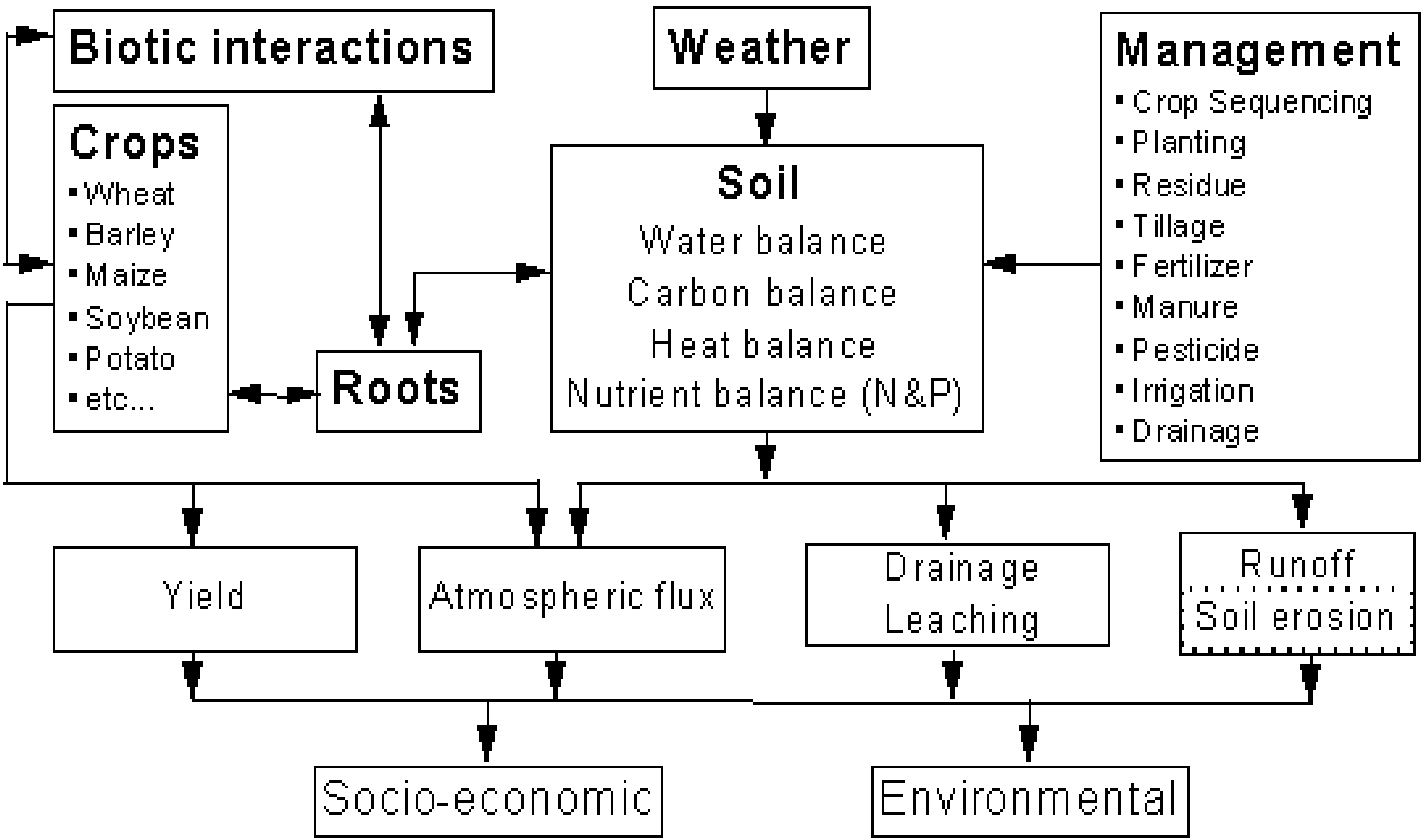
2014 Nitrogen Fertilizer Efficiency



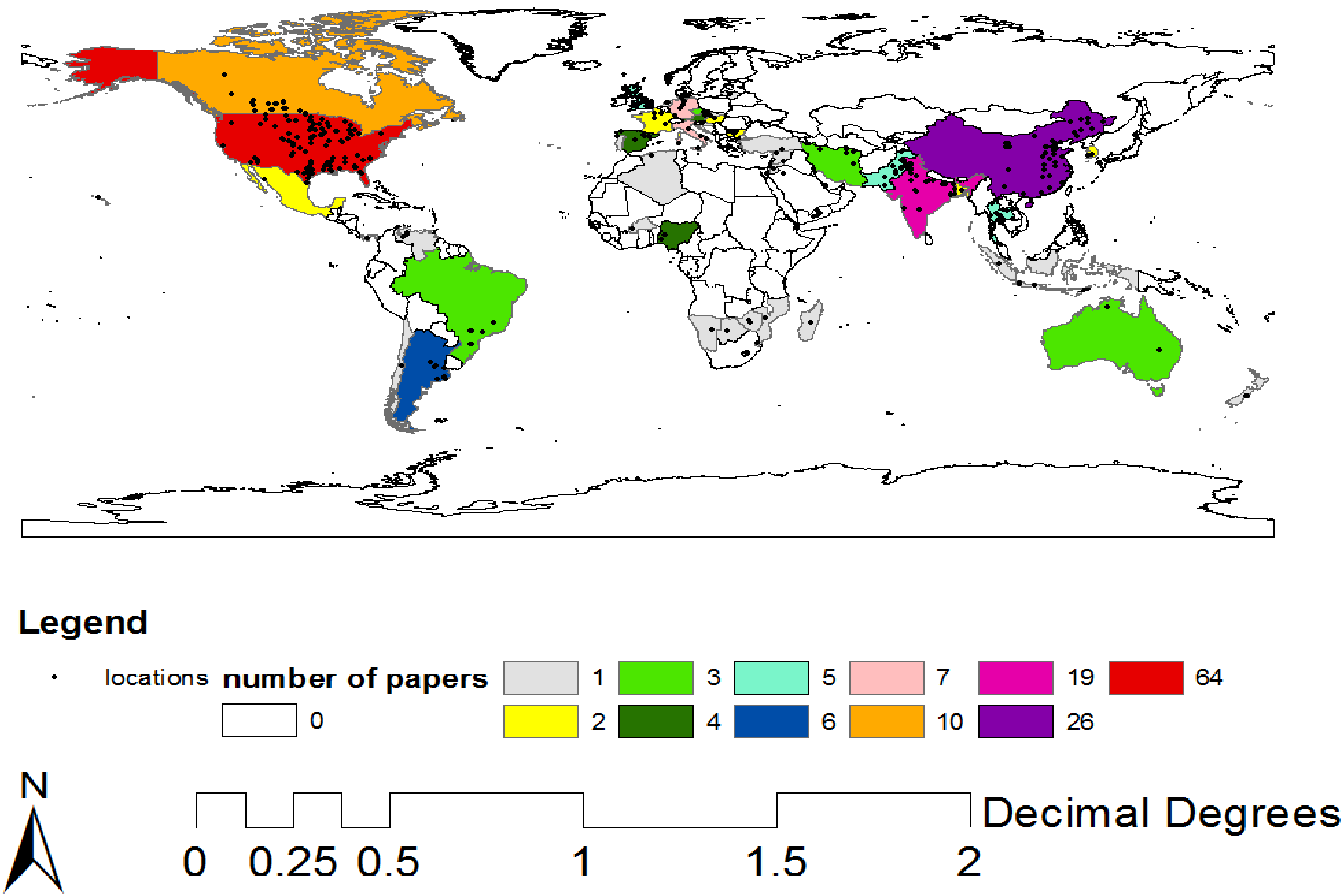
SALUS
(System Approach for Land Use Sustainability)



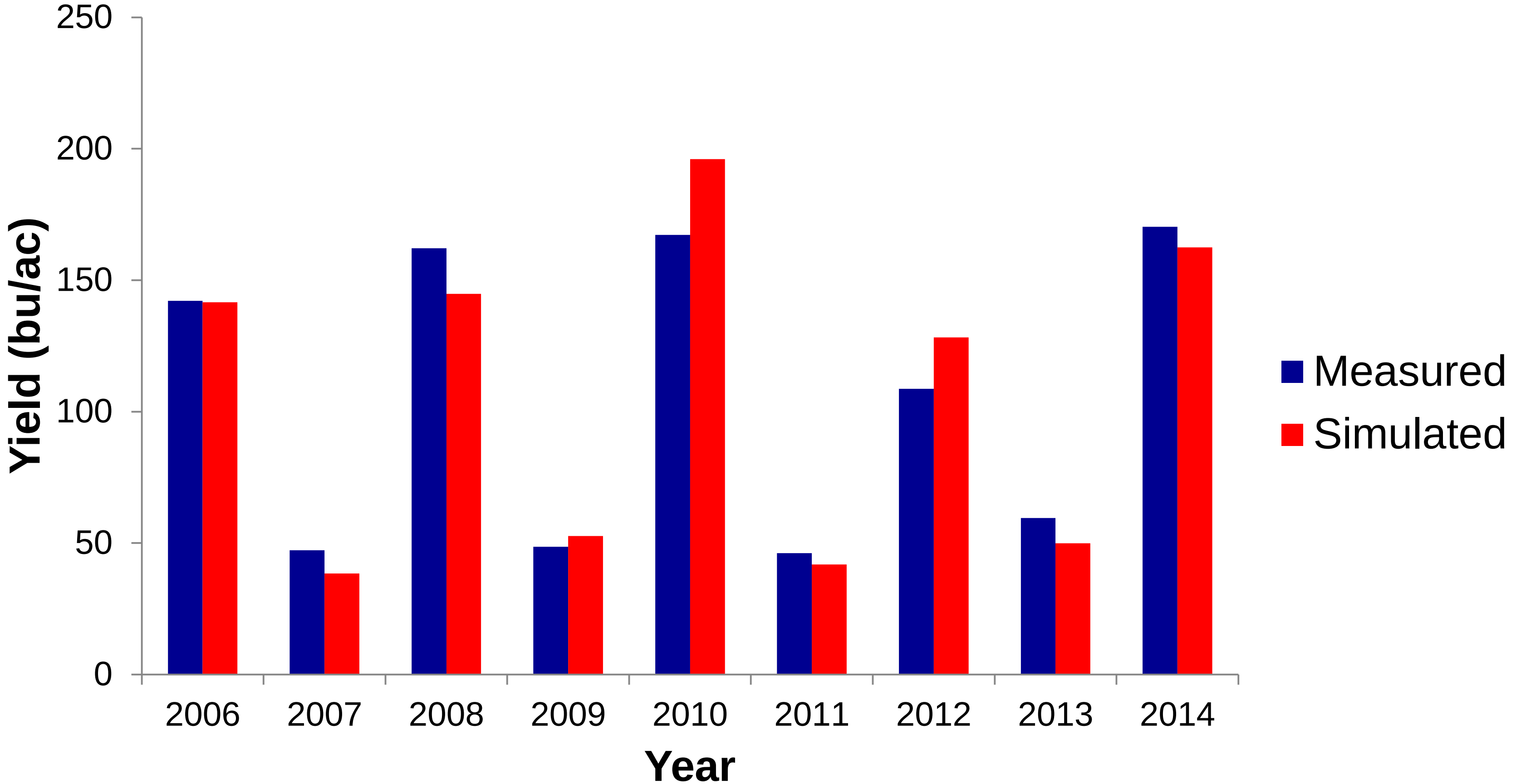
SALUS
(System Approach for Land Use Sustainability)

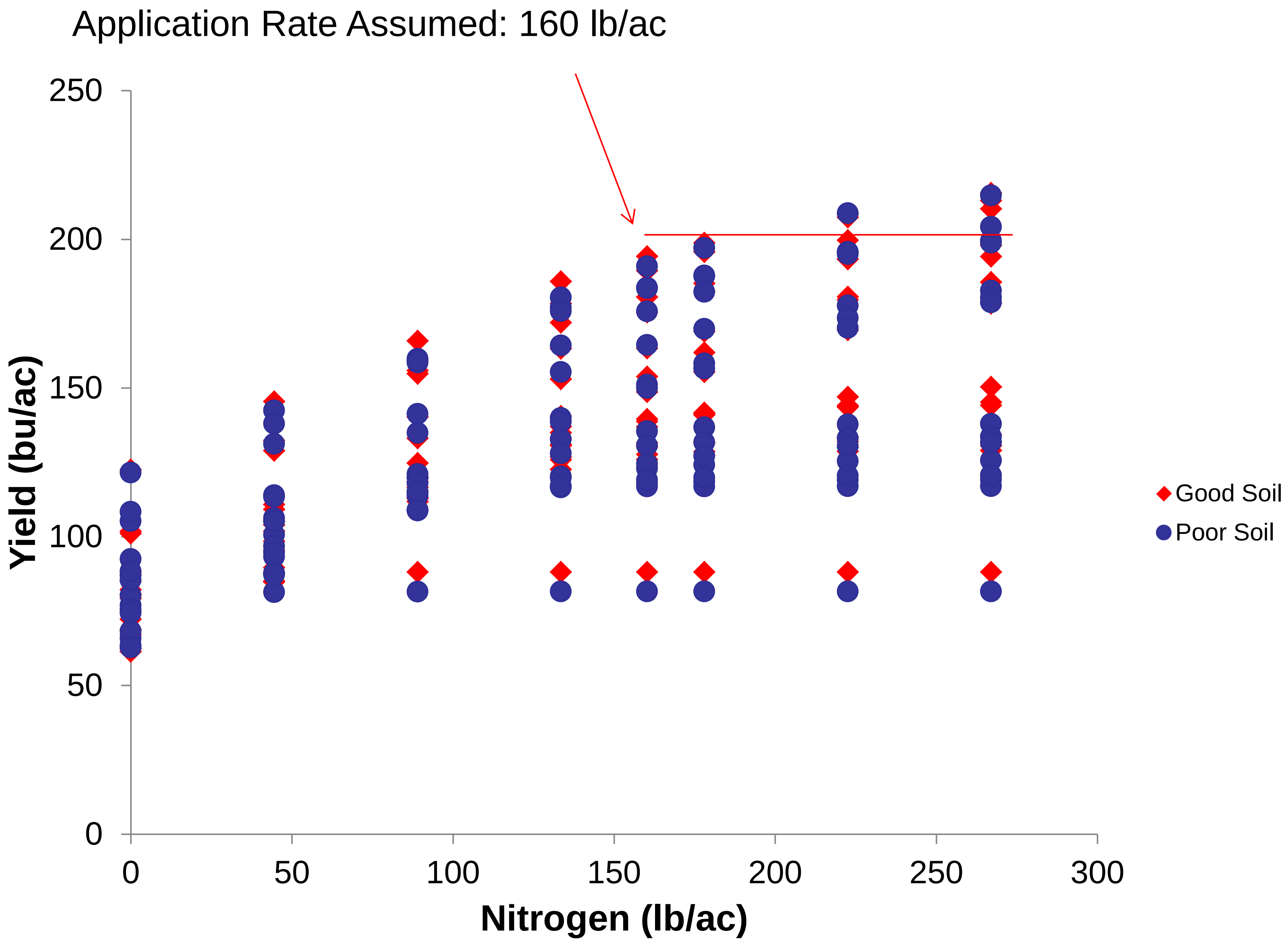


Model validation



SALUS Simulations vs. Measured Yields

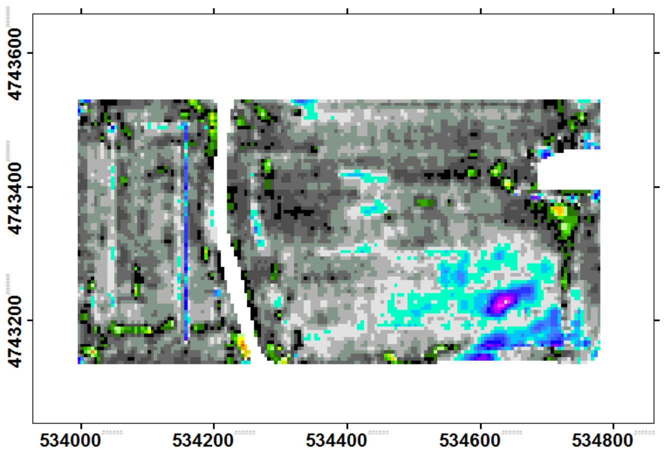




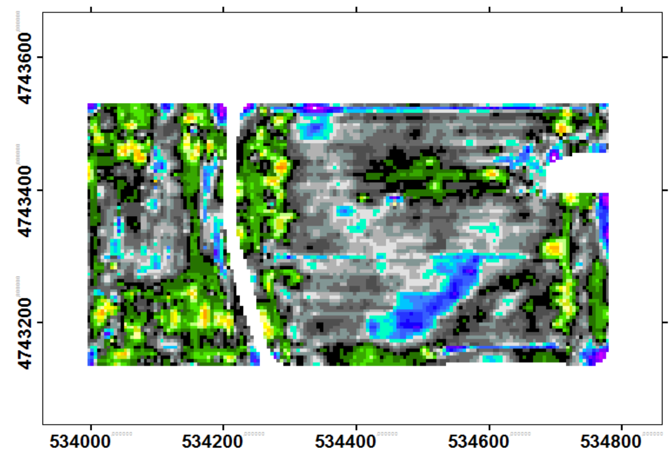
Application Rate Assumed: 160 lb/ac
Yield (bu/ac)
Nitrogen (lb/ac)
Good Soil
Poor Soil
0
50
100
150
200
250
300

Yield Maps

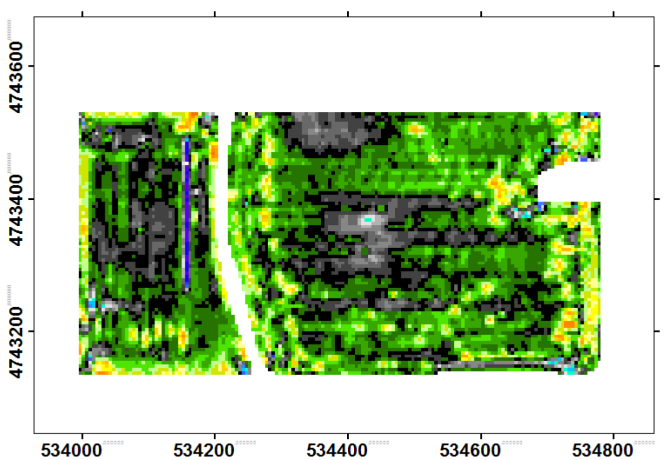
Yield 2009



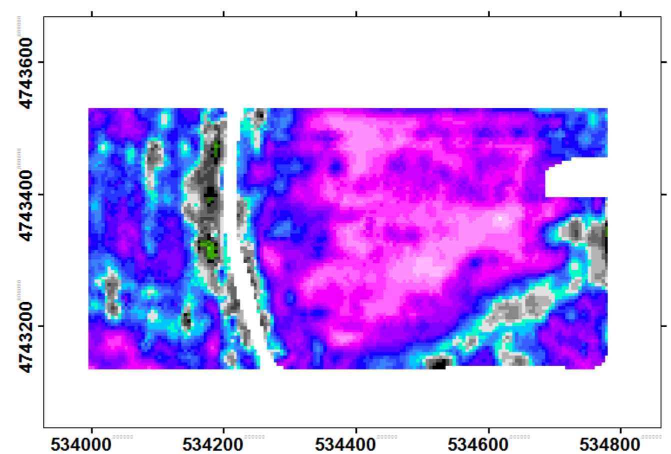
Yield 2010



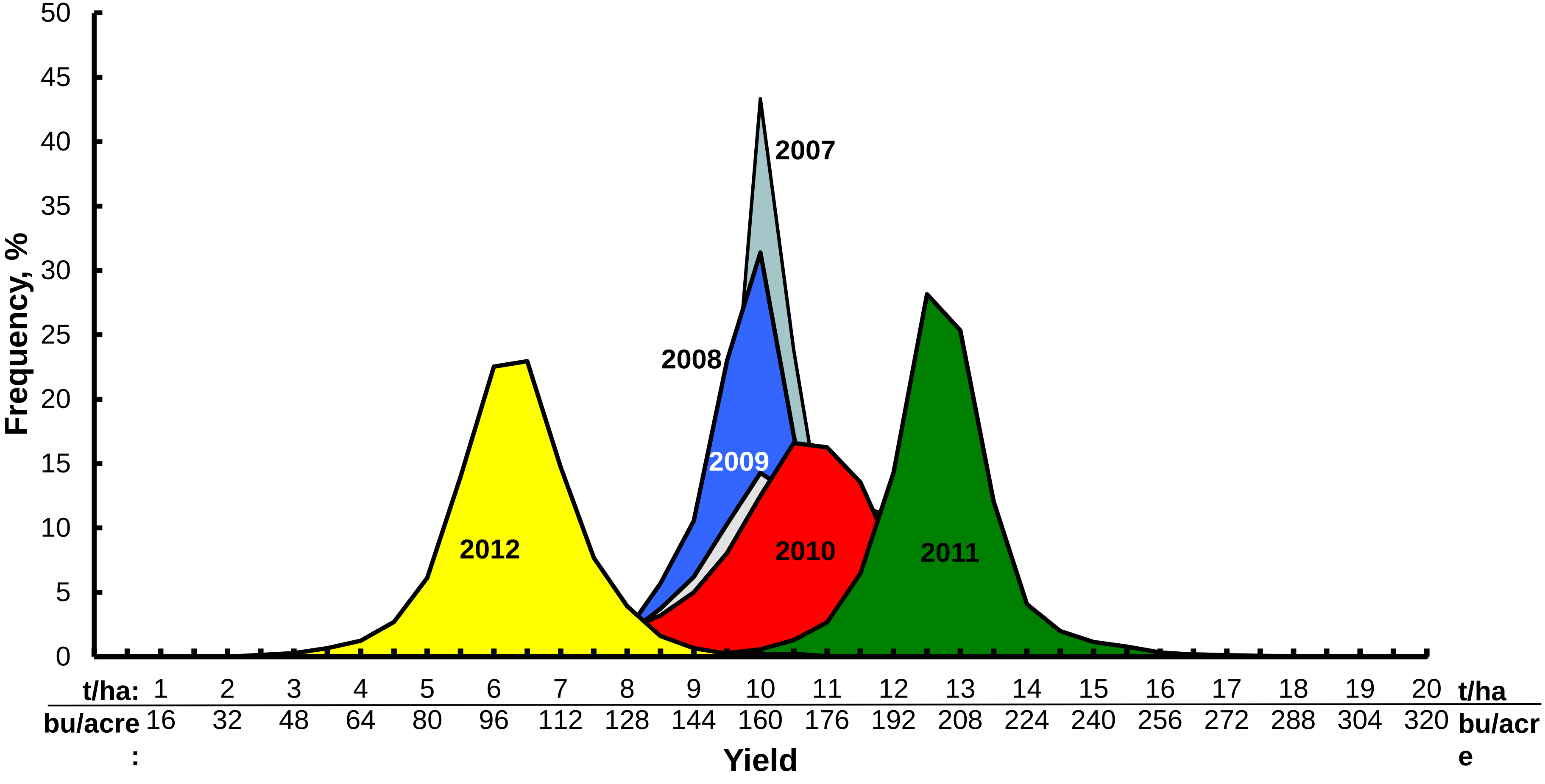
Yield 2011



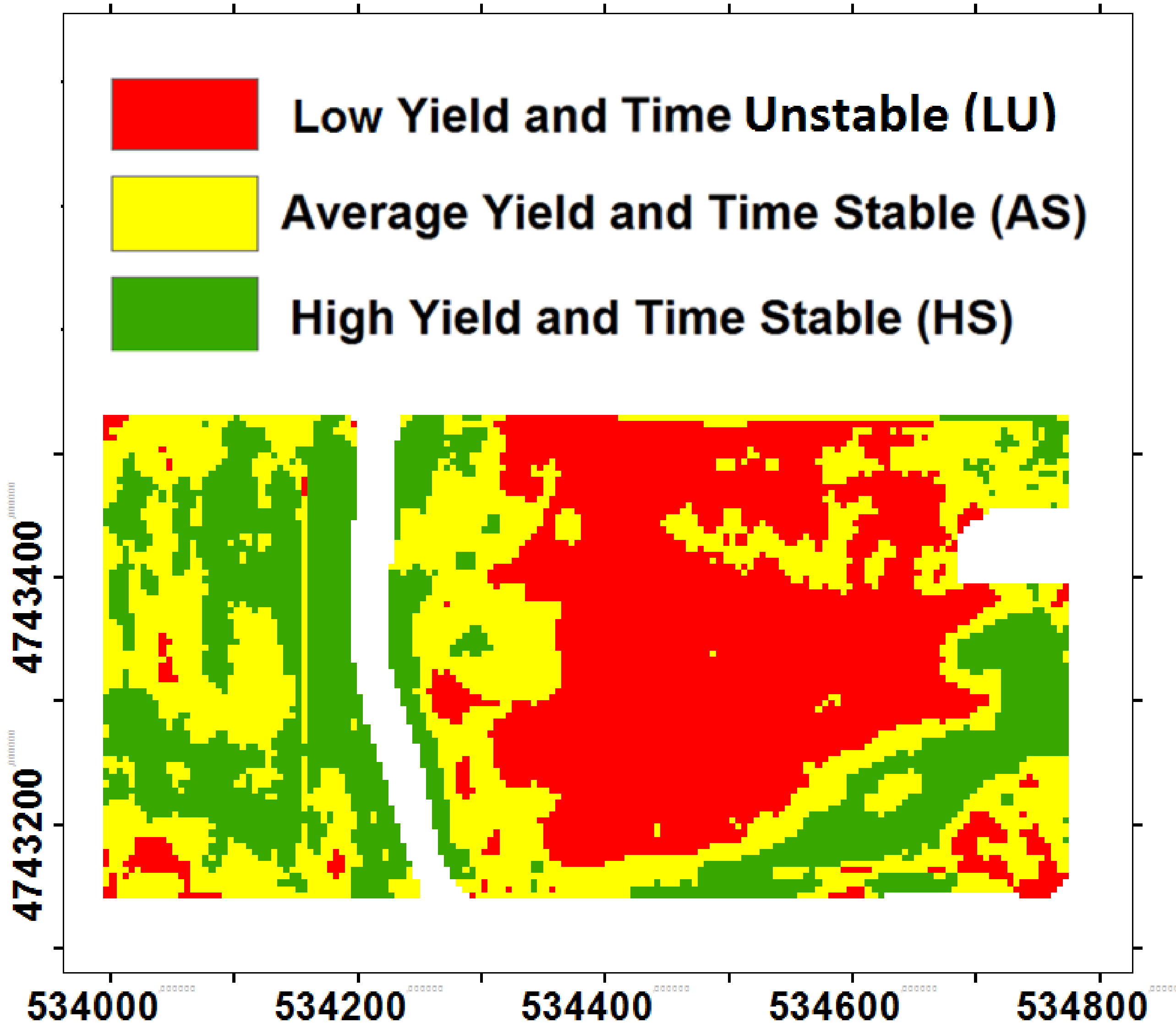
Yield 2012



6 Years of Yields in a Single Field

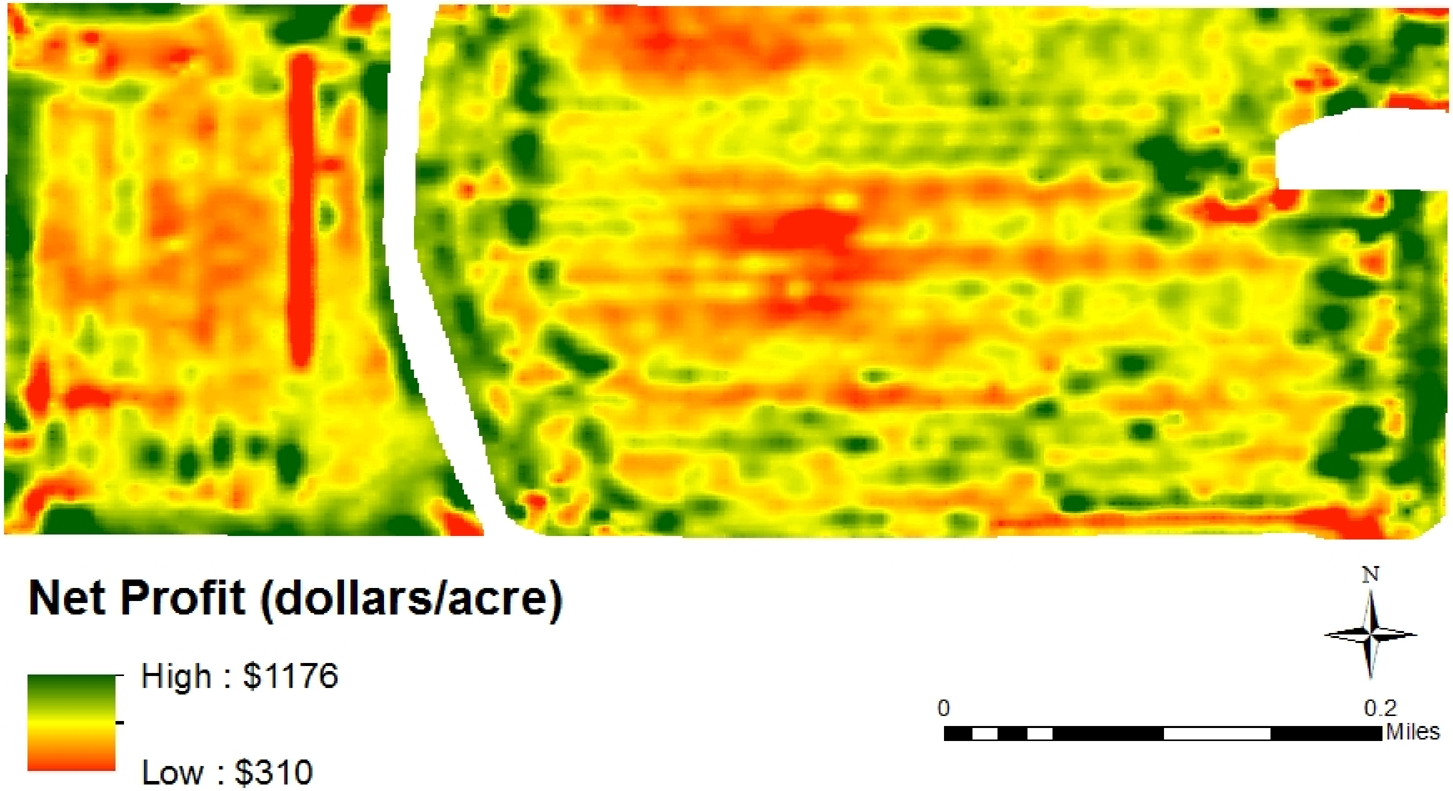


Stability Map



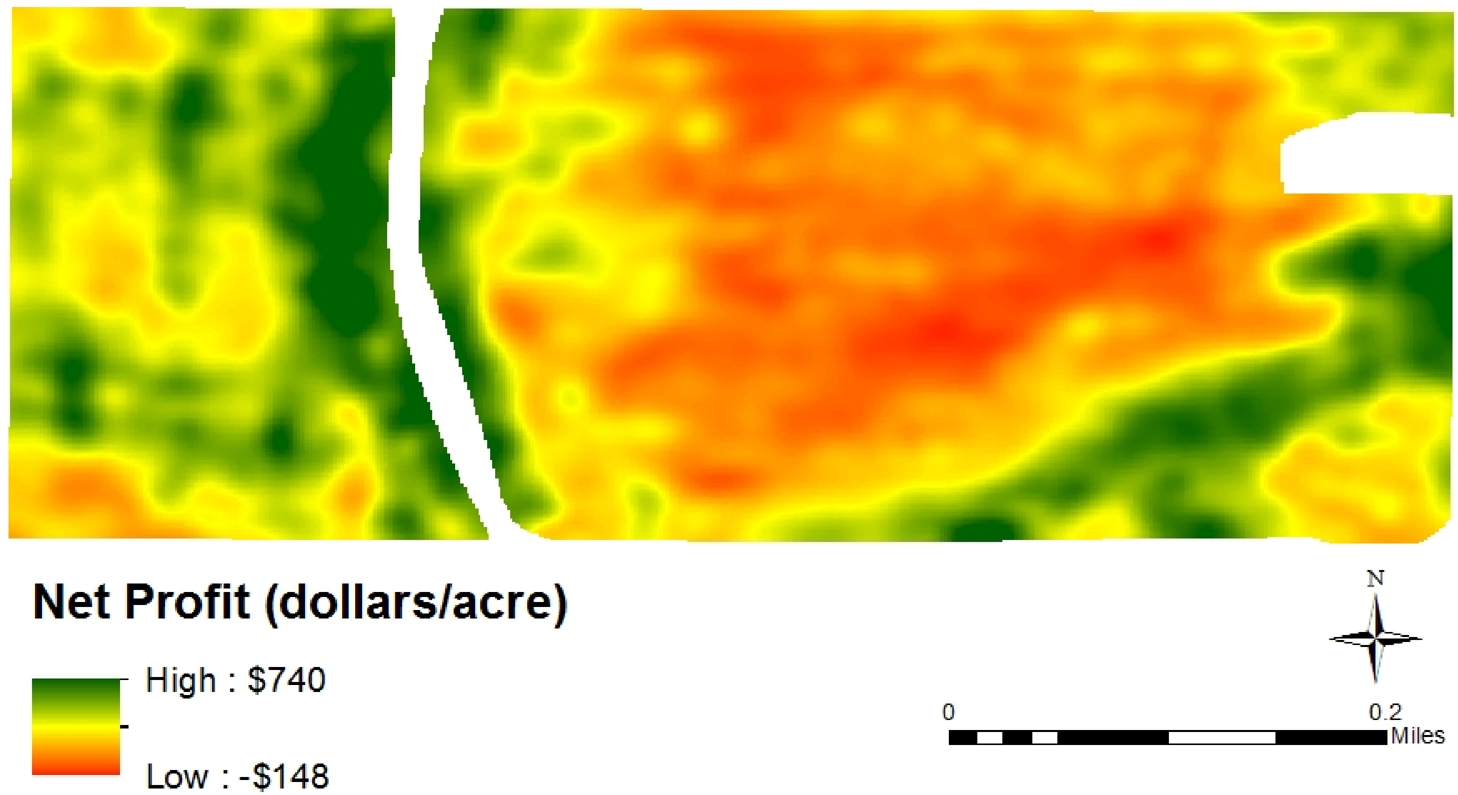
Measured profit 2011

Green: Profit Red: Lower Profit Avg: $740/acre



Measured profit 2012

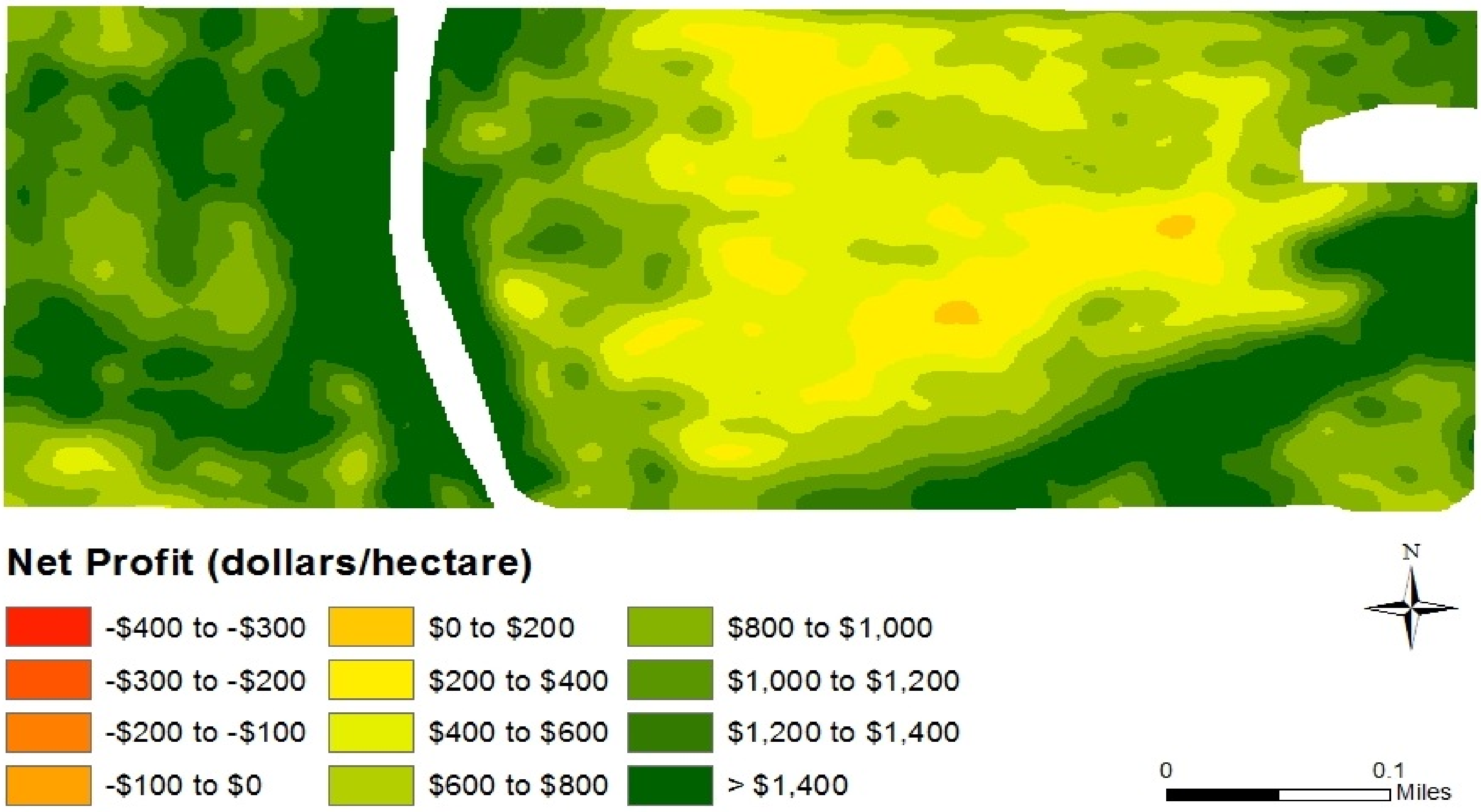
Green: Profit Red: Loss Avg: $194/acre



SALUS Best Nitrogen Management 2012

Green: Profit Red: Loss Avg: $428/acres

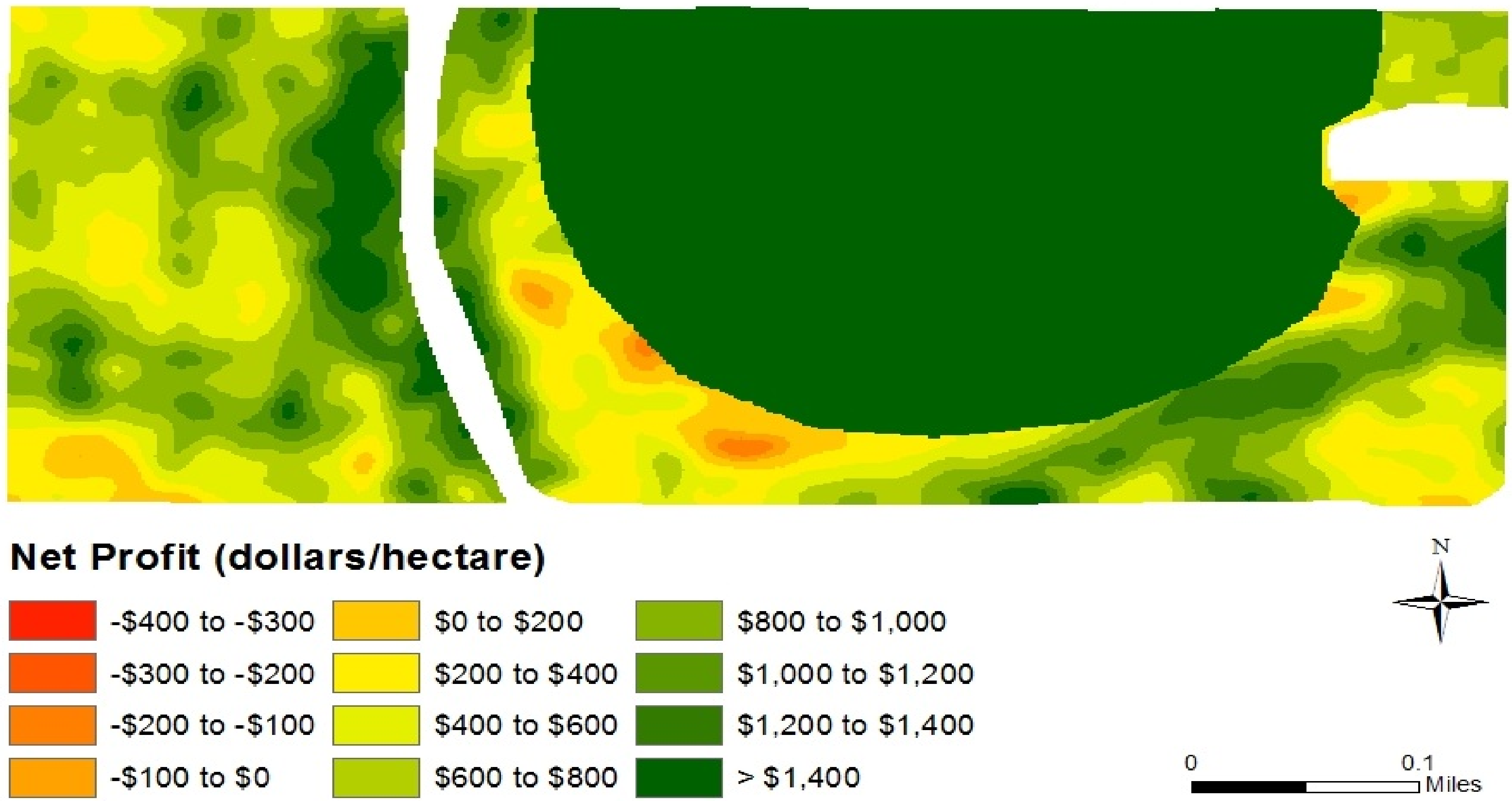
2012, Only 30 # N/ac



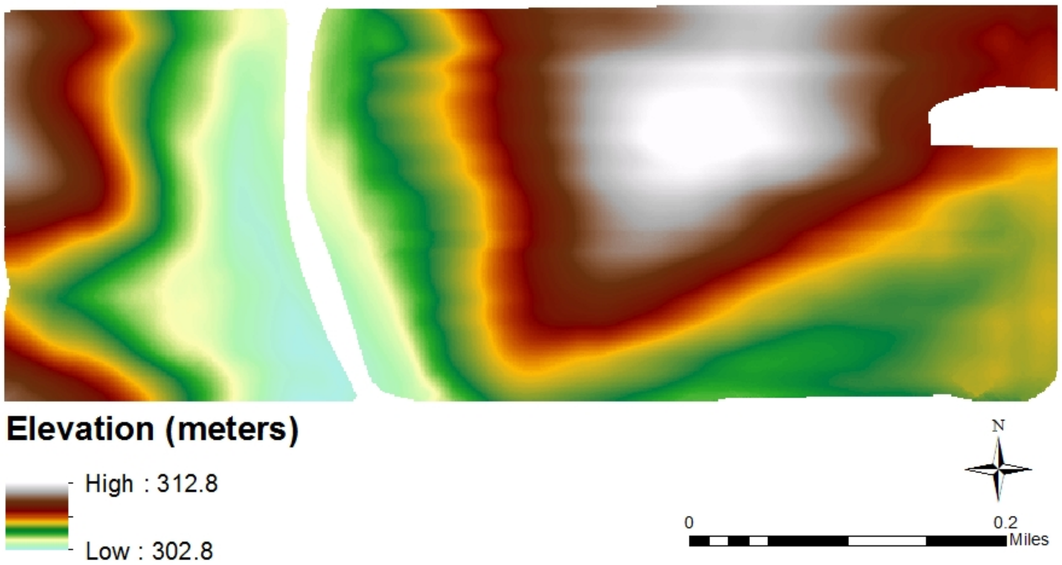
SALUS Irrigation 2012

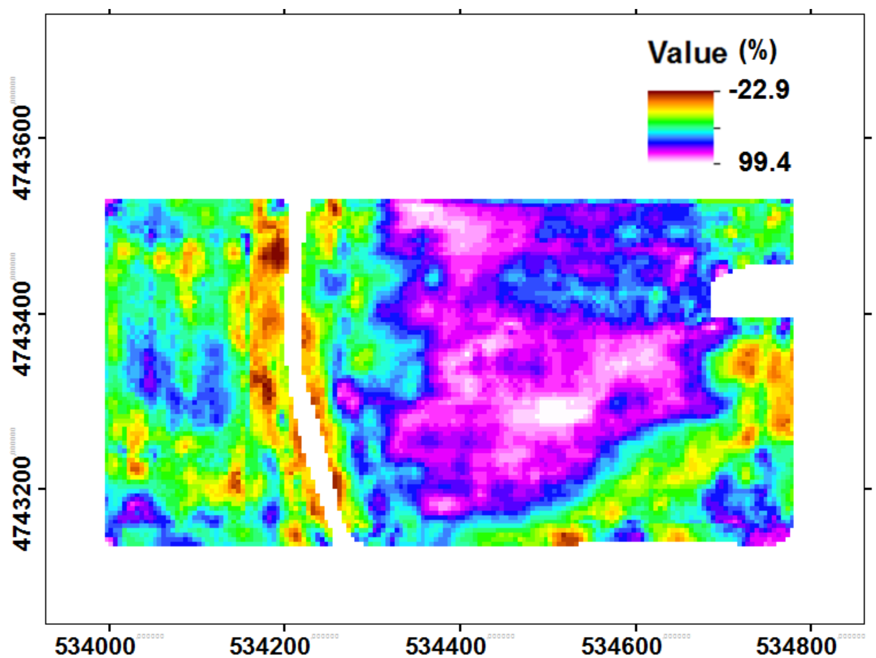
Green: Profit Red: Loss Avg: $980/acres

2012, Irrigated 200 # N/ac

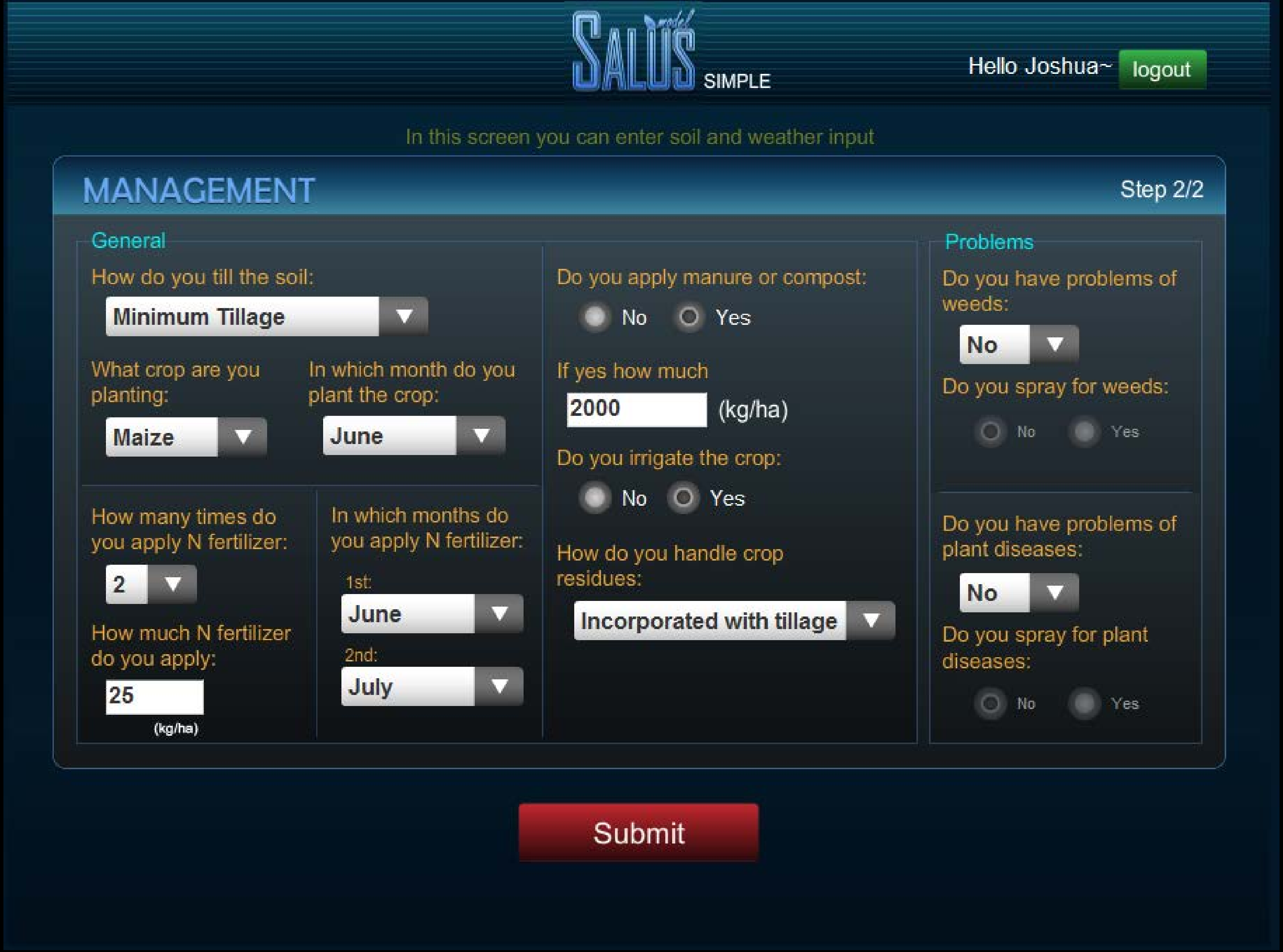


Field Topography






Site
Salus Simple Interface
140.134.48.19/salus/SalusSI_EN/index.html
SALUS model SIMPLE
The System Approach to Environmental Sustainability
Welcome to the SALUS model-simple interface. SALUS is a computer simulation crop model designed to improve crop production and reduce environmental impact. In this web page users by answering a set of simple questions (i.e. soil type, planting details, fertilizer, irrigation, etc.) can simulate the effect of a management strategy on crop yield, nitrate leaching and carbon sequestration.
SALUS
Name
bruno
Password
*****
login
Dr. Bruno Basso(bruno.basso@unibas.it)
Register



- Specify management strategies

SALUS model SIMPLE

Hello Joshua~ logout

Field Name **Maize01** 10/10 View Input

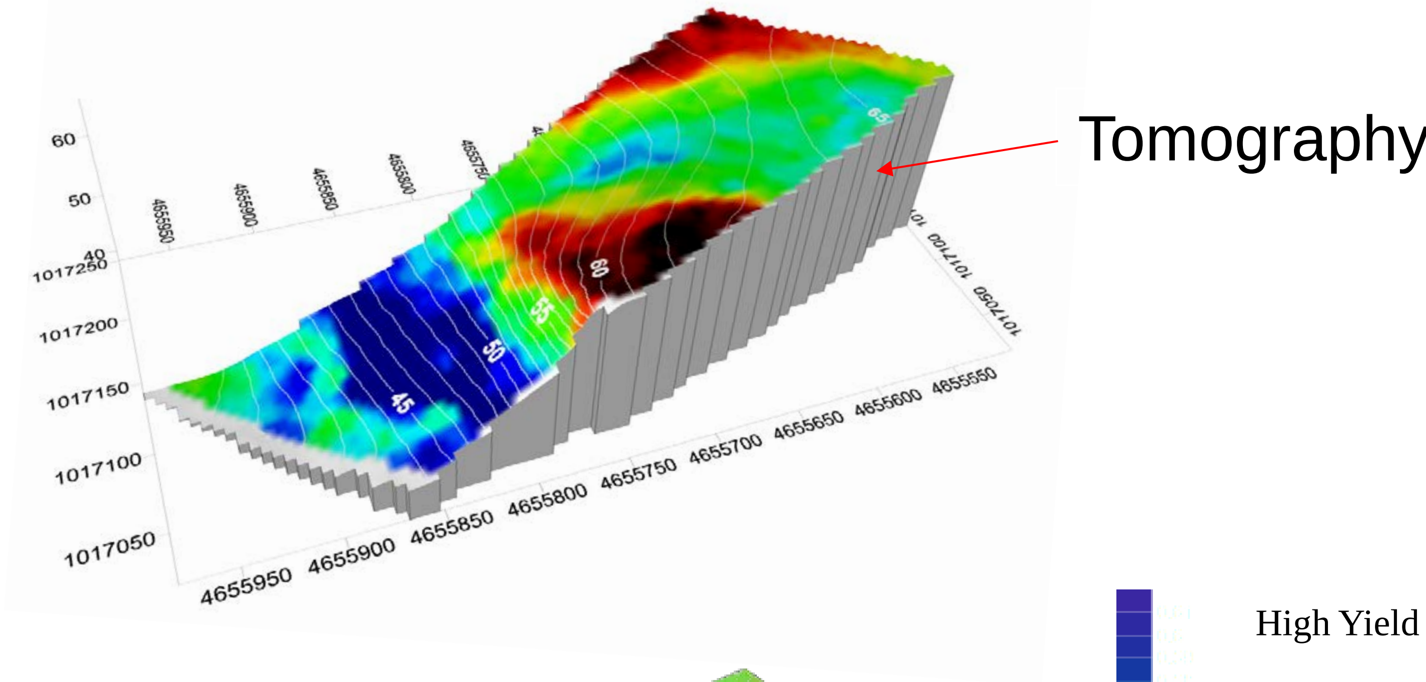
Results of 6 years	Best Year	Average Year	Worse Year	Total for 6 years
Yield (kg/ha)	18522	14947	11658	--
Nitrate leaching (annual) (kg/ha)	0	0.43	2.56	2.56
Nitrogen in the soil at Harvest (kg/ha)	43.08	78.69	116.46	--
Nitrogen Use Efficiency (Yield/ N)	1234	996	777	--
N2O emissions (kg/ha)	1.75	1.76	1.77	10.55
CO2 emissions annual (kg/ha)	2932.52	7331.18	9653.07	43987.07
Soil carbon change (%)	--	--	--	-0.06
Water Use Efficiency (kg/mm)	40	31.51	25.37	--
Water Stress Index	17	11.83	5	--
Drainage (mm)	221.46	82.21	0	--
Soil Evaporation (mm)	296.65	454.37	535	2726.2
Plant Transpiration (mm)	262.5	218.45	180.82	1310.72
Soil water content at Harvest (mm)	221.46	82.21	0	--

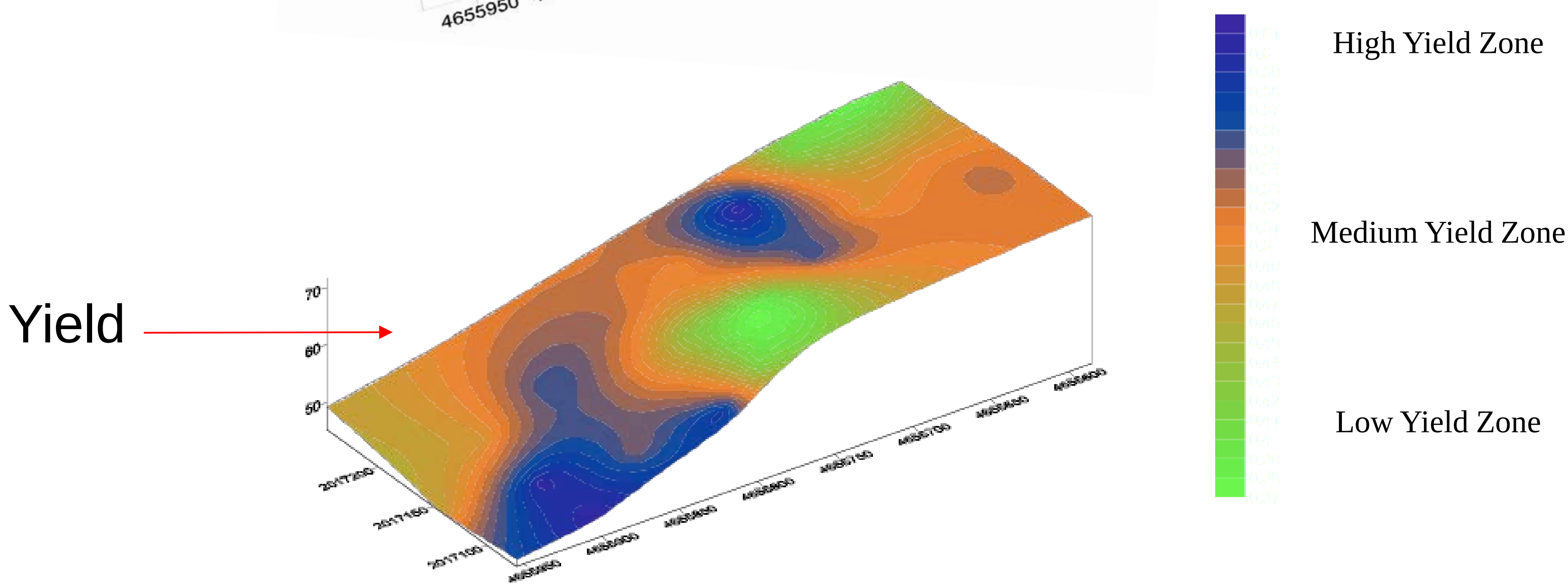
Agronomic Management Sustainability Index: WORST BEST 0 1 **0.86** AMSI Detail

Try Again Compare Outputs

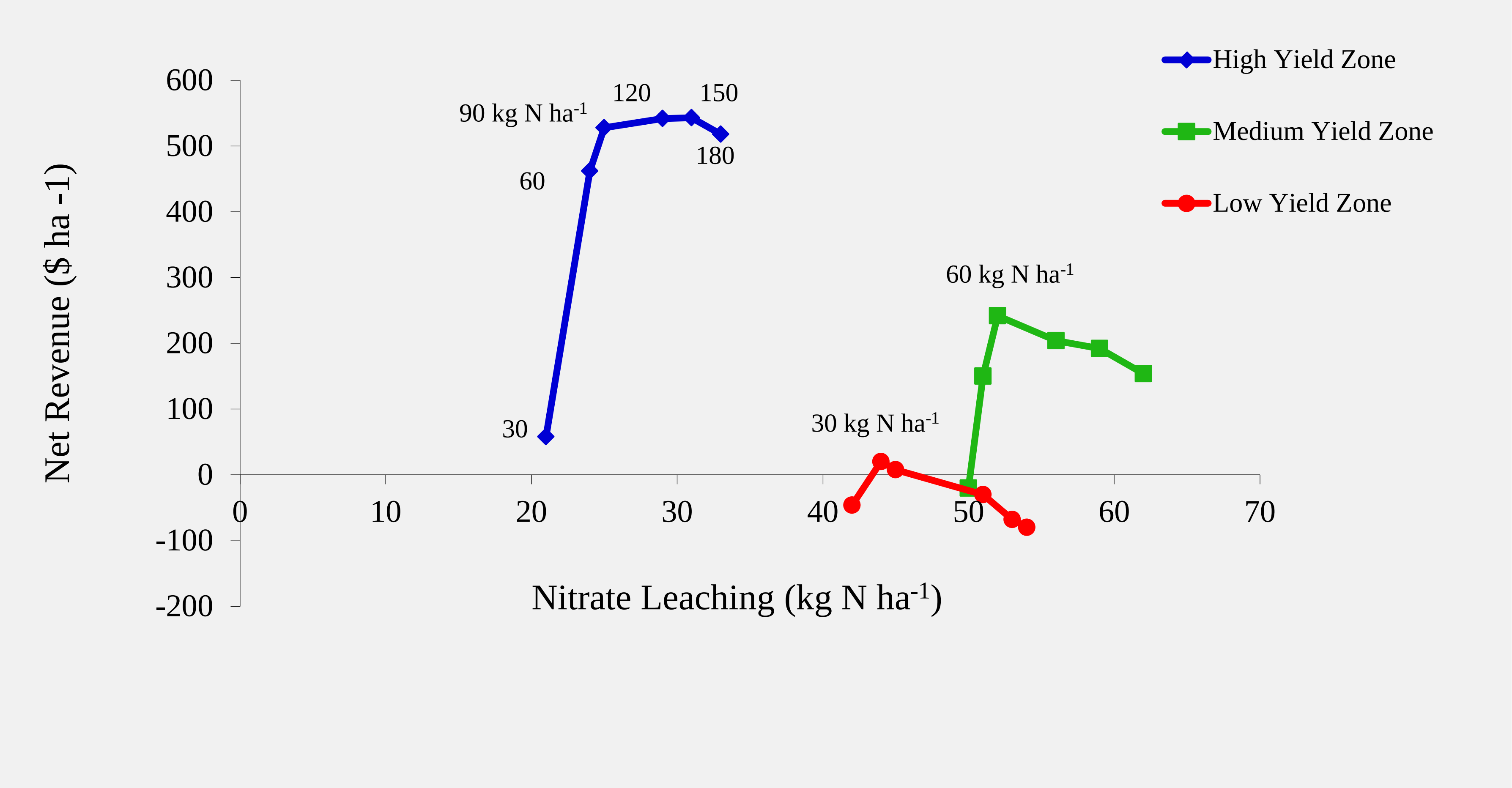
- Simulation results and AMSI index

Homogeneous zones





Strategic and tactical N management using spatially explicit crop modeling

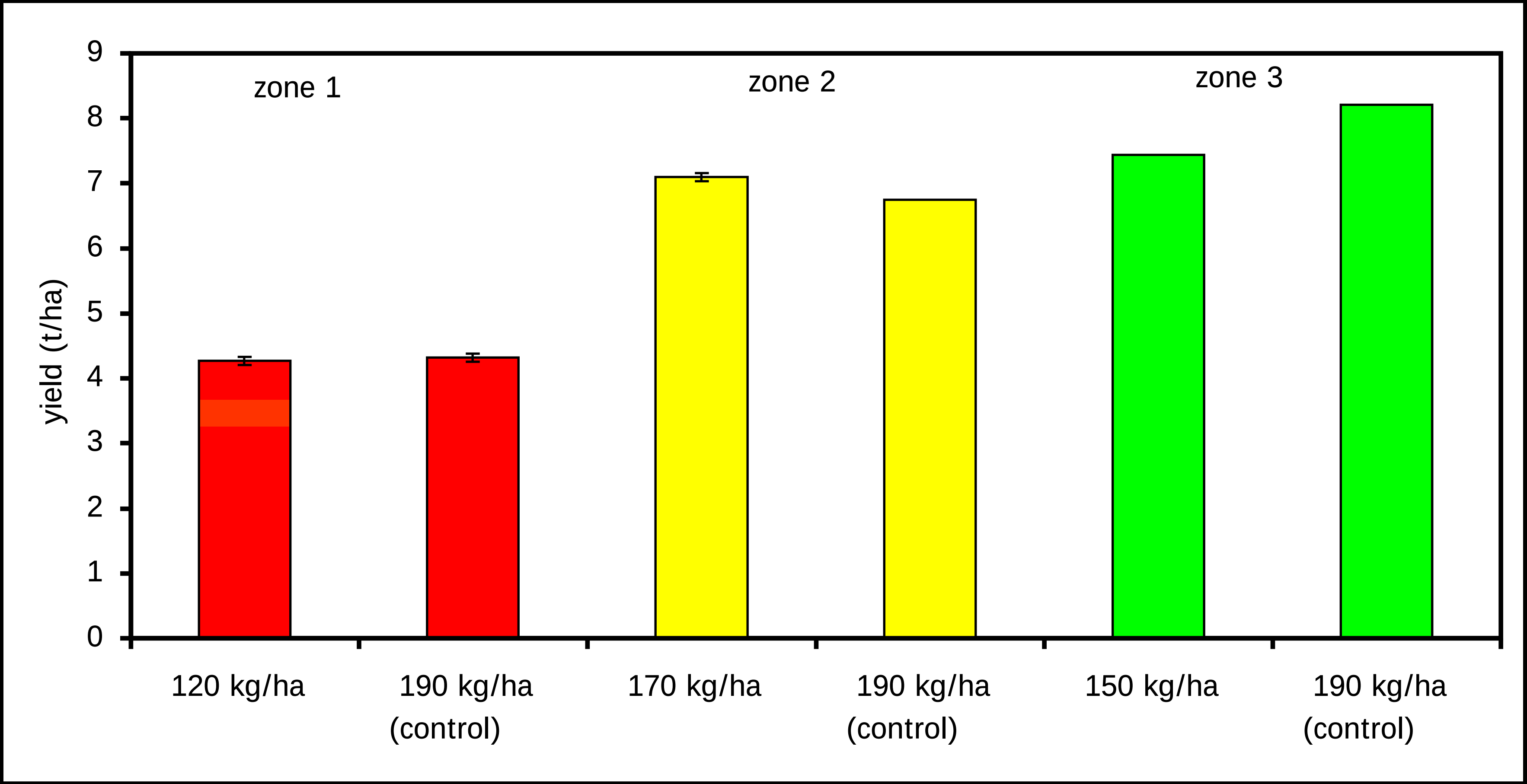


Dual criteria optimization through tested model determines the N rate that minimizes nitrate leaching and increases net revenues for farmers

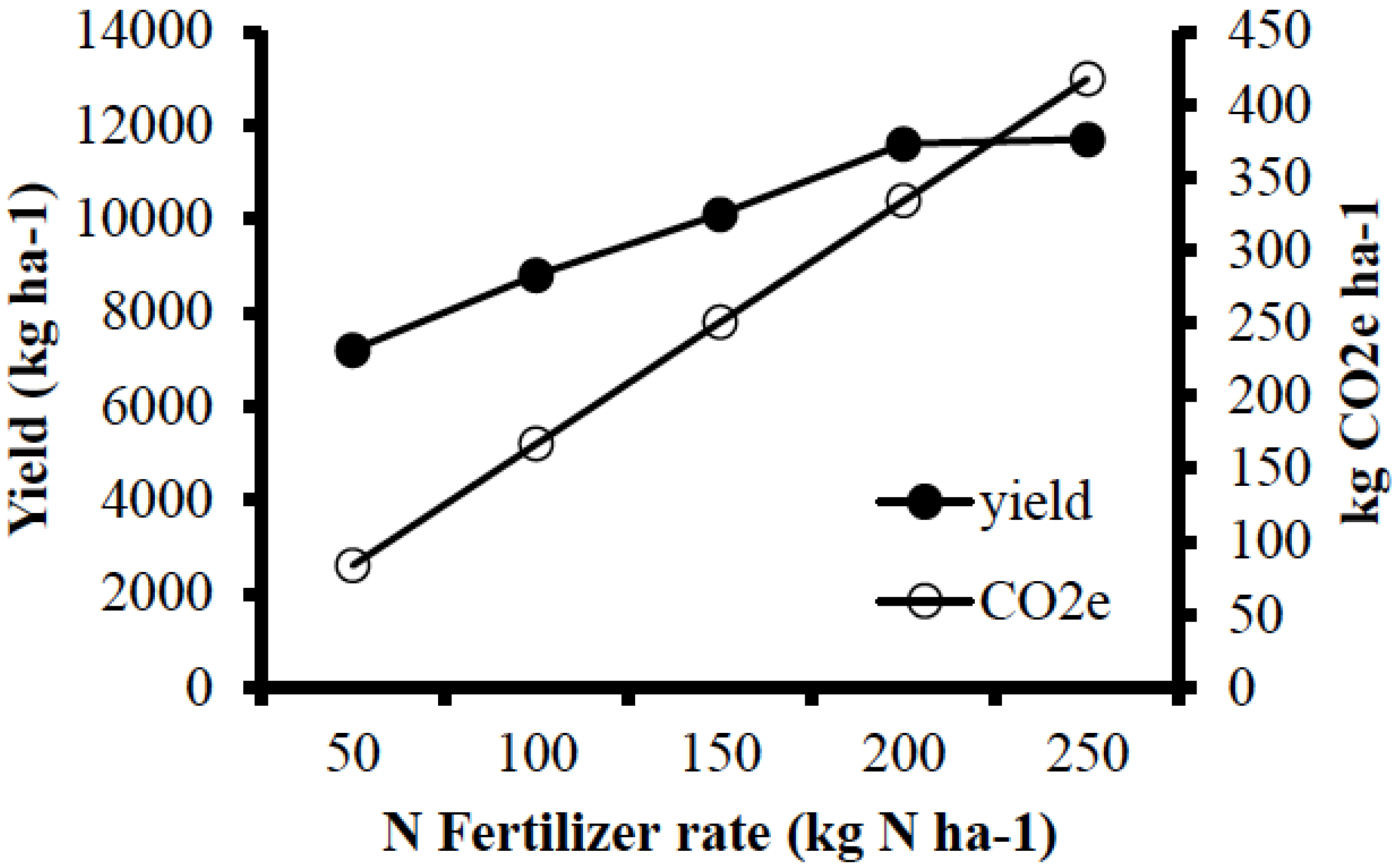
(Basso et al., 2011; Eur J. Agron 35:215–2

Observed Variable Rate Nitrogen

Variable rate nitrogen rates were selected using SALUS model after evaluating the N response for each of the N rate in each zone for 30 years of available weather



Reducing Greenhouse Gas Emissions



Basso et al., 2012

Precision agricultural management as adaptation and mitigation strategies

Precision Agriculture Strategies reduce risks and allows the stabilization of ecosystems services for the following reasons:

- Gains in energy efficiency for farm operations that consume fuel, including mechanical operation such tillage, irrigation, fertilization etc..

- Gains in production or yield efficiency for grain, and other agricultural products

- Abetment of the GHC emission (N_2O) by better fertilizer use

Conclusions

The proper simulation of the water entering the soil and the amount available to crops allow to estimate the right amount of N fertilizer and irrigation (if available) to apply in the most efficient and sustainable way.

It will help farmers manage their variability and quantify the effects of management practices, genetics, soil and weather on yield, and support decisions related to crop management strategies for optimizing profitability and increase resource use