NP-212: Climate Change, Soils and Emissions
NP-216: Agricultural Competitiveness and Sustainability

Dave Huggins, USDA-ARS Soil Scientist

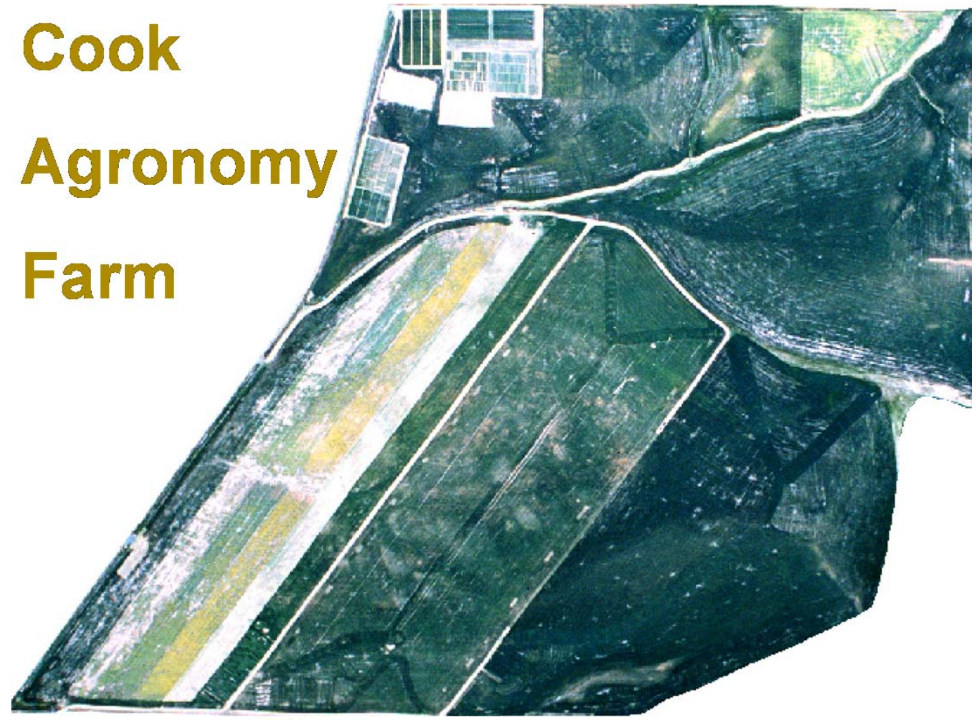
Mitigating Ag. Sources of Particulate Matter and GHG Emissions in the PNW

Objectives (Smith, Huggins)

- Assess management impacts on soil C sequestration (REAP)
- Understand dynamics of soil N including N_2O losses (GRACEnet)
- Develop precision agricultural practices that increase N use efficiency and decrease N_2O emissions

Cropping Systems Research

Cook
Agronomy
Farm

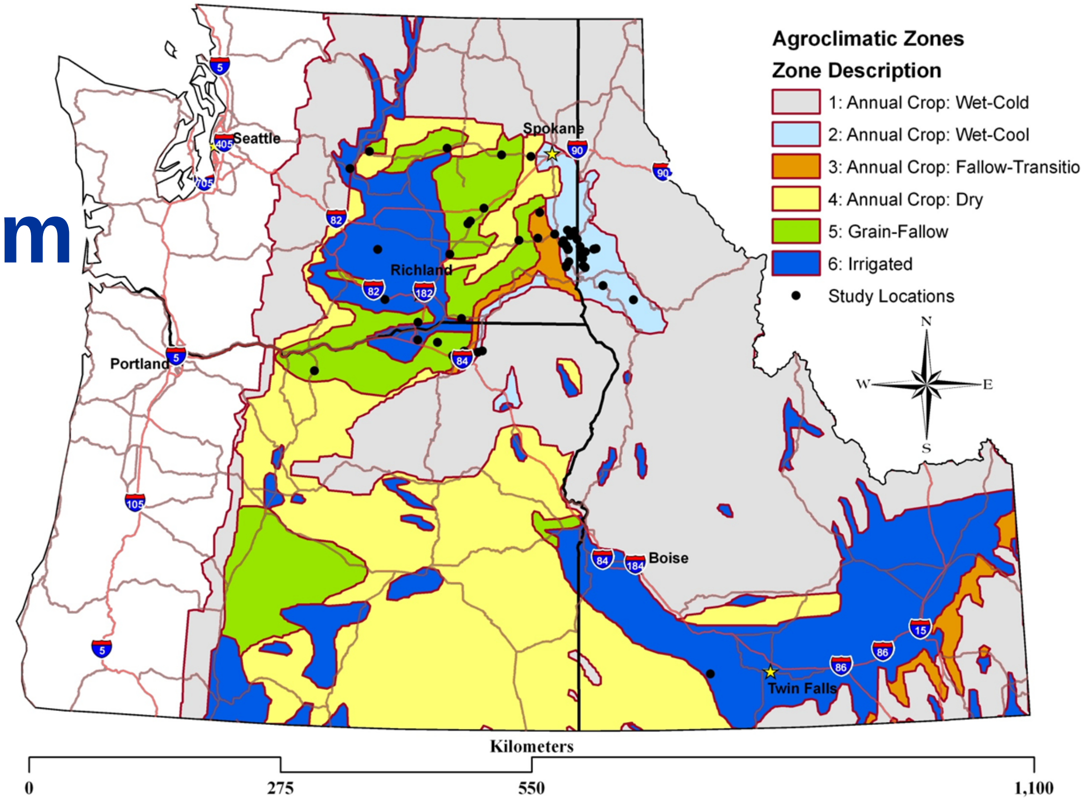


Palouse
Conservation
Field
Station

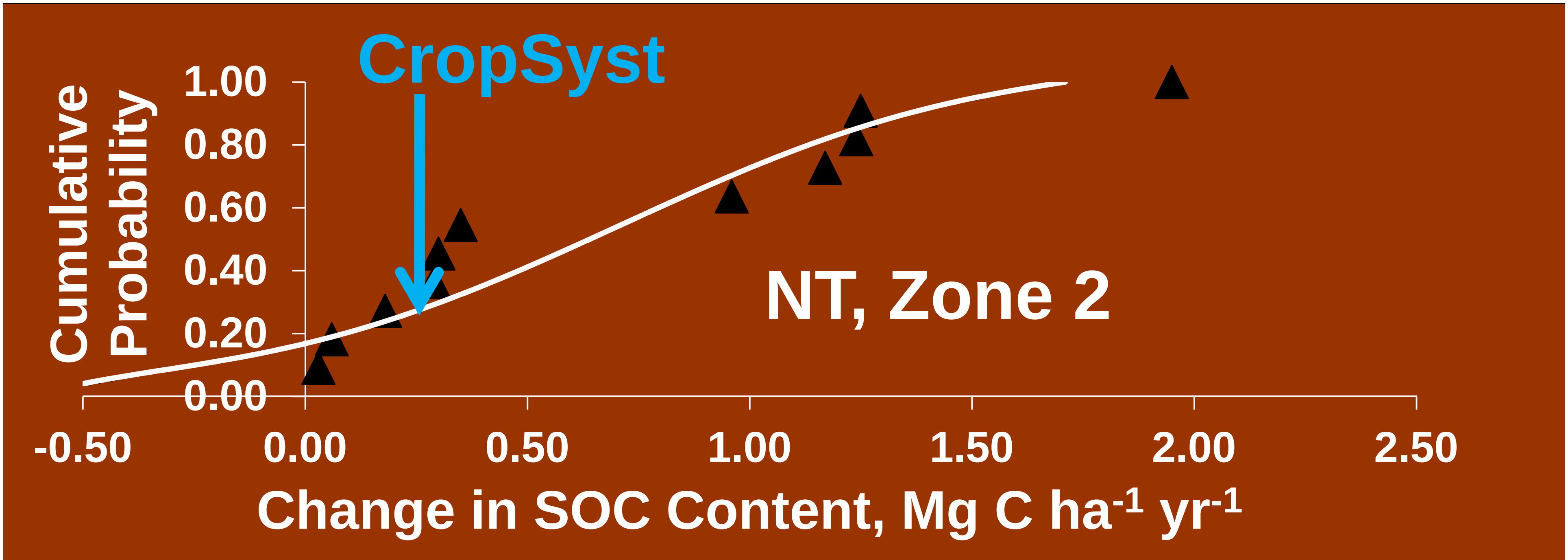
Soil C Sequestration

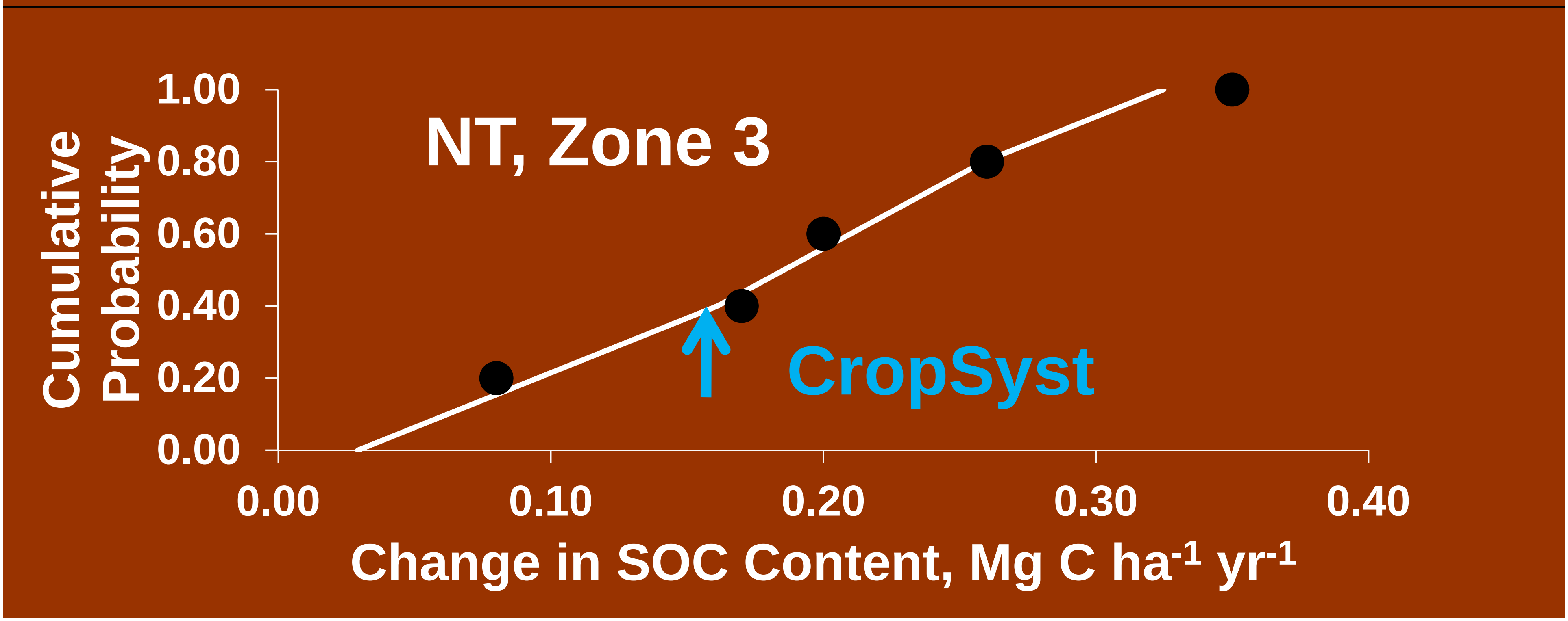
- **129 data sets**
- **Data primarily from ACZ's 2 and 3**
- **Scenarios:**
  - **Conversion to cropland**
  - **CT to NT**

(Brown and Huggins, in review)



Location of past and current soil C studies, dryland agriculture, PNW


CropSyst
1.00
0.80
0.60
0.40
0.20
0.00
Cumulative Probability
NT, Zone 2
-0.50
0.00
0.50
1.00
1.50
2.00
2.50
Change in SOC Content, Mg C ha-1 yr-1


1.00
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0.20
0.00
Cumulative Probability
NT, Zone 3
CropSyst
0.00
0.10
0.20
0.30
0.40
Change in SOC Content, Mg C ha-1 yr-1

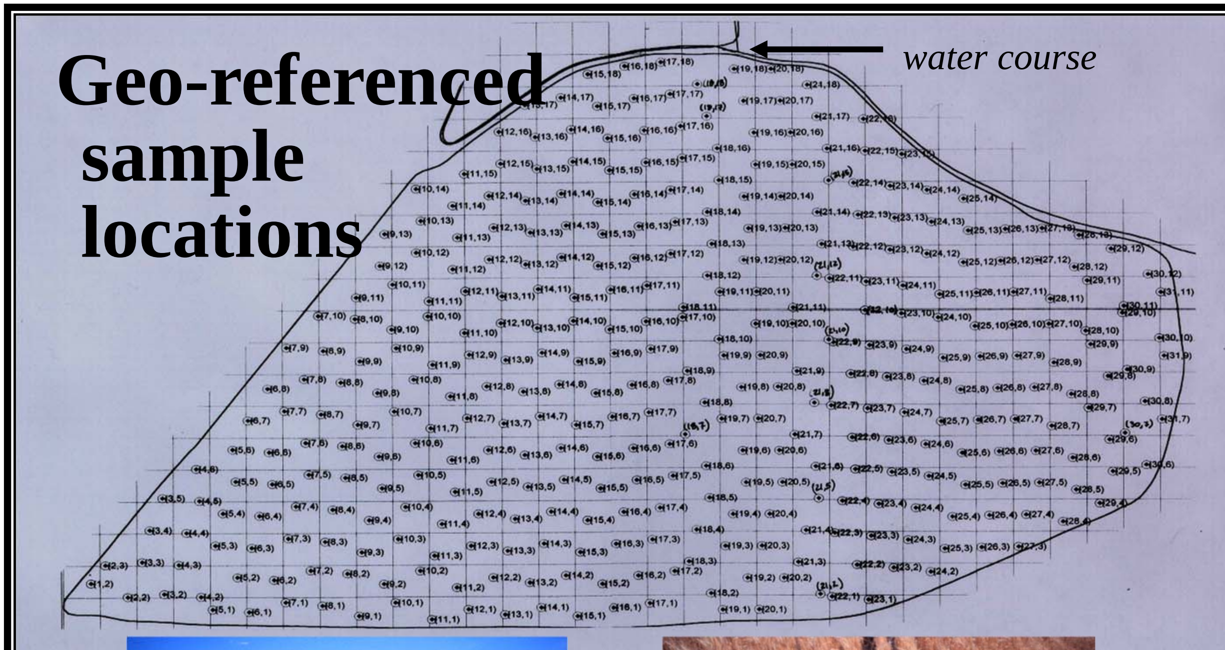
Cook Agronomy Farm Direct Seed and Precision Farming Systems

Develop principles and strategies that reduce risk, increase profits and improve environmental quality

Pattern Analysis

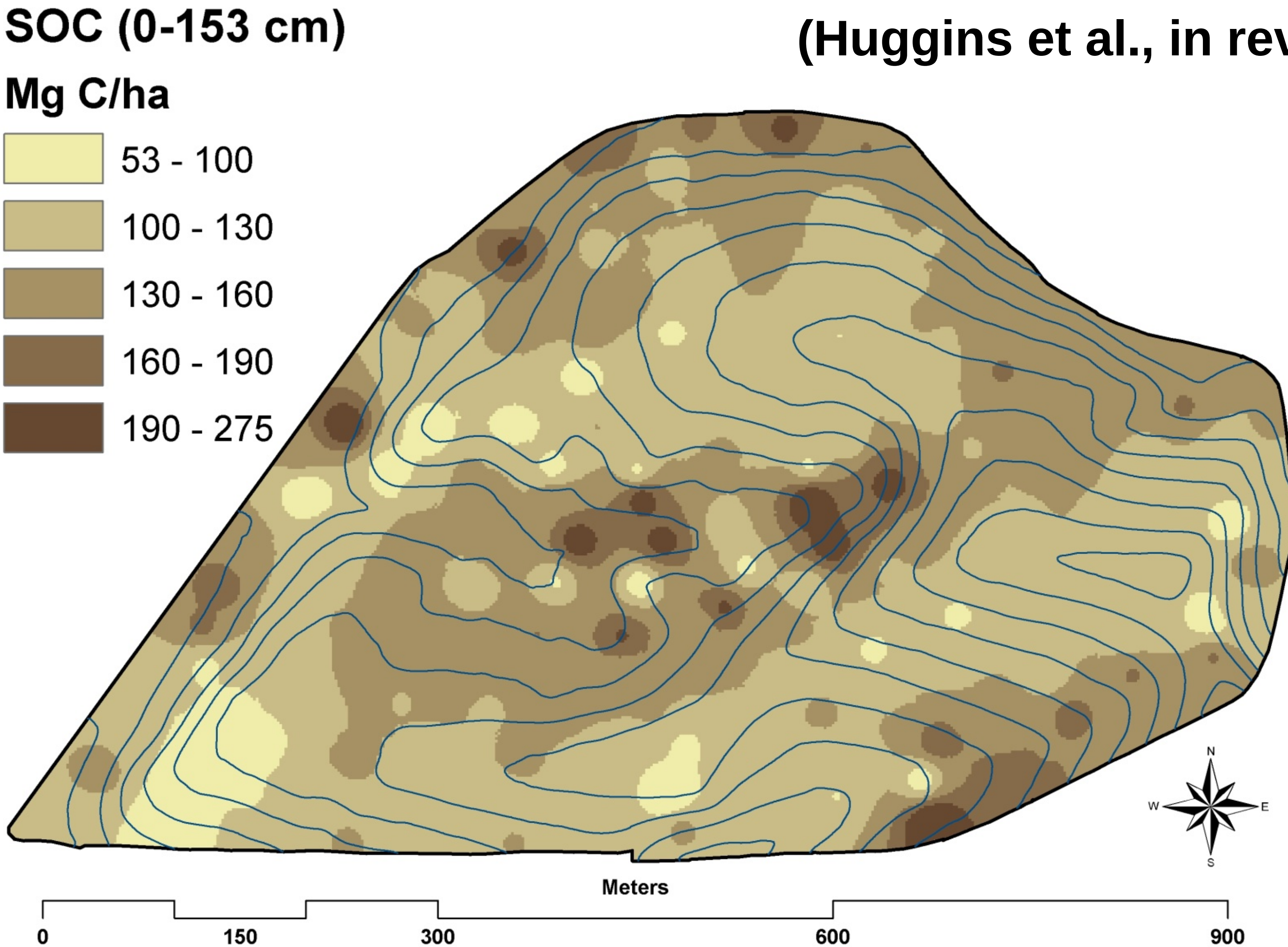
Non-aligned grid sampling scheme

Geo-referenced sample locations



Soil Organic Carbon (CAF)

(Huggins et al., in review)



Soil C Sequestration

- SOC databases lacking for low precipitation areas (wheat-fallow)
- Baseline sampling of SOC prior to management change is largely nonexistent
- Large variability among studies:
  - Soil erosion processes
  - Inconsistent sampling and analytical methods
  - Large field-scale soil C variability
- A validated C model for the PNW would aid evaluation of SOC changes

Research at the Cook Agronomy Farm

- Direct-Seed Crop Rotations (Huggins)
- Economic Assessment (Painter)
- Precision N Management (Huggins)
- Residue Mgmt. and Soil C (Huggins)
- Water (Keller, Smith, Brown, Brooks, Huggins)
- Soil-borne Diseases (Paulitz)
- Weed Seed Bank (Burke)
- Crop Modeling (Stockle)
- GHG Monitoring (Lamb, Smith, Huggins)

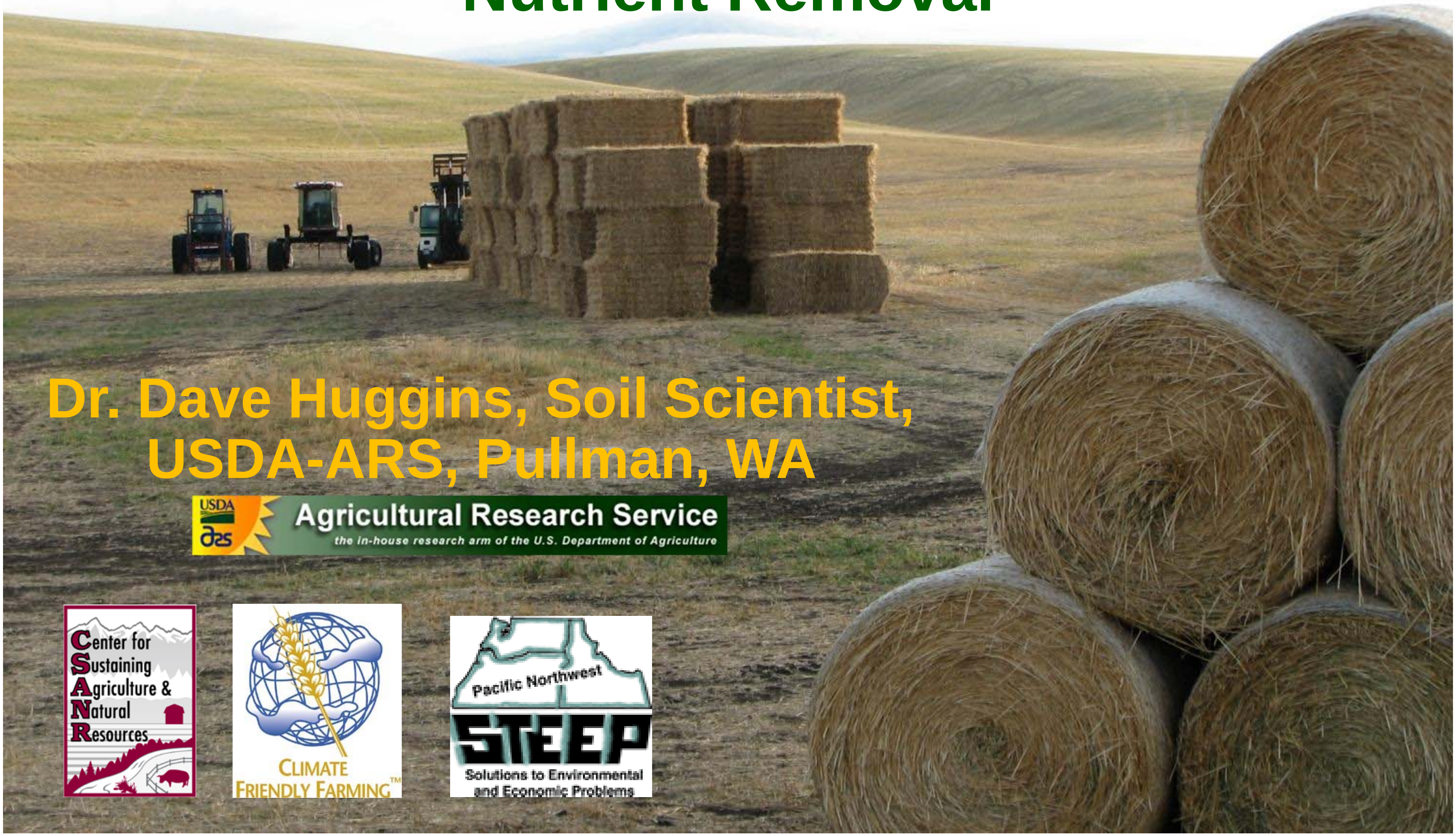
Renewable Energy Assessment Project (REAP)

Overall Goal: Develop sustainable practices for production and harvest of stover and crop residues for bioenergy

- Huggins et al., 2011 (DOE Sun Grant Initiative)
- Johnson et al., 2011 (SWCS)
- Karlen and Huggins (in review)
- Huggins et al., (in review)

Harvesting Wheat Straw

Trade-offs among Bio-energy, Soil Quality and Nutrient Removal



Dr. Dave Huggins, Soil Scientist,
USDA-ARS, Pullman, WA

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Center for Sustaining Agriculture & Natural Resources

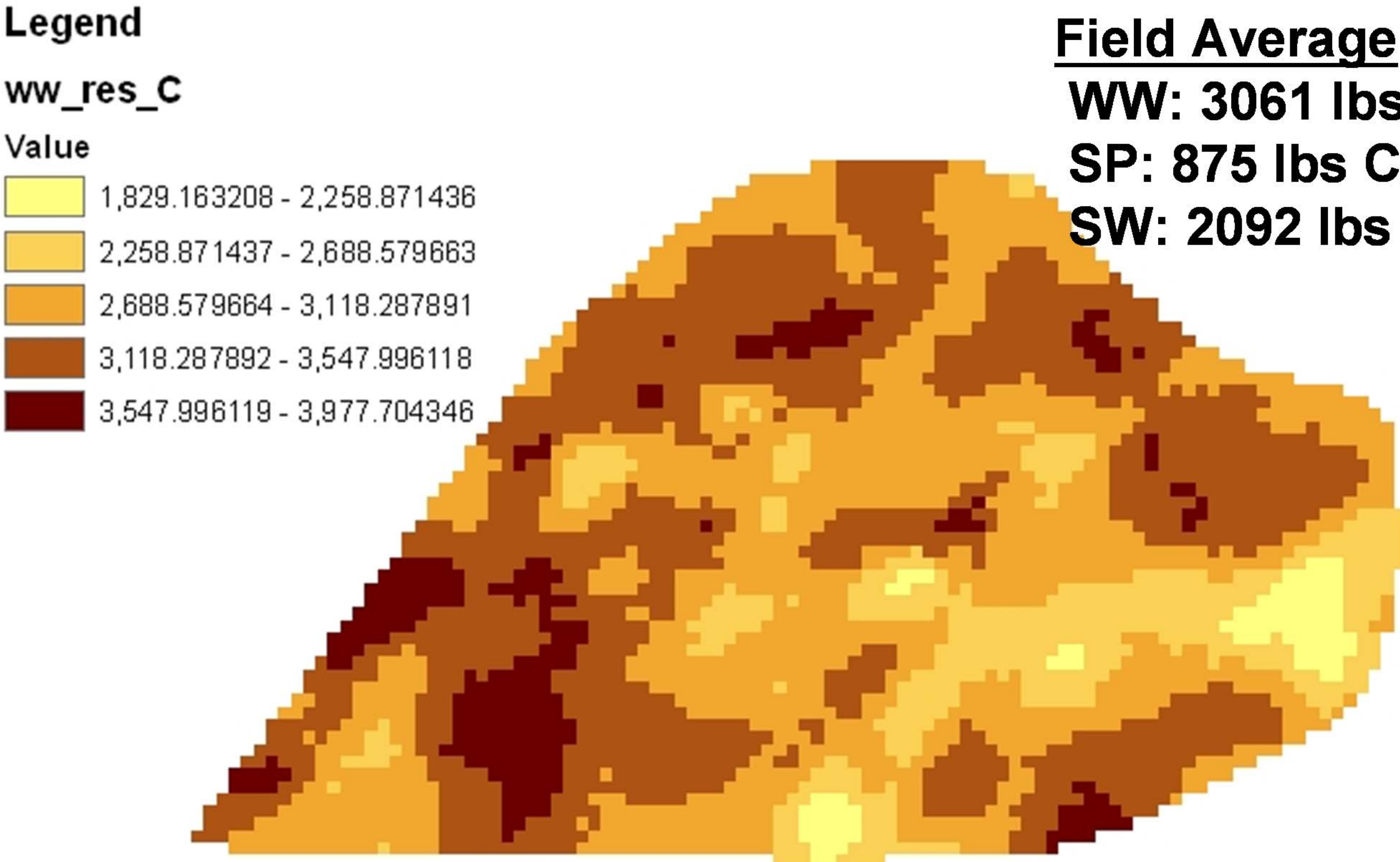
Climate Friendly Farming™

Pacific Northwest STEEP
Solutions to Environmental and Economic Problems

Winter Wheat Residue: Carbon, lbs/ac

Field Average

WW: 3061 lbs C/ac
SP: 875 lbs C/ac
SW: 2092 lbs C/ac



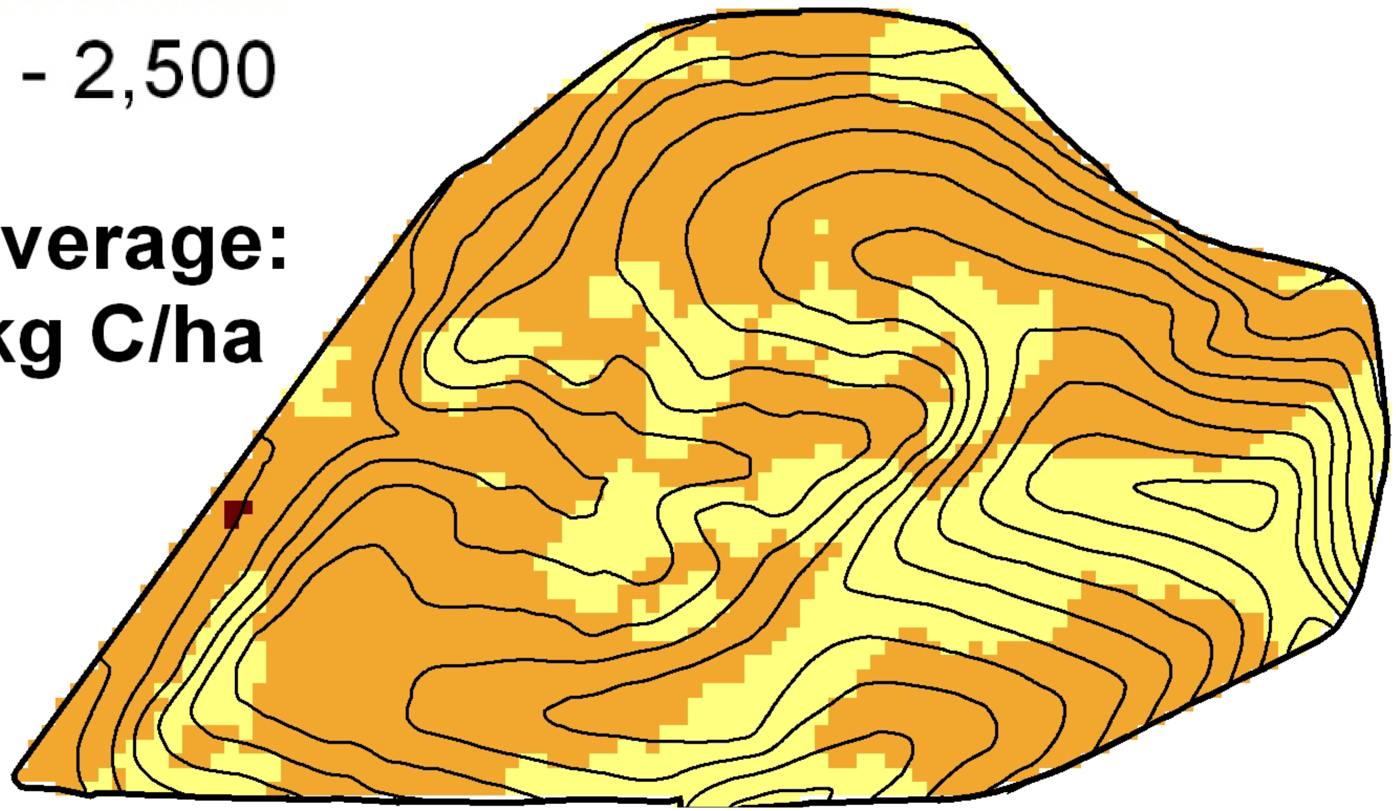
Annual C inputs needed to maintain organic matter: 2000-2500 lbs/ac

Residue carbon remaining in field after baling

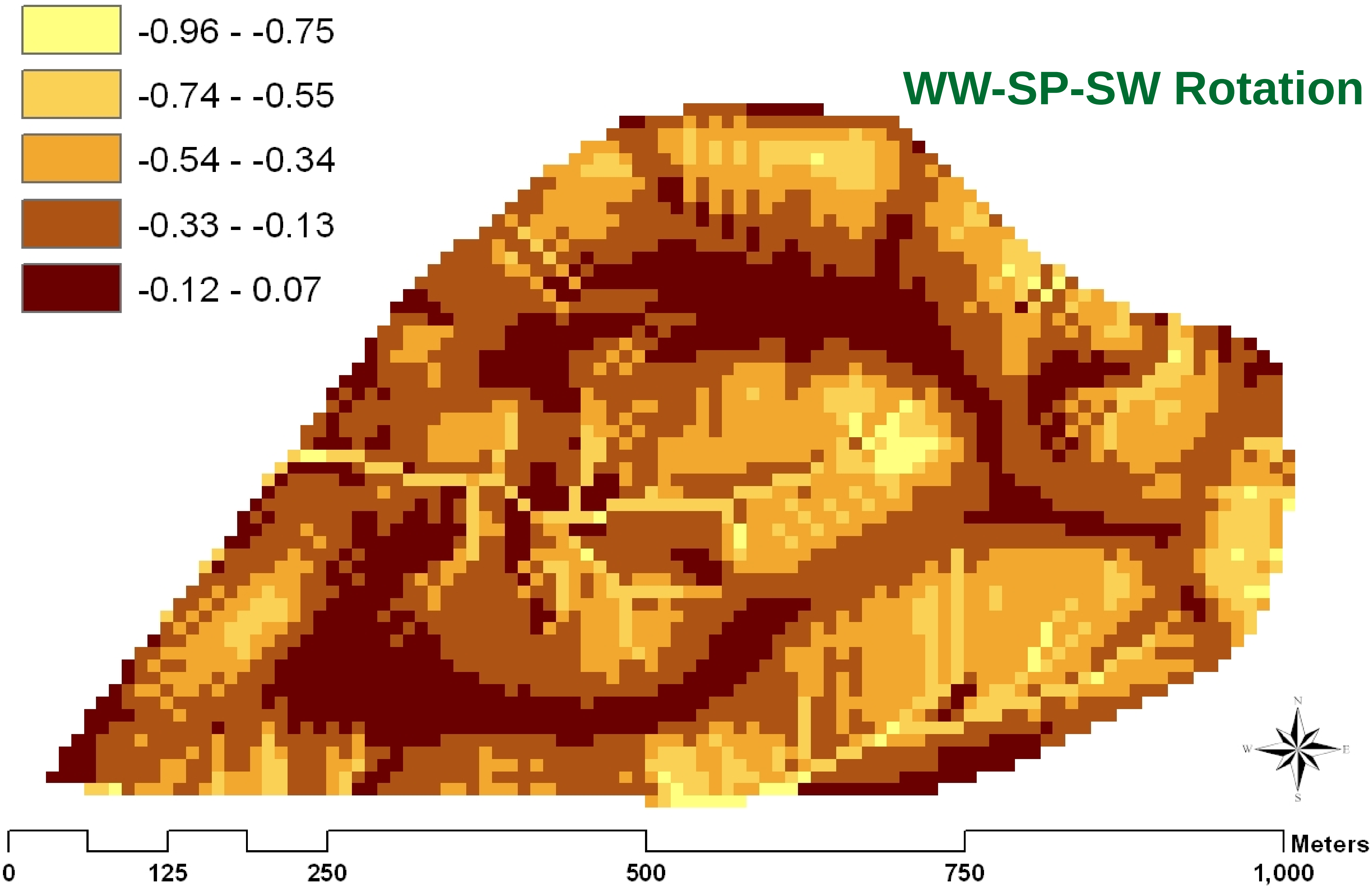
kg C/ha

- 1,000 - 1,500
- 1,500 - 2,000
- 2,000 - 2,500

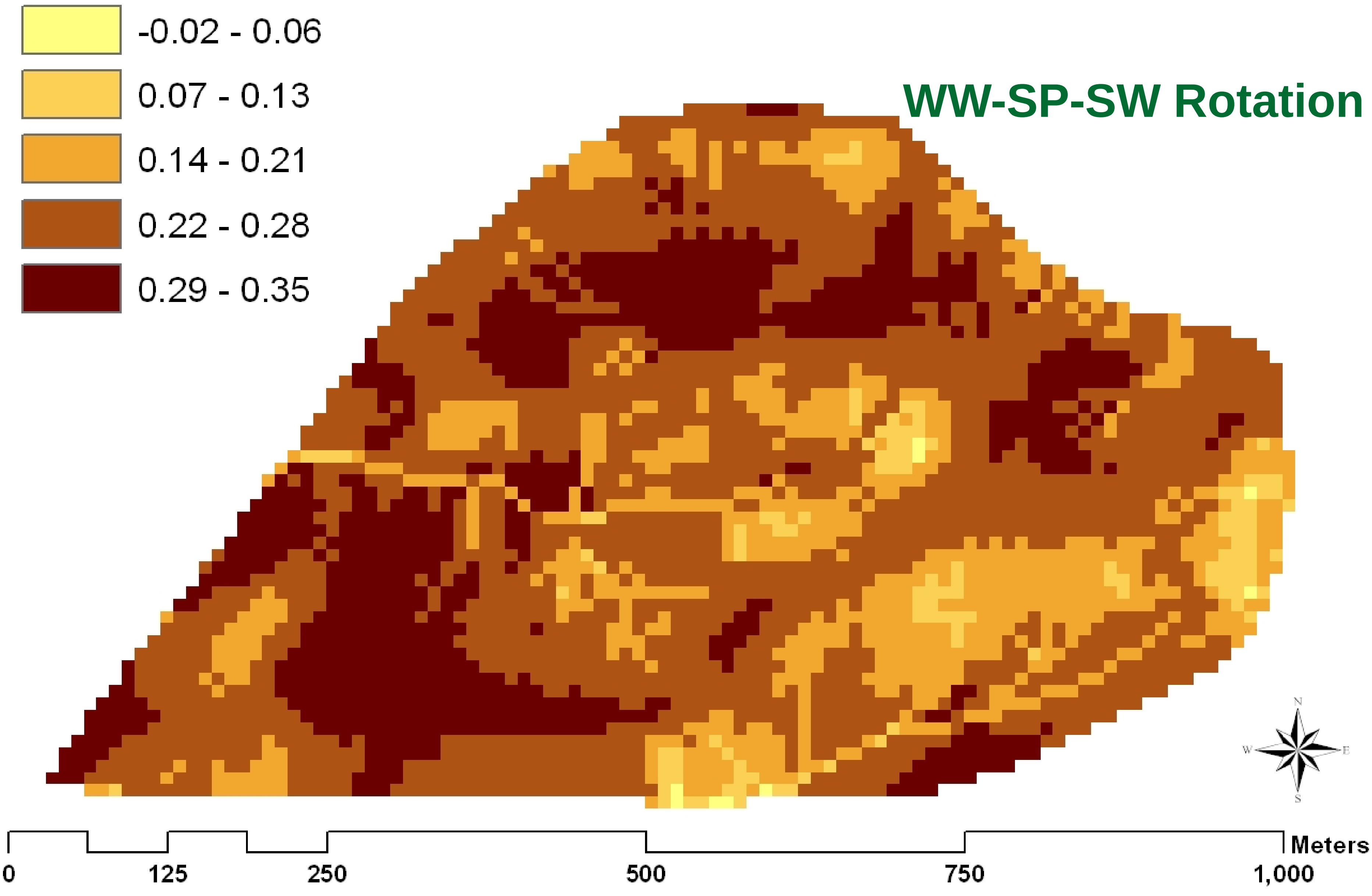
Field average: 1563 kg C/ha



SCI, Conv. Tillage, Baled Straw

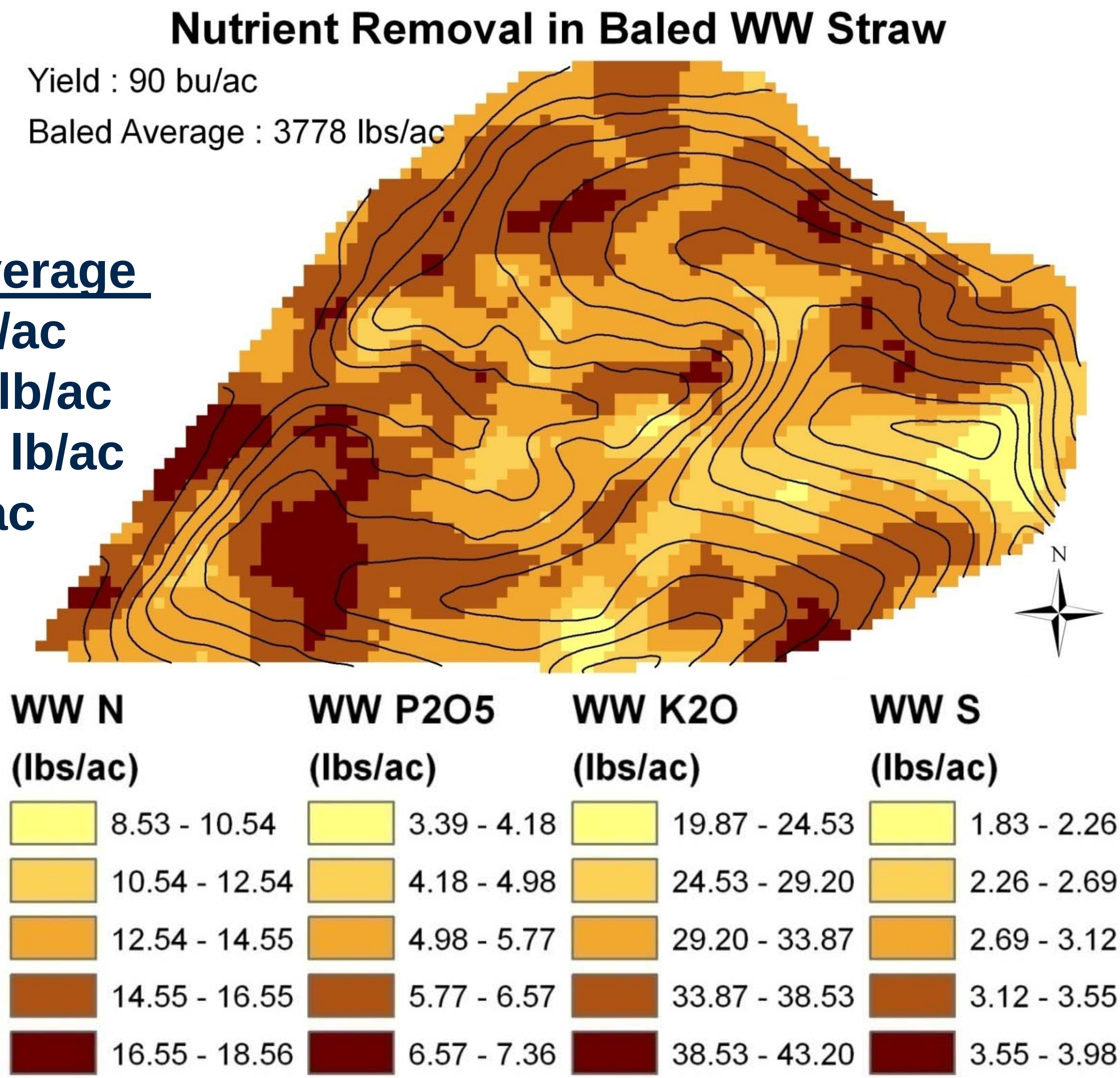


SCI, No-till, Baled Straw



Field average
N: 14 lb/ac
P_2O_5: 6 lb/ac
K_2O: 33 lb/ac
S: 3 lb/ac

$13/ton



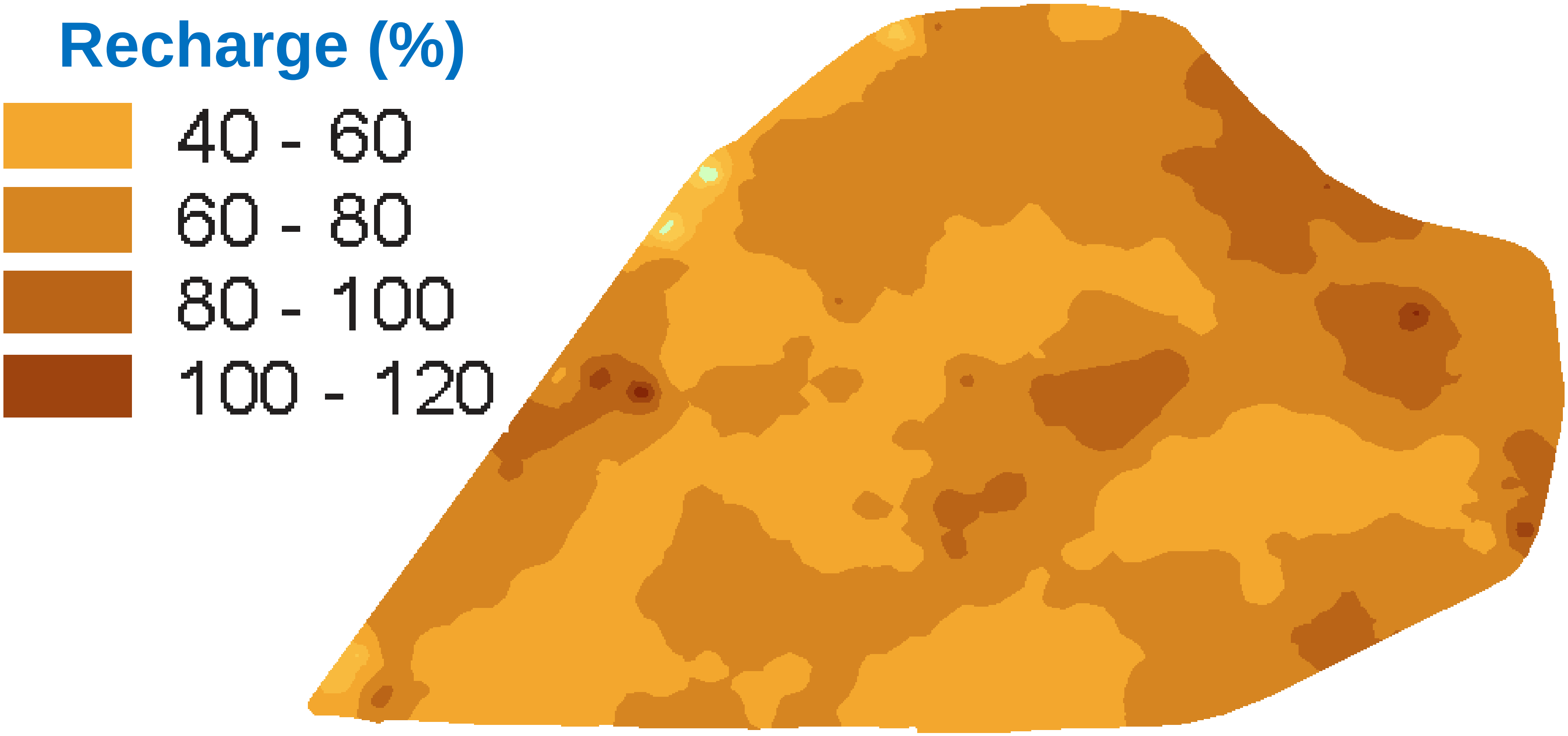
Harvesting Wheat Residues

- Large range in residue amounts may lead to site-specific harvesting strategies
- Protect soil from erosion, >1000 lbs/ac surface residues
- Crop residue C returns must be evaluated on a rotation basis; to maintain SOM, >5,000 lbs/ac
- Nutrients in wheat straw: about $13/ton
- Trade-offs should be evaluated on a site-specific basis, support practices such as crop rotation, reduced tillage and site-specific nutrient management need to be considered

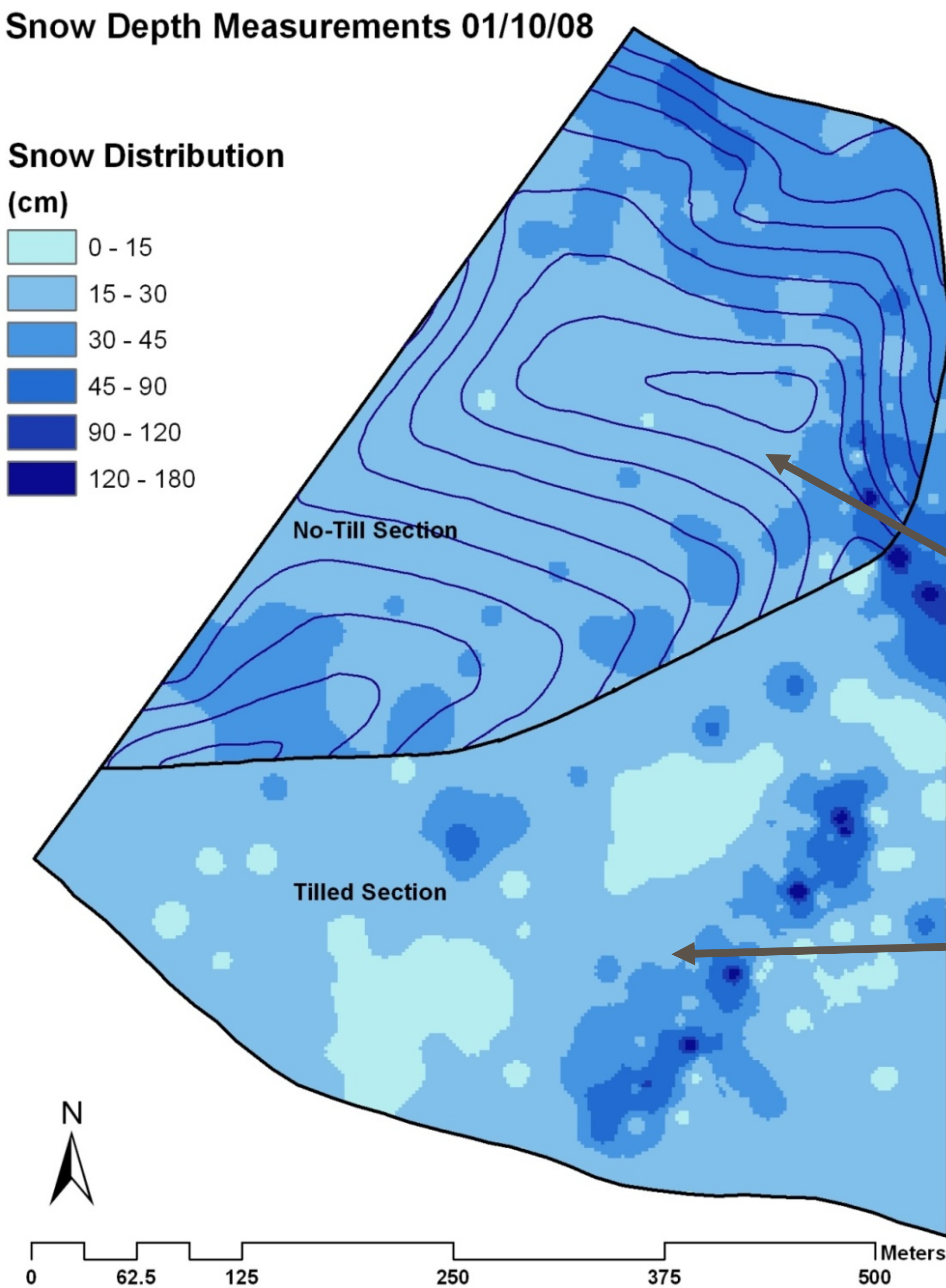
Precision Agriculture: Intuitively Attractive

Soil water recharge (1999-2000): percentage of fall-winter precipitation (400 mm) found in spring soil profile (0-1.53 m)

(Abdou and Huggins, 2011)



Field average: 64%



(Qiu et al., 2011)

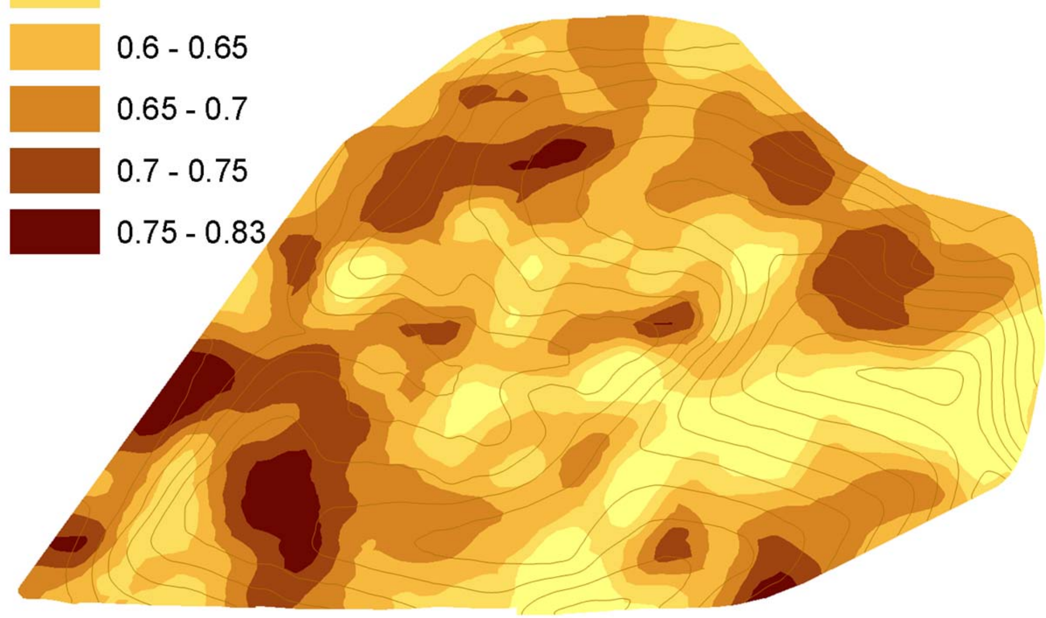
Snow depth measurements show more even distribution of water in no-till

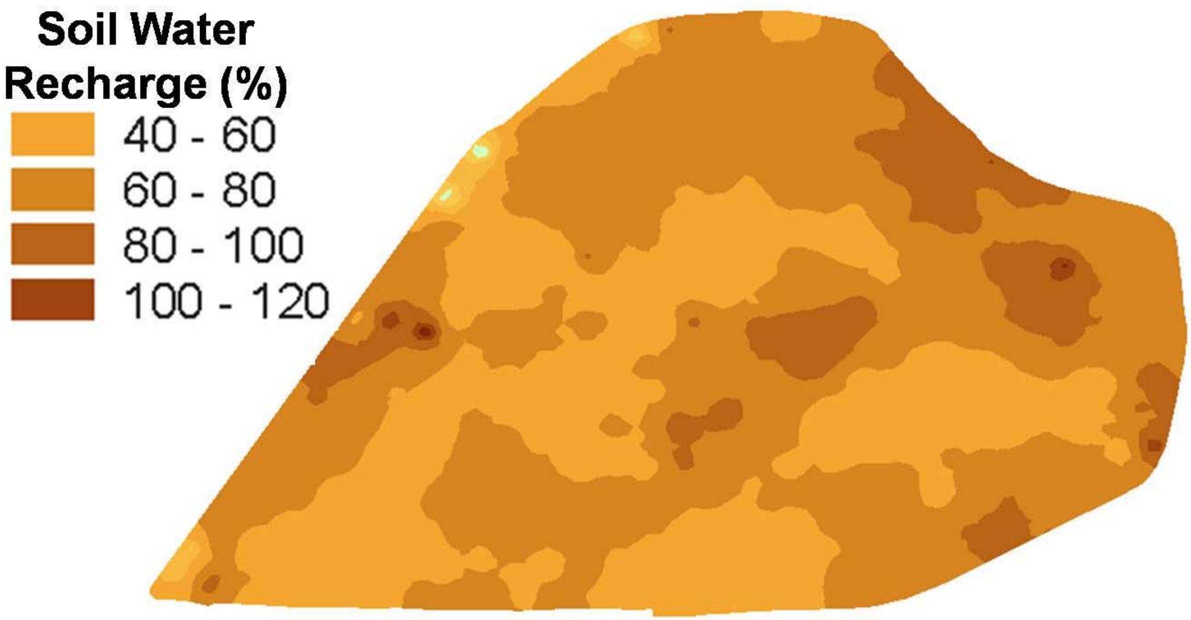
No-till with standing stubble

Conventional tillage with no surface residues

Ridge: 2.4”
South: 1.1”
Valley: 0.5”

Cook Agronomy Farm
1999-2003





Soil Water Recharge: 1999-2000 (percentage of winter precipitation found in soil profile)

Field average: 64%

Develop site-specific N recommendations based on manipulation of wheat density and applied N

Tabitha Brown

David Huggins

Jeff Smith

Kent Keller

Chad Kruger

USDA ARS

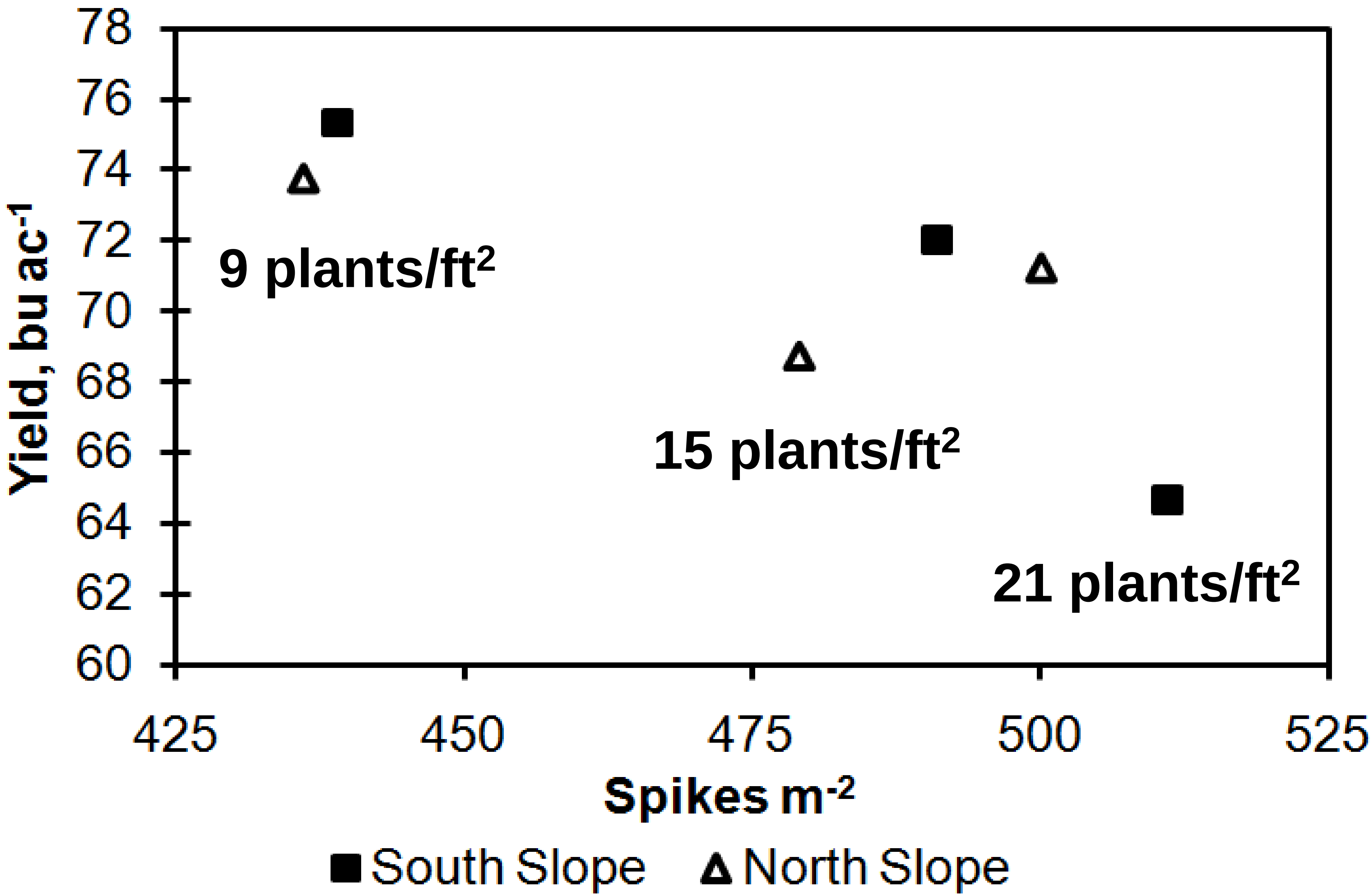
SCF
Site-specific Climate-friendly Farming

Nitrogen Systems: Policy-oriented Integrated Research and Education
NSPIRE
IGERT
WSU

Research Questions

- Can water and N use be regulated across the landscape through manipulation of wheat spike density and applied N?
- Will landscape level manipulation of wheat spike density and applied N result in greater water and N use efficiency and less N losses (NO_3^- leaching, N_20 flux)?
- Can NUE diagnostic tools useful to growers and others be developed?

2010 Winter Wheat

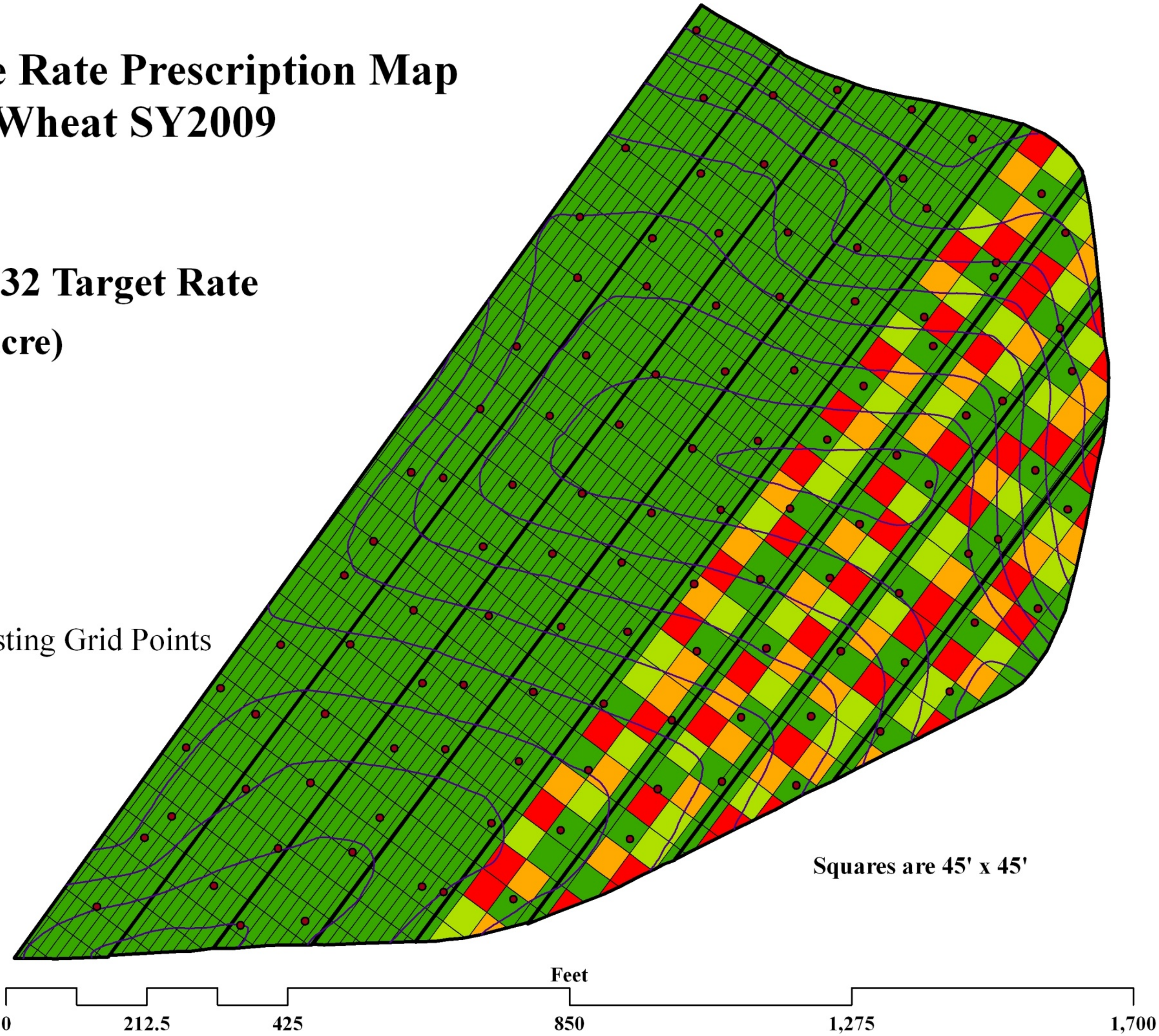


Variable Rate Prescription Map
Winter Wheat SY2009

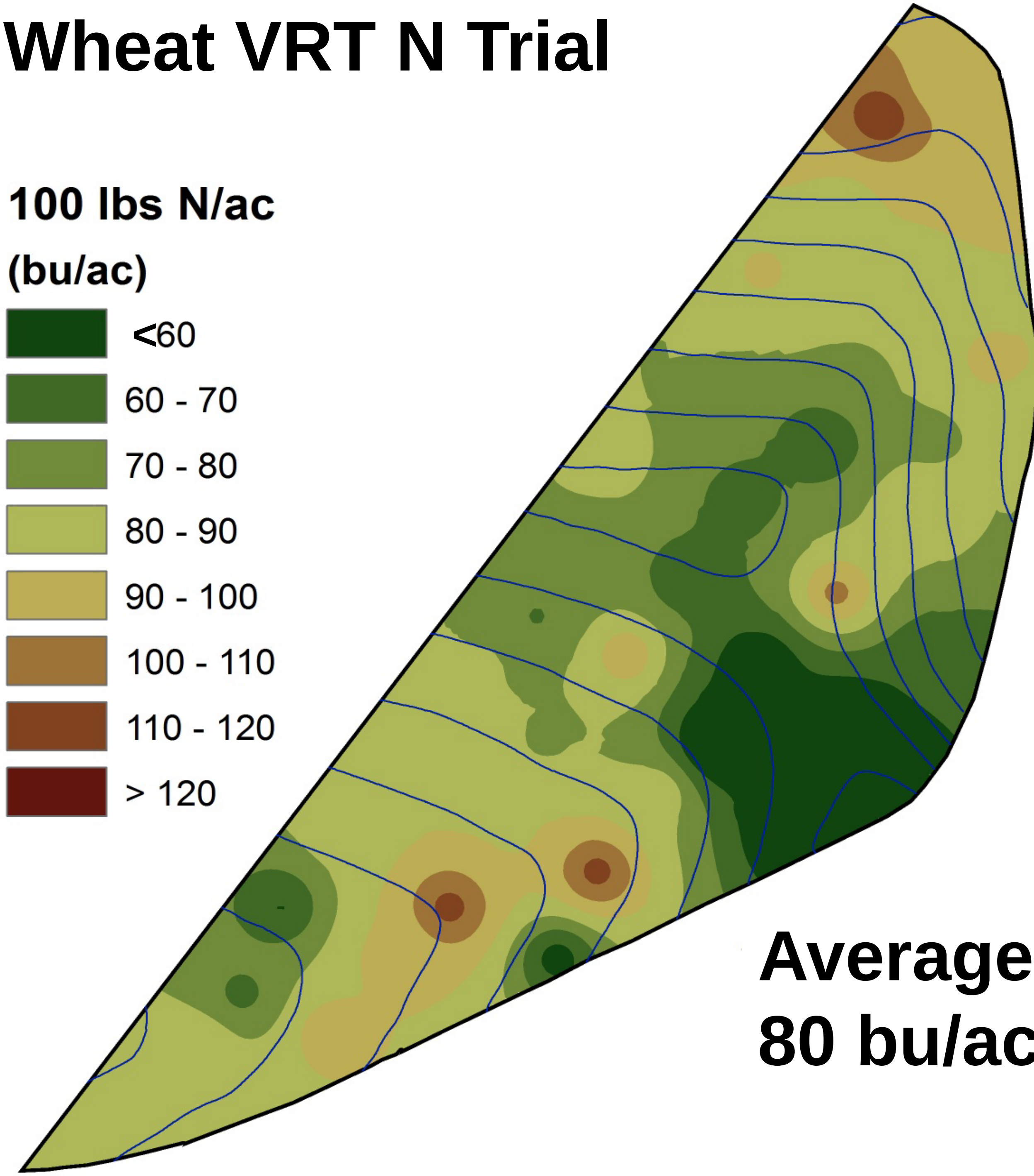
Solution 32 Target Rate

(gallons/acre)

- 0
- 12
- 19
- 26
- Existing Grid Points

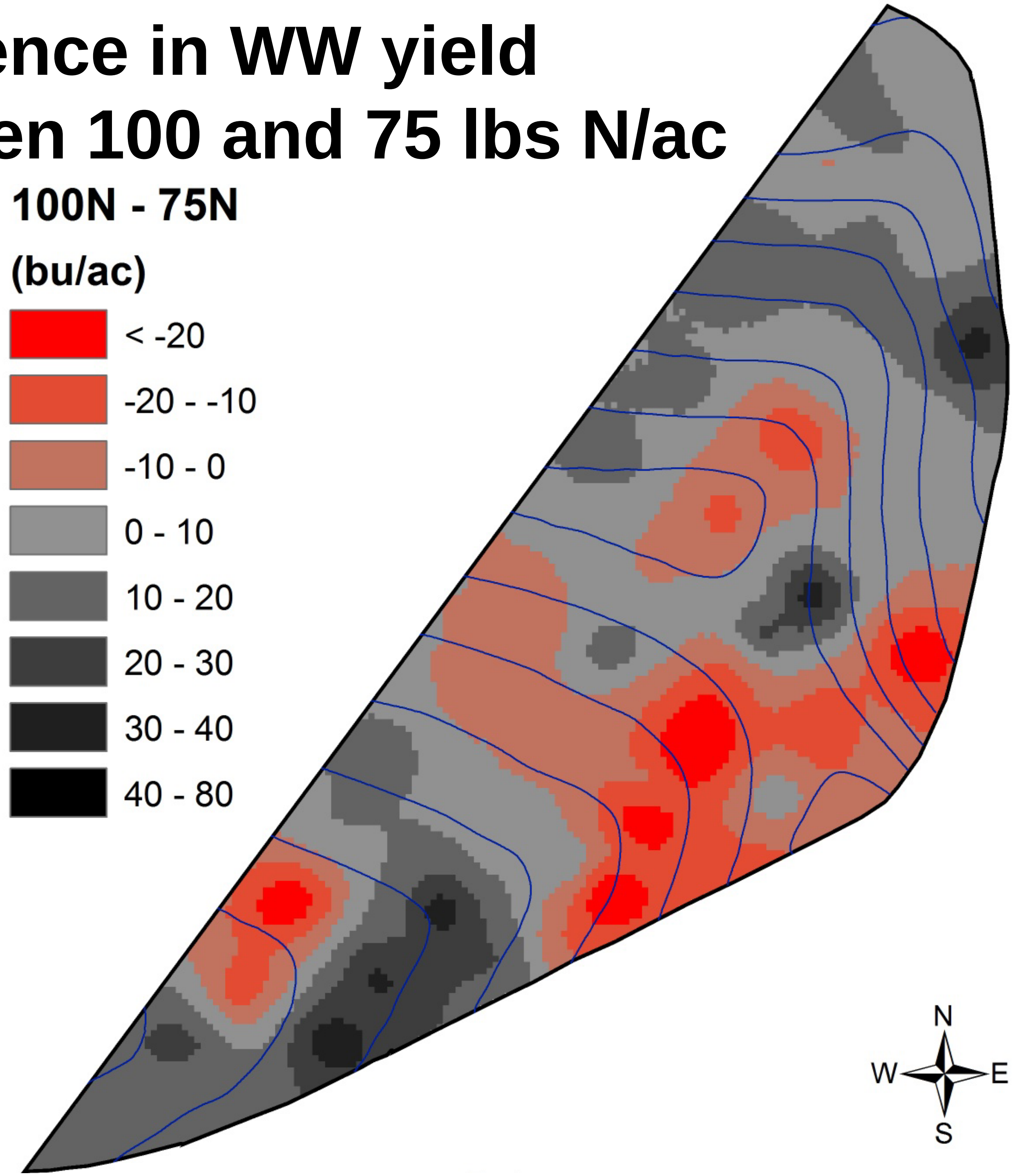


Winter Wheat VRT N Trial

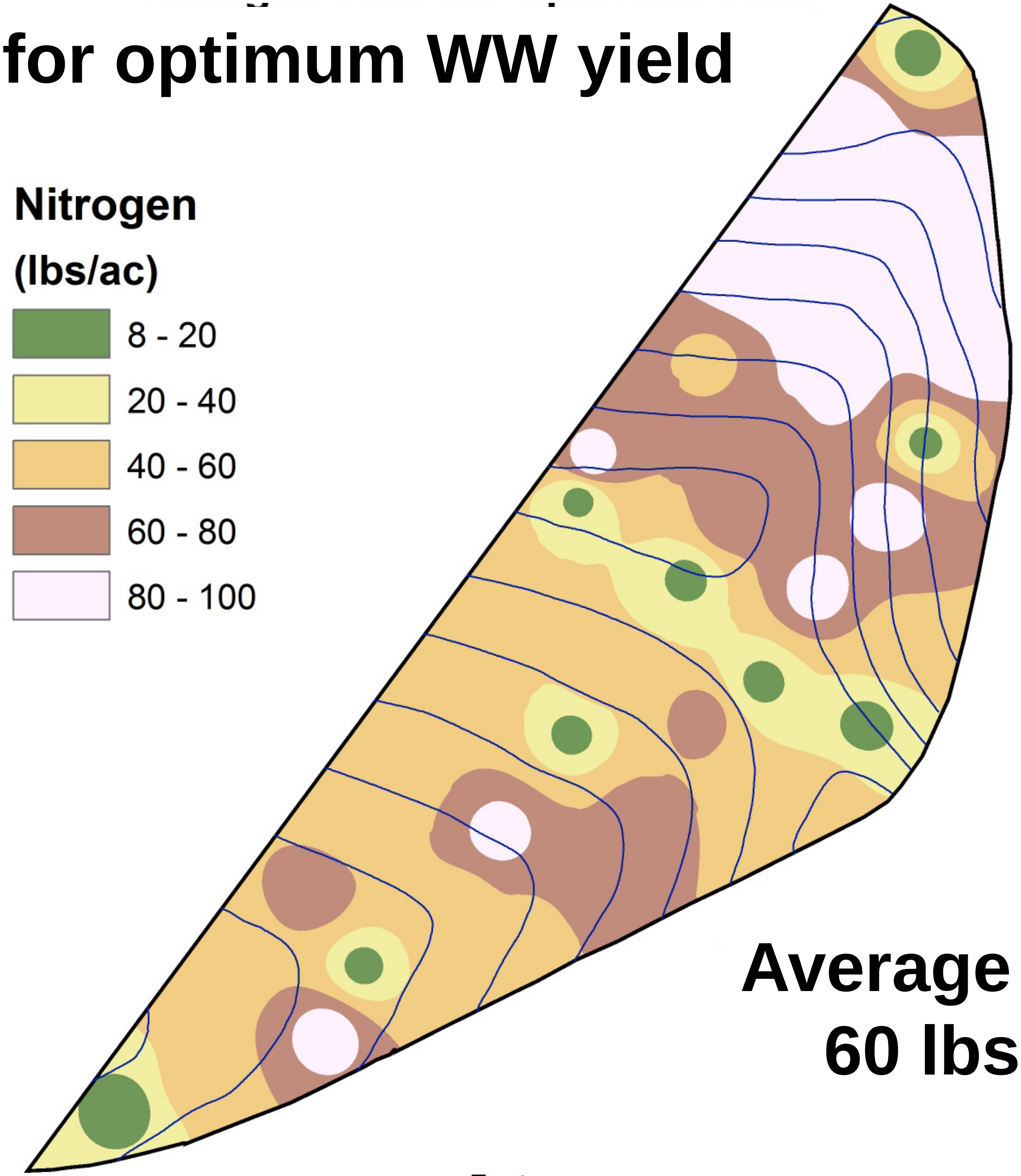


Average: 80 bu/ac

Difference in WW yield between 100 and 75 lbs N/ac

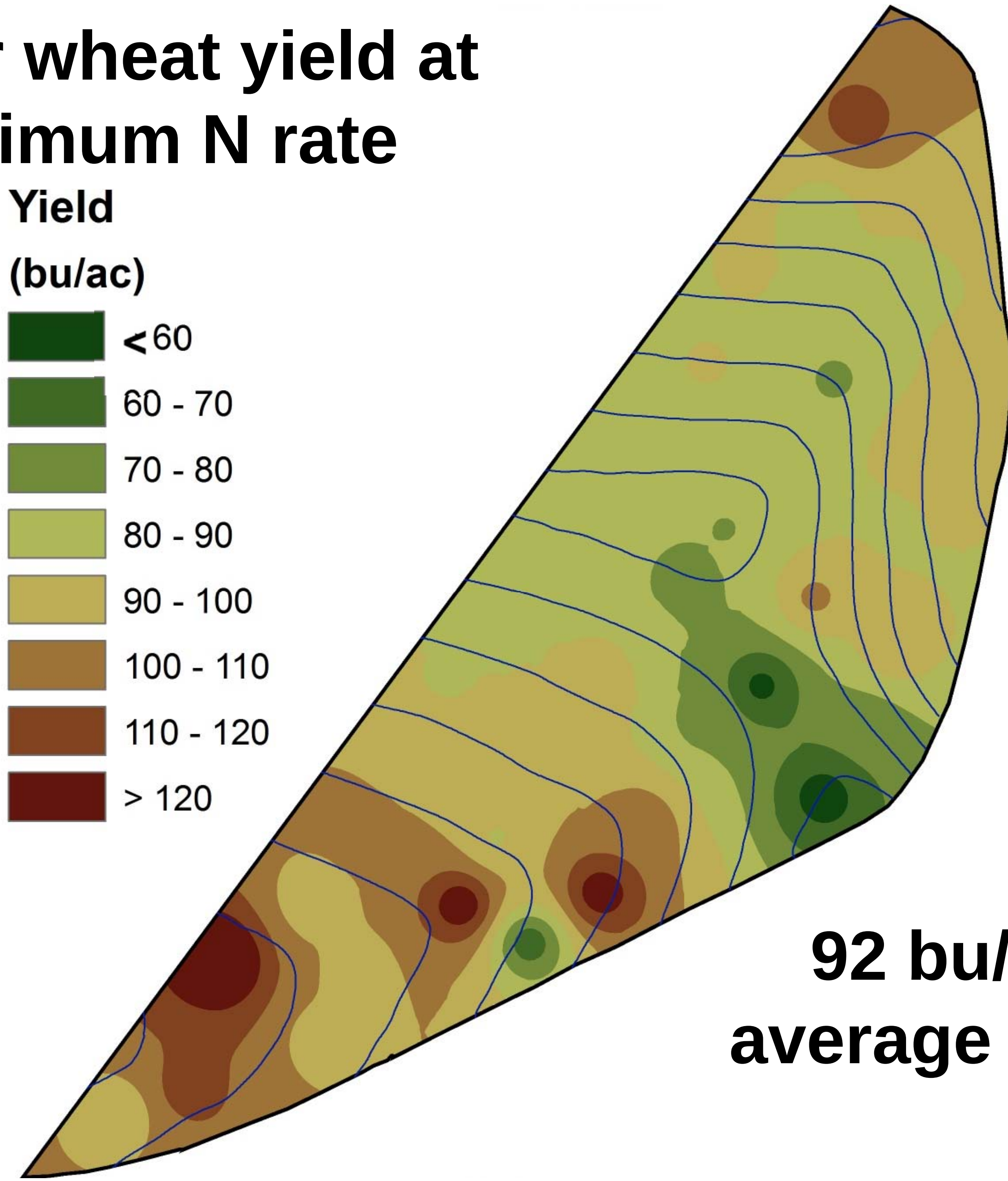


N rate for optimum WW yield



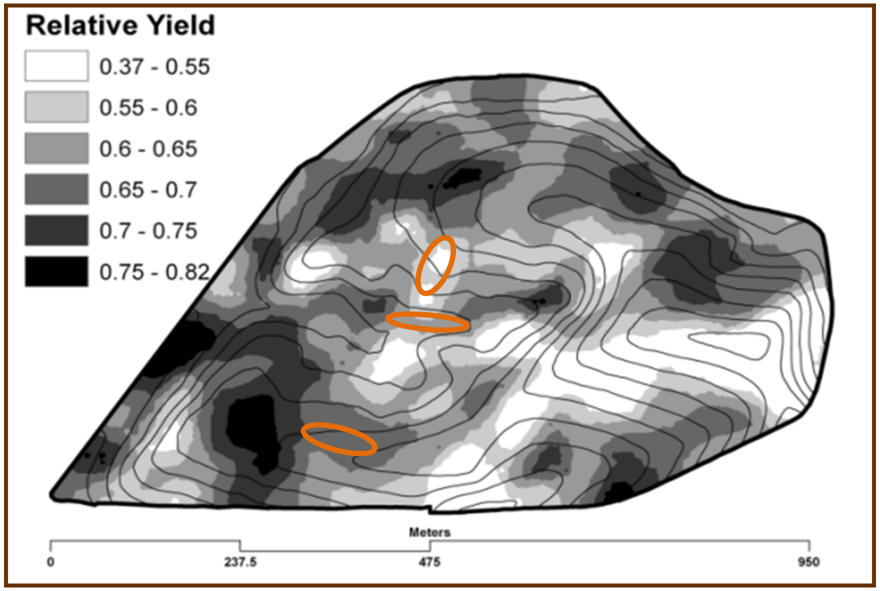
Average N rate: 60 lbs N/ac

Winter wheat yield at optimum N rate



92 bu/ac average yield

Experimental Design 2010 – 2011 Crop

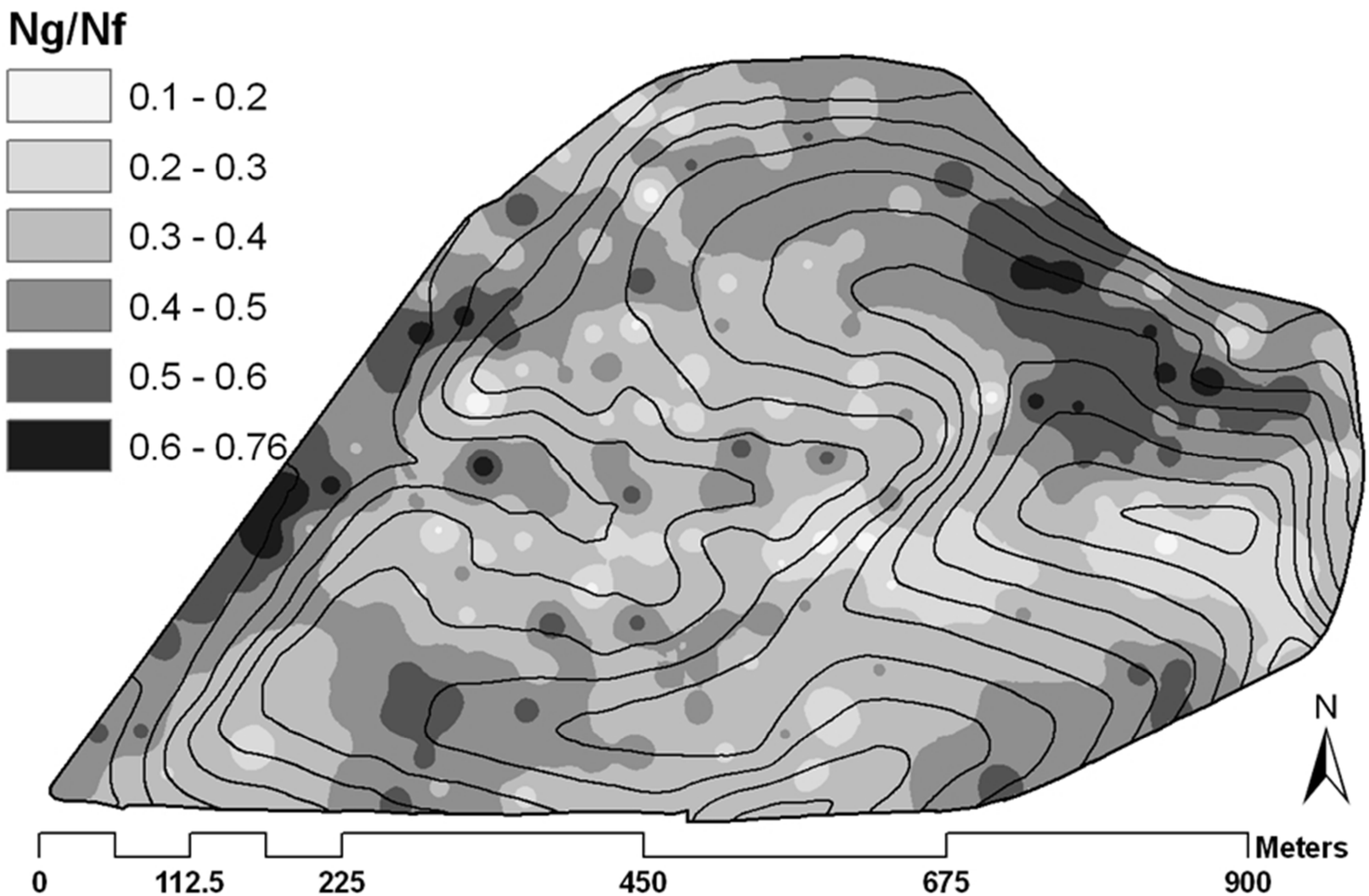


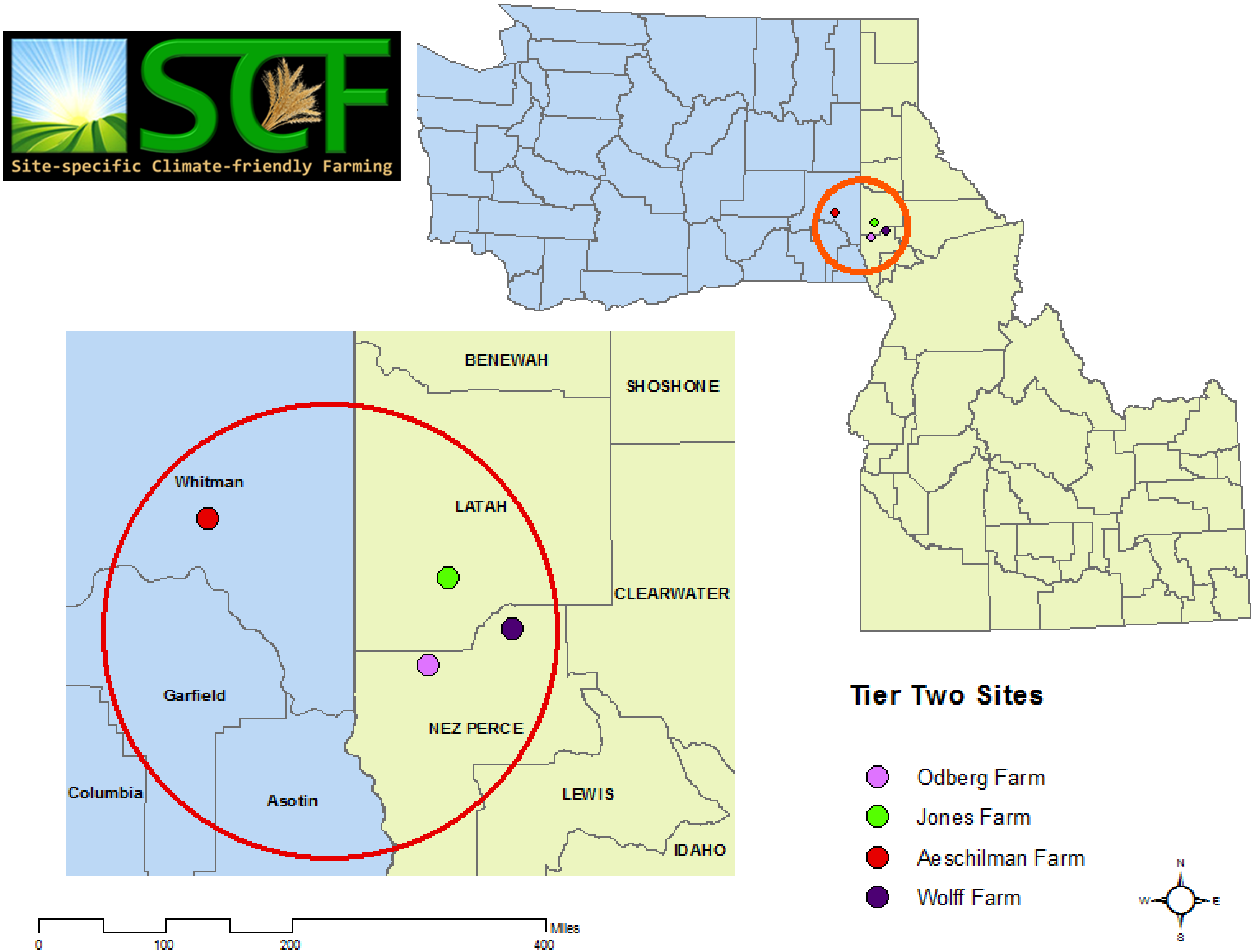
- **Divided field into three zones: low, intermediate and high yielding**
- **Four seeding rates:**

  324,000, 668,000, 1,012,000 and1,360,000 seeds/ac
- **Five fertilizer rates:**
  - **11, 35, 70, 110 & 125 lbs N per acre as Urea (46-0-0)**

Soft White Club 'Chukar', direct seeded after garbs

Field-scale Evaluation of NUE

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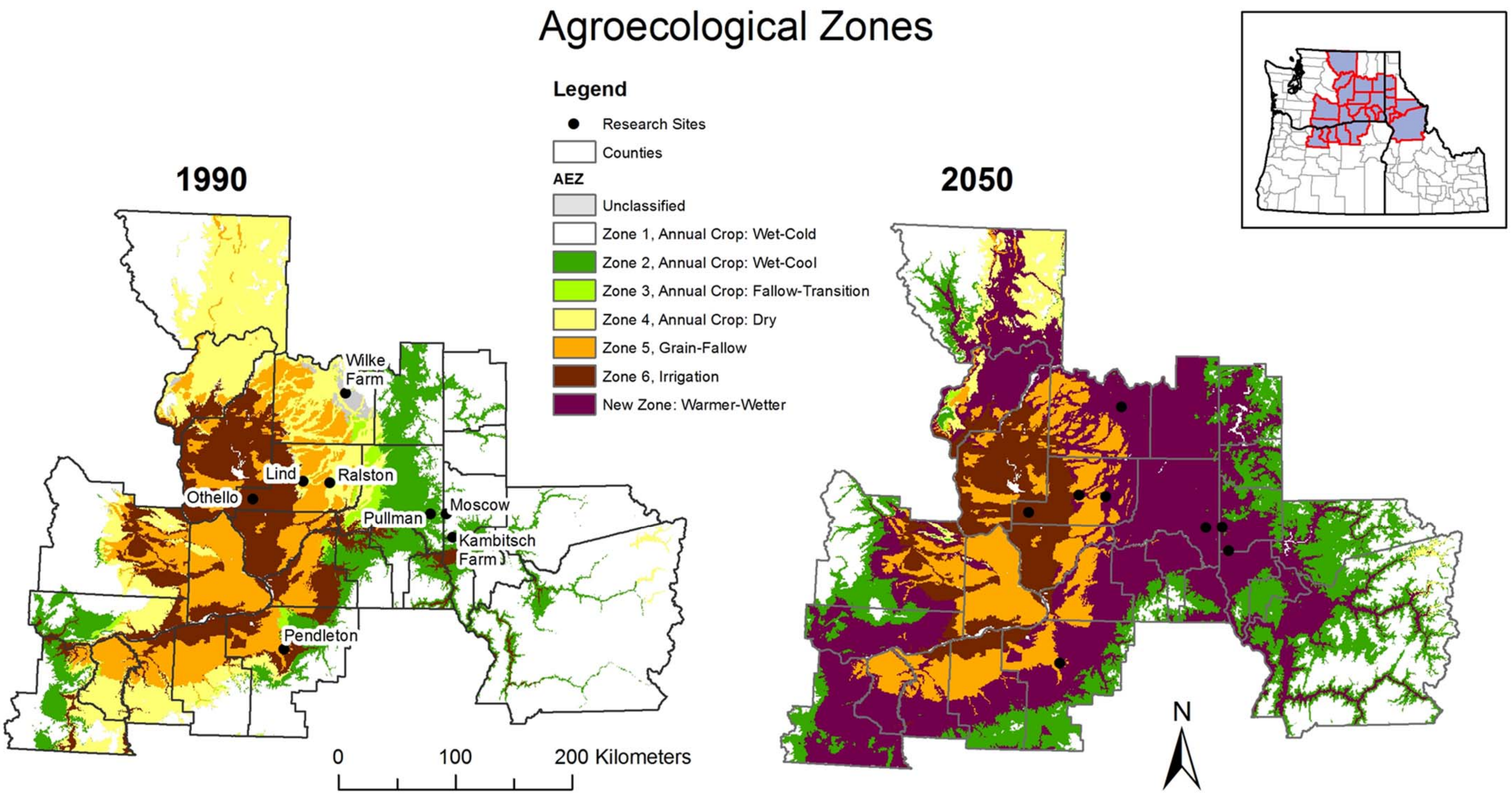
SHOSHONE
Whitman
LATAH
CLEARWATER
Garfield
NEZ PERCE
Columbia
Asotin
LEWIS
IDAHO
Tier Two Sites
Odberg Farm
Jones Farm
Aeschilman Farm
Wolff Farm
N
W
E
S
Miles
0
100
200
400

Projected Shifts in AEZ's



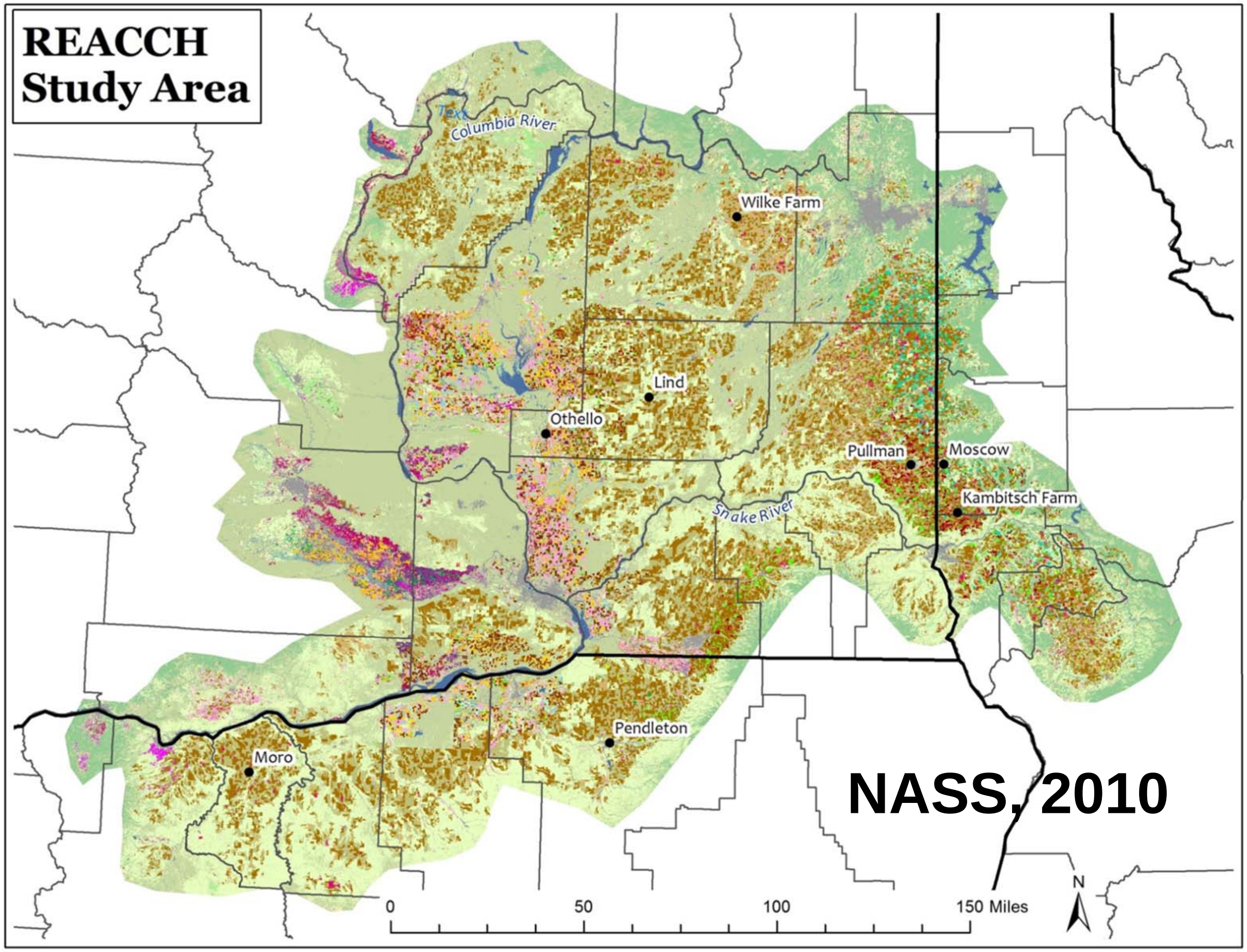
NP216 – Agricultural Competitiveness and Sustainability

Increasing Inland Pacific Northwest Wheat Production Profitability

Objective

- **Develop dynamic agroecological zones for PNW**
  - **Develop method to define major AEZ’s (e.g. the wheat-fallow zone) for the REACCH study area based on a single year of National Agricultural Statistical Service (NASS) cropland data**

Development of Dynamic AEZ's for the PNW (Huggins)



REACCH
Regional Approaches to Climate Change – PNA

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Washington State University

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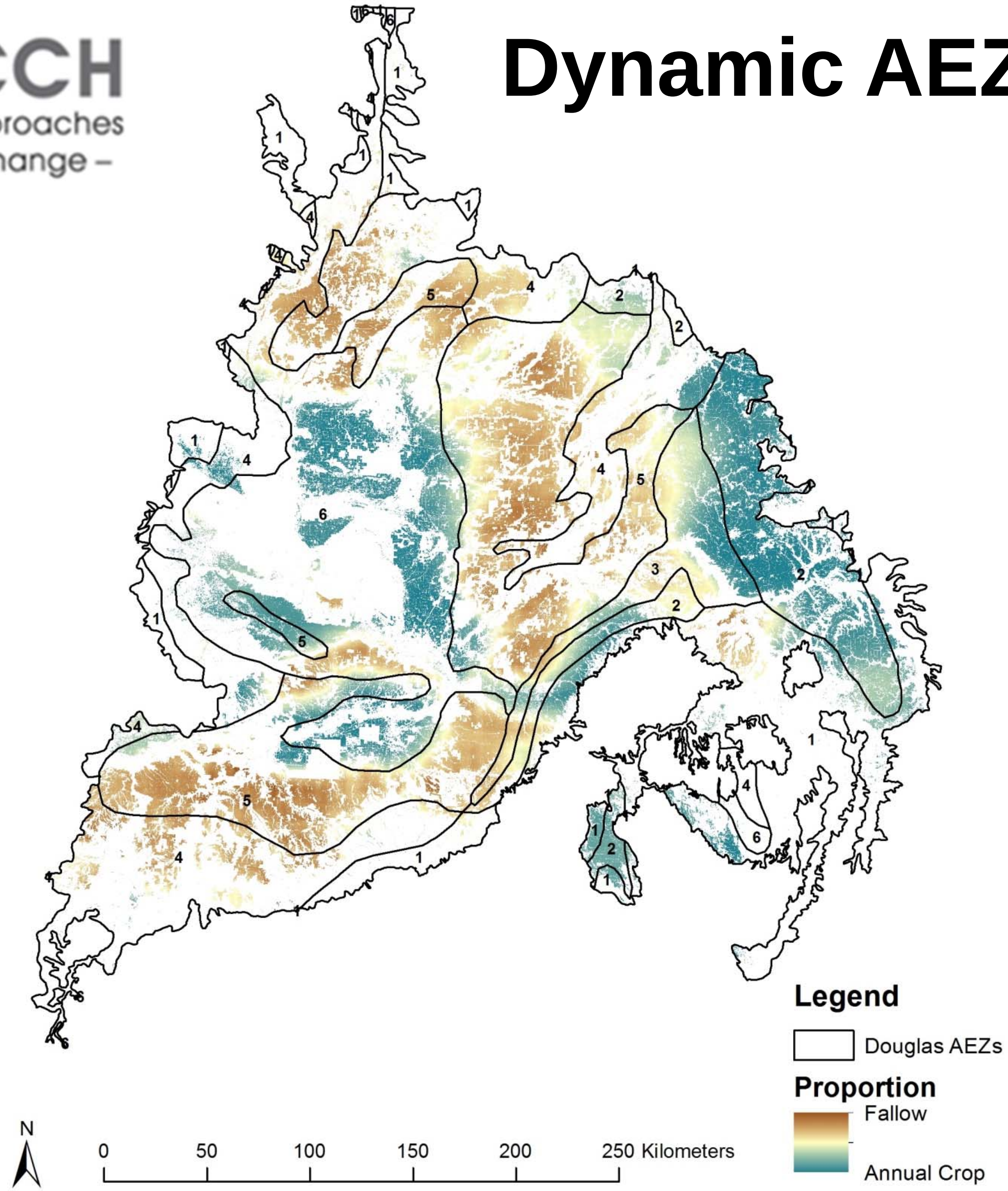
Dynamic AEZ's



REACCH
Regional Approaches to Climate Change – PNA

Dynamic AEZ's

- **Develop baseline boundaries of current AEZ's and the capacity to evaluate shifts in AEZ boundaries over time**
- **Assess biophysical (e.g. climate, soils, terrain) and socioeconomic factors (e.g. commodity prices) most useful for classifying AEZ's**
- **Link climate change mitigation and adaptation strategies to AEZ's**

PCFS Research

- **Direct-seed farming systems; economics; soil acidification; cropping system intensification; residue mgmt. and SOC; crop modeling; GHG monitoring**

REACCH
Regional Approaches to Climate Change – PNA

Western Region
Sustainable Agriculture Research and Education

WASHINGTON STATE UNIVERSITY

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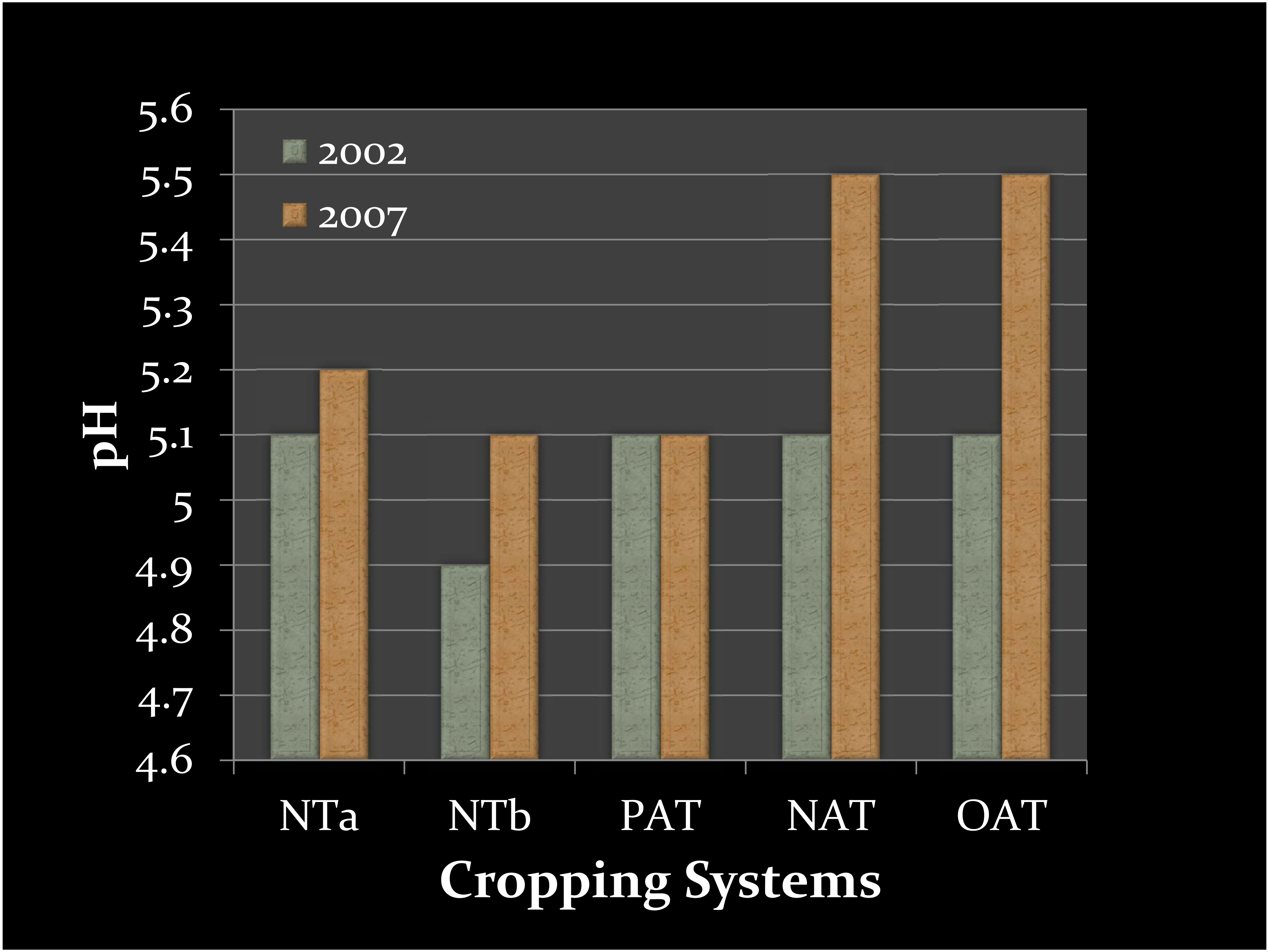
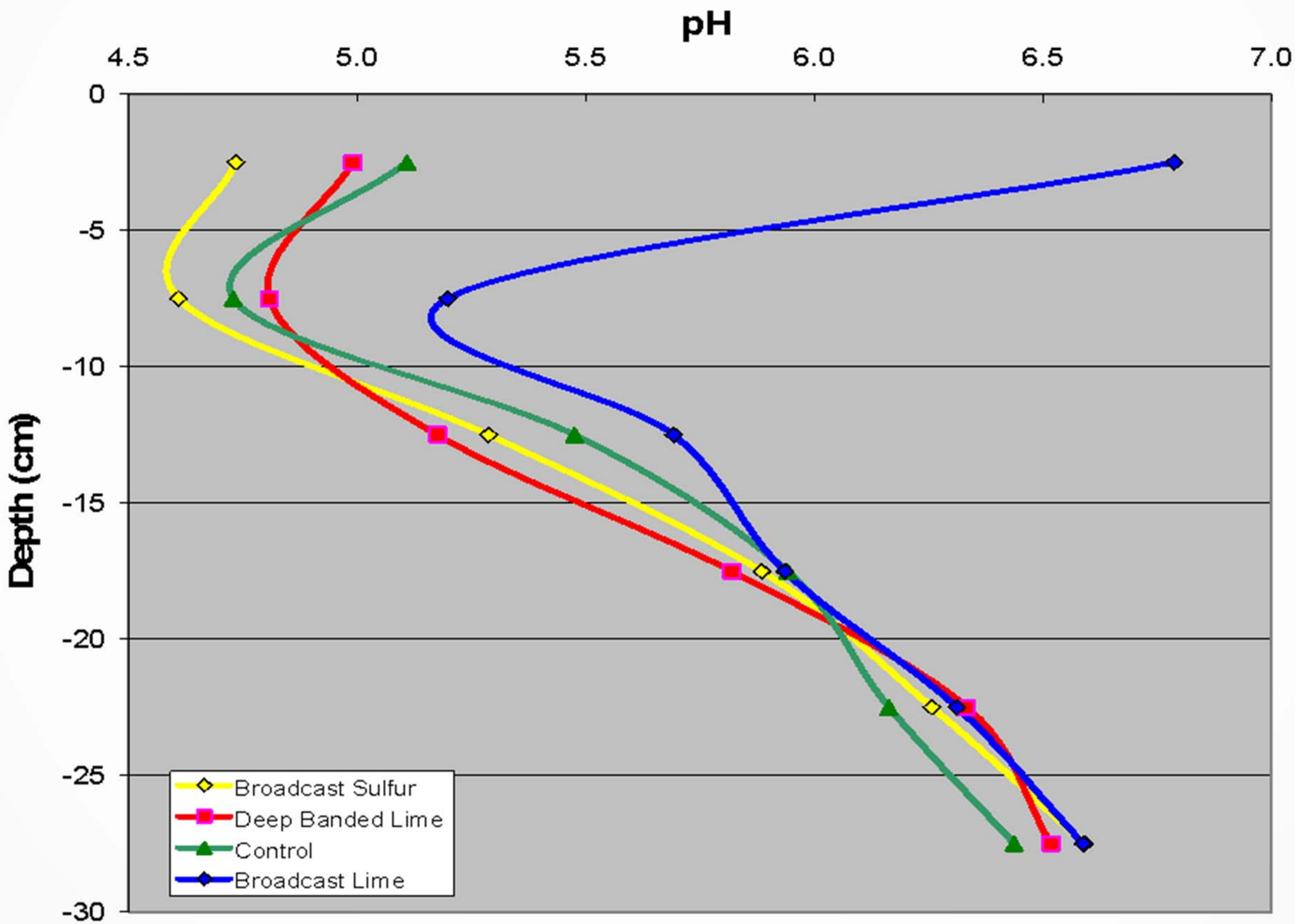
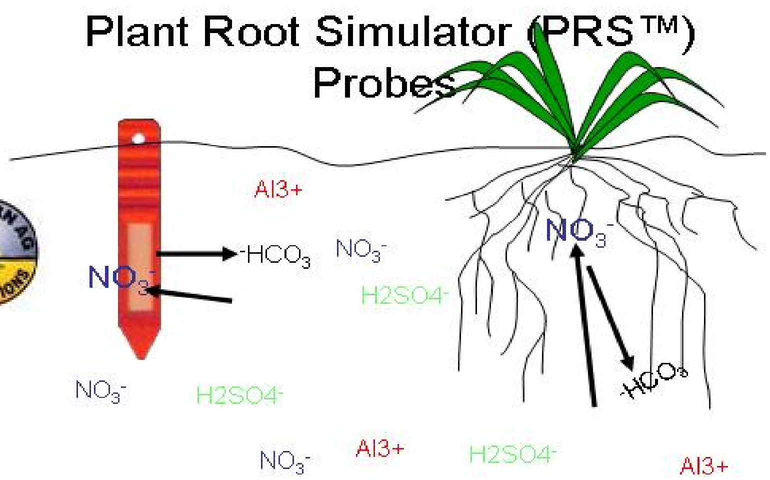


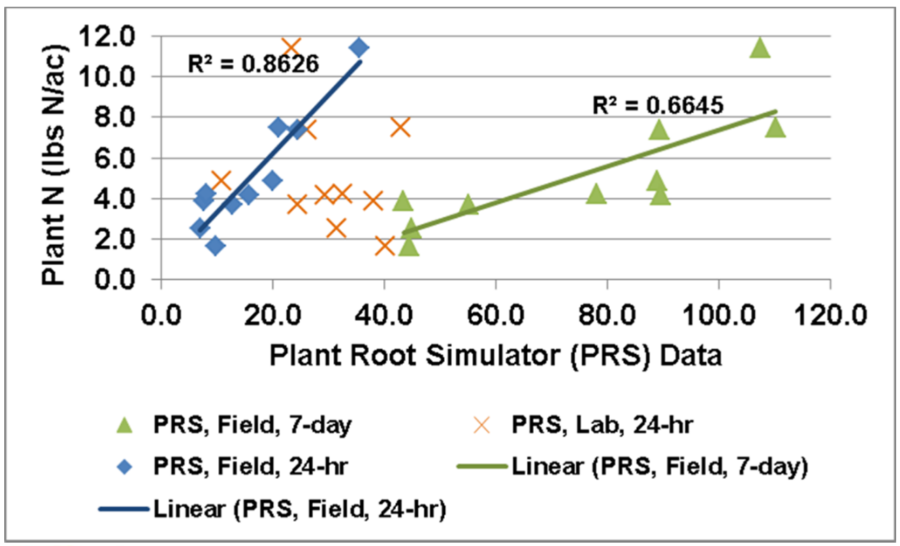
5.6
5.5
5.4
5.3
5.2
5.1
5
4.9
4.8
4.7
4.6
pH
2002
2007
NTa
NTb
PAT
NAT
OAT
Cropping Systems

Lime Study at PCFS



Bioavailability of Soil Nutrients





Alternatives to Stubble Burning

DEPARTMENT OF ECOLOGY State of Washington

- **Evaluate the loss of C and nutrients (N, P, S) from residue burning**
- **Assess stubble burning impacts on seedling nutrition, grain yield**

Offoot

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