Reetz Agronomics

"Fertility Lessons Learned From The Past To Take Into The Future."

With 40 years of experience studying fertility issues — 28 with the International Plant Nutrition Institute and 12 with Purdue University — Harold Reetz says a lot of progress has been made in the area of fertilizer-use efficiency. However, the owner of Reetz Agronomics in Monticello, Ill., says there is some unfinished business yet to be completed. Reetz will share fertility lessons he's learned over decades that no-tillers can bank on in their no-till management system, as well as things he sees no-tillers needing to adapt to or adopt in the next 20 years. Tips he'll share involve maximizing the potential of today's genetic improvements in corn, ways to boost the lagging yields of soybeans, site-specific technologies that aid in managing field variability and much more.

Dr. Harold Reetz

Ph.D. – CPAg – CCA

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Fertility Lessons Learned From The Past To Take Into The Future

National No-Till Conference

Cincinatti, Ohio

January 14, 2010

"…whoever makes two ears of corn,
or two blades of grass to grow
where only one grew before,
deserves better of mankind,
and does more essential service to his country than the whole race of politicians put together."

--- from Gulliver's Travels

Growing Population Means Growing Need for
Food, Feed, Fiber, and Fuel from Crop Production

Global Population Density (2007)

More efficient land use is essential

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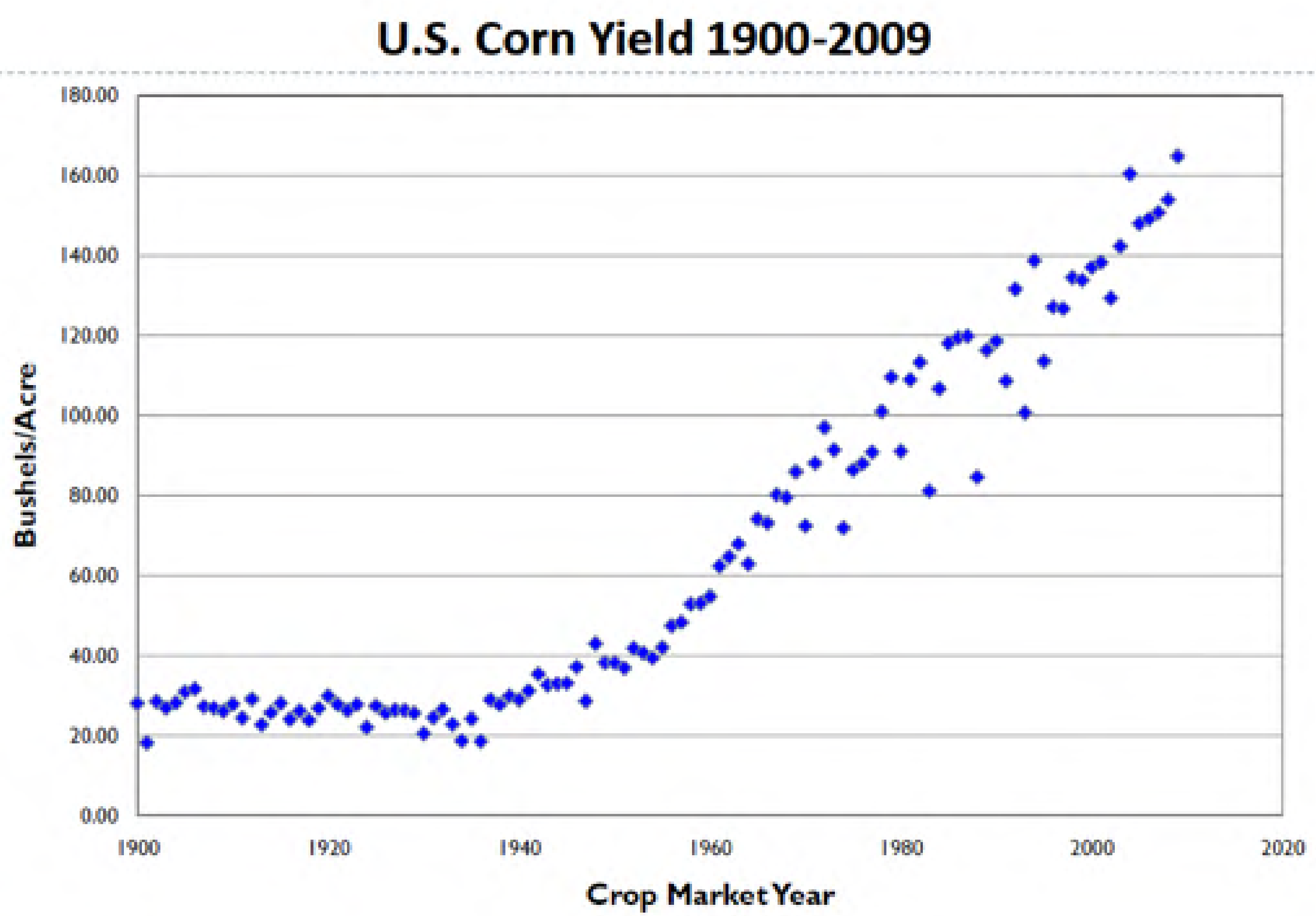

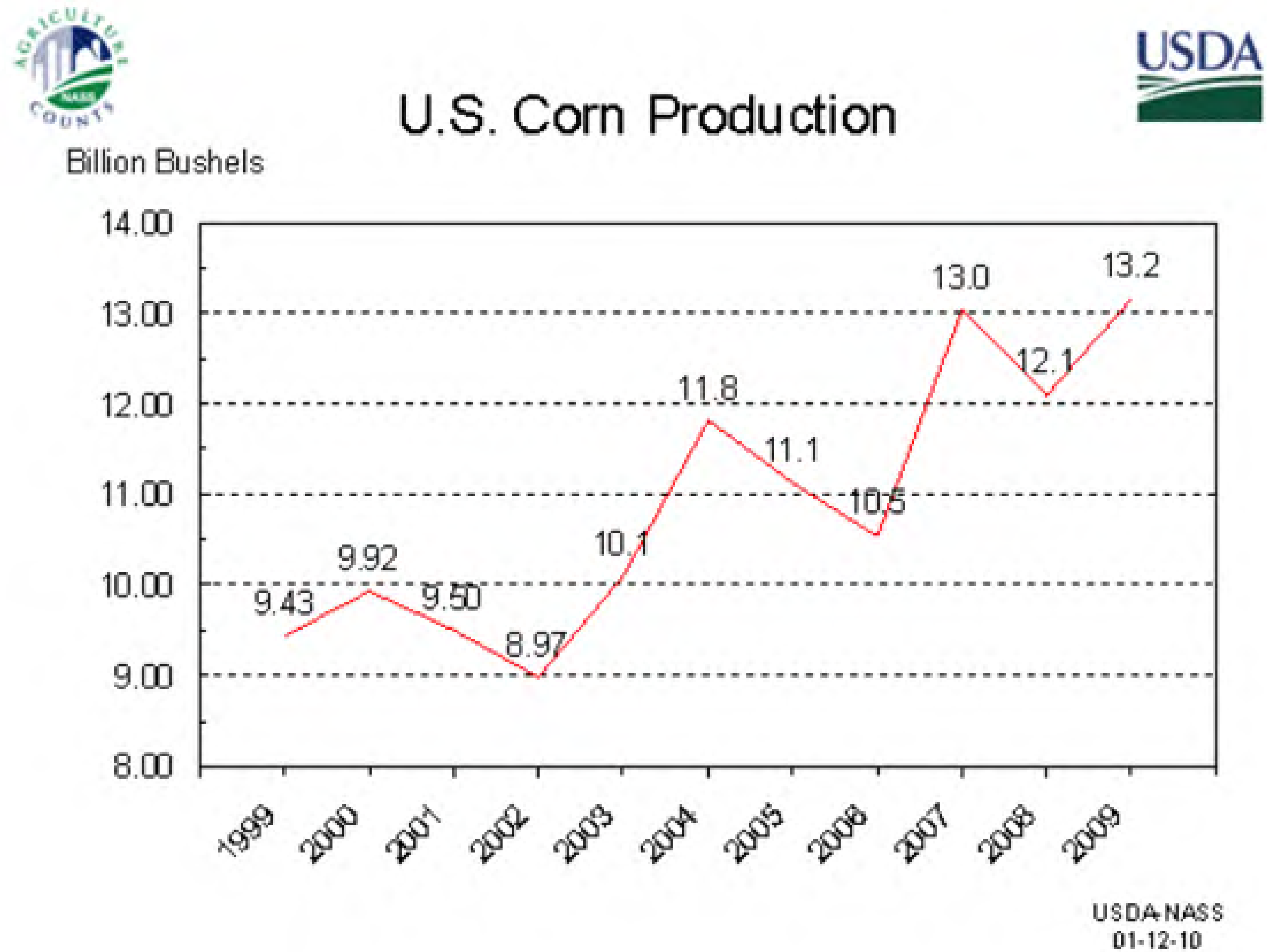

U.S. Corn Production
Billion Bushels
14.00
13.00
12.00
11.00
10.00
9.00
8.00
9.43
9.92
9.50
8.97
10.1
11.8
11.1
10.5
13.0
12.1
13.2
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
USDA-NASS
01-12-10

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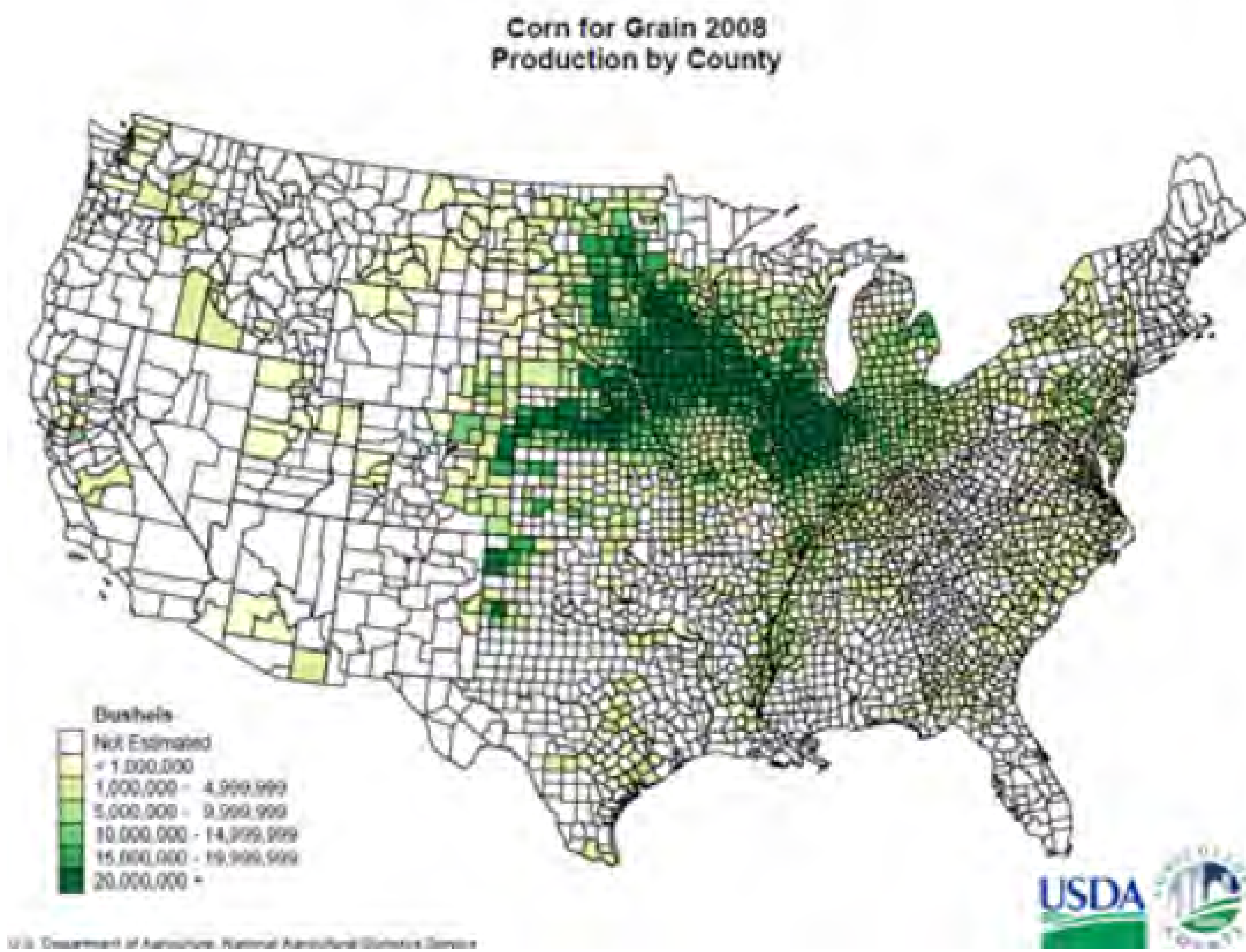
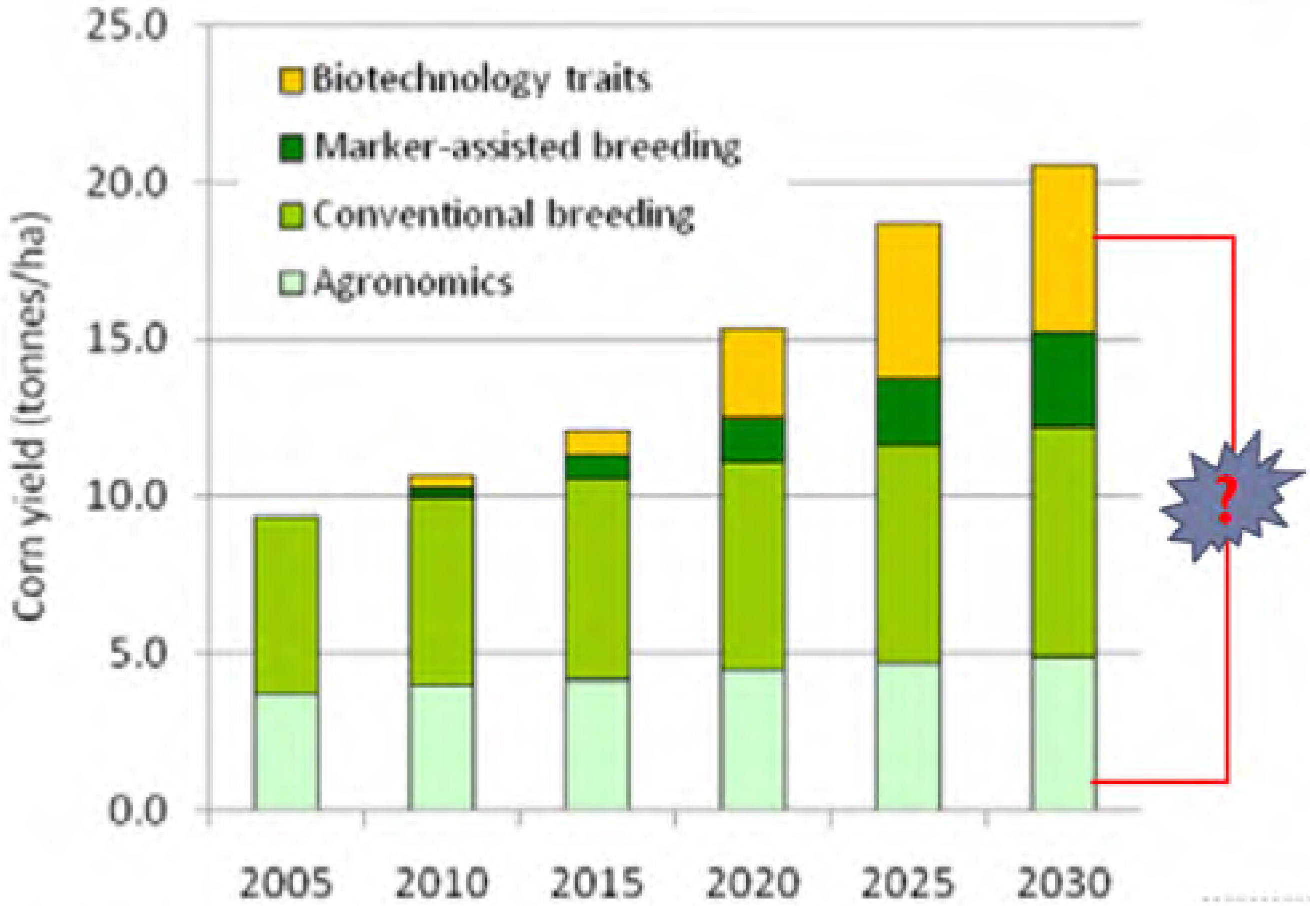
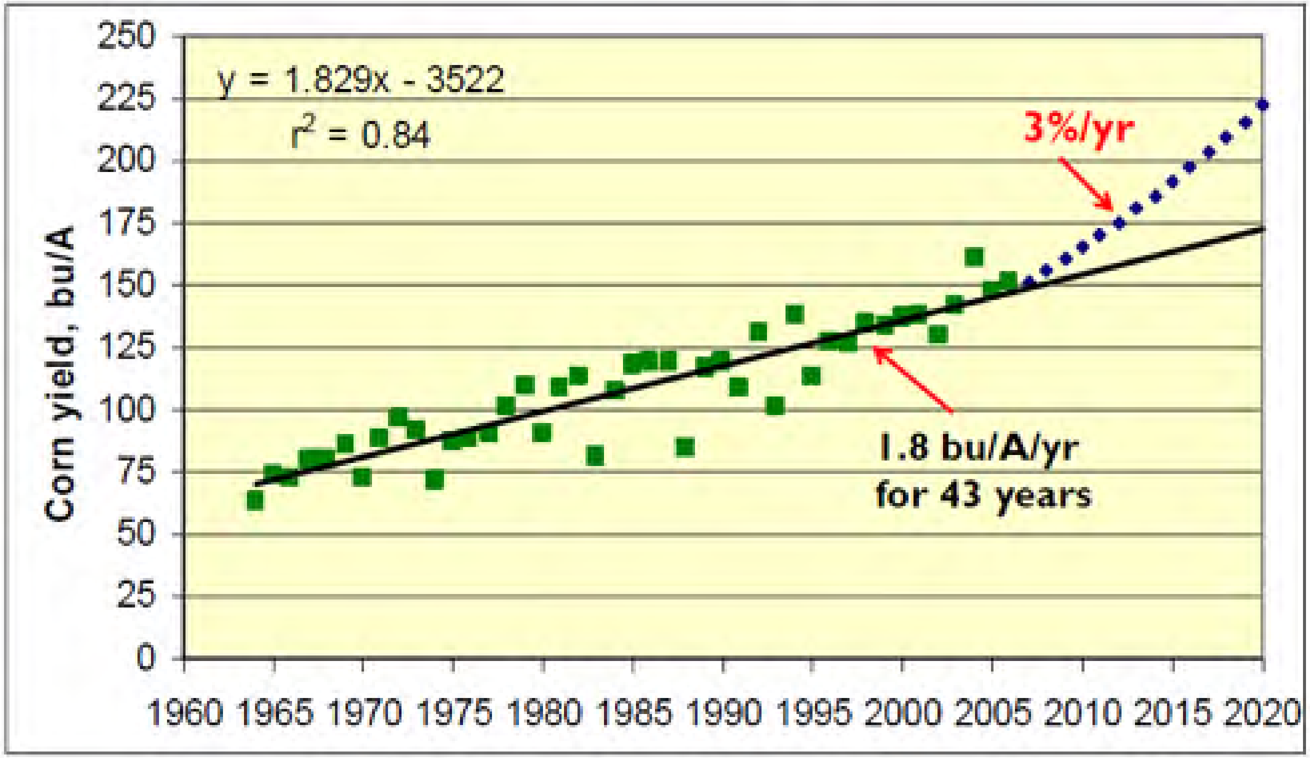


Sources of Increased Yield Potential



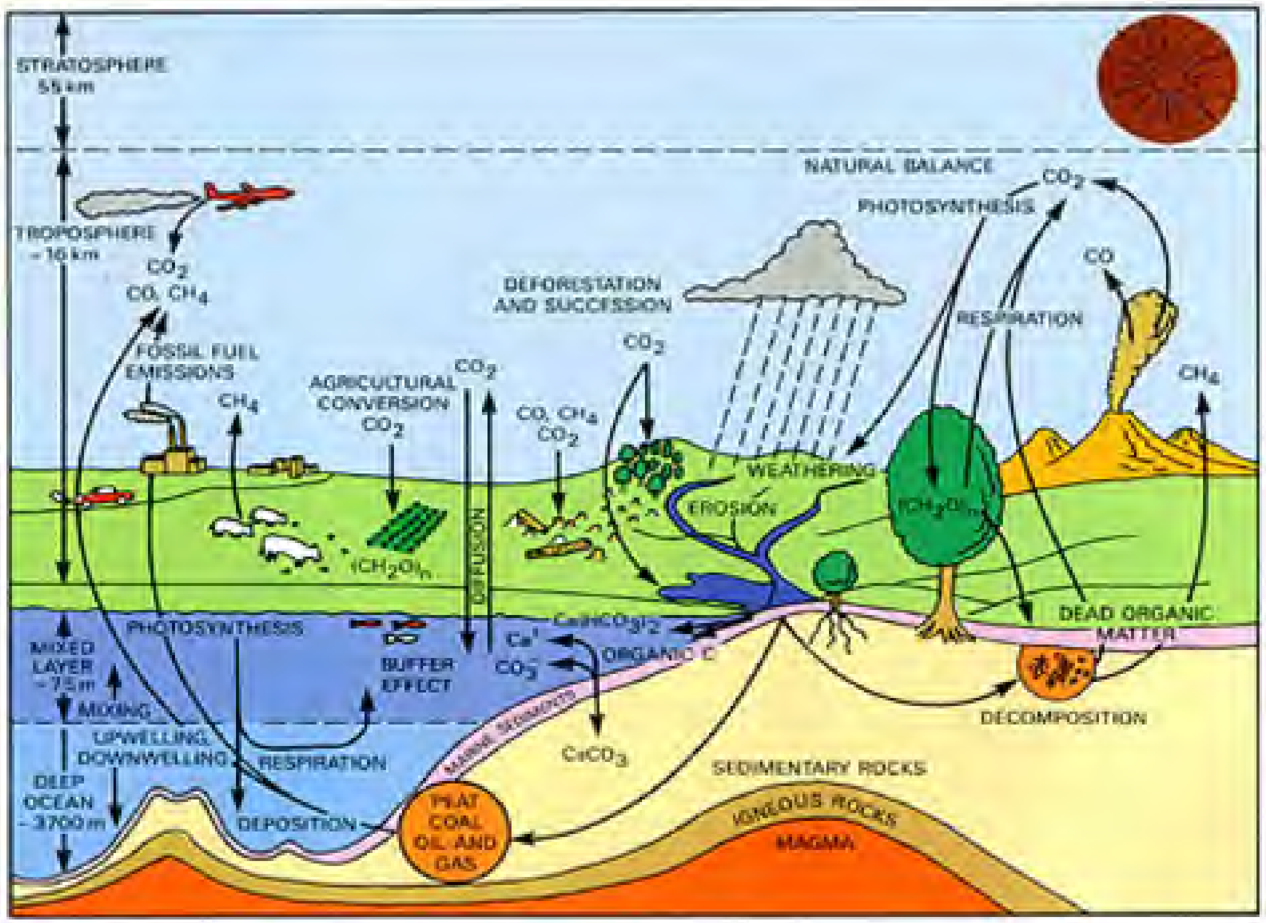
Edgerton, M. D. 2009. *"Increasing Crop Productivity to Meet Global Needs for Feed, Food, and Fuel"*. Plant Physiology:149, pp. 7–13.

Corn Yield Trend & Need

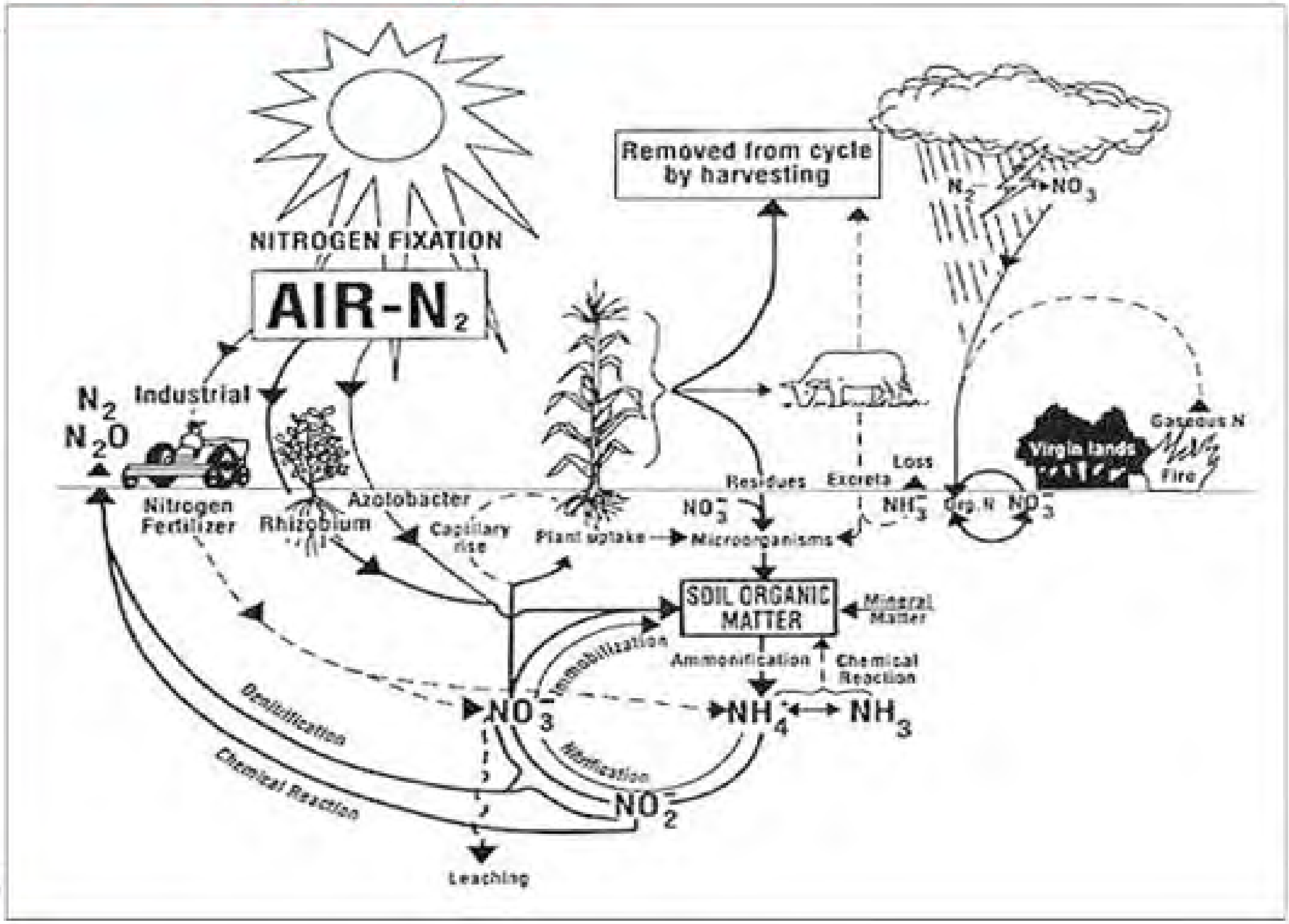


Breaking the 1.8 barrier will require our
best agronomic science + best agronomic management

The Carbon Cycle



The Nitrogen Cycle



Nitrogen Uptake by Growing Corn Plants

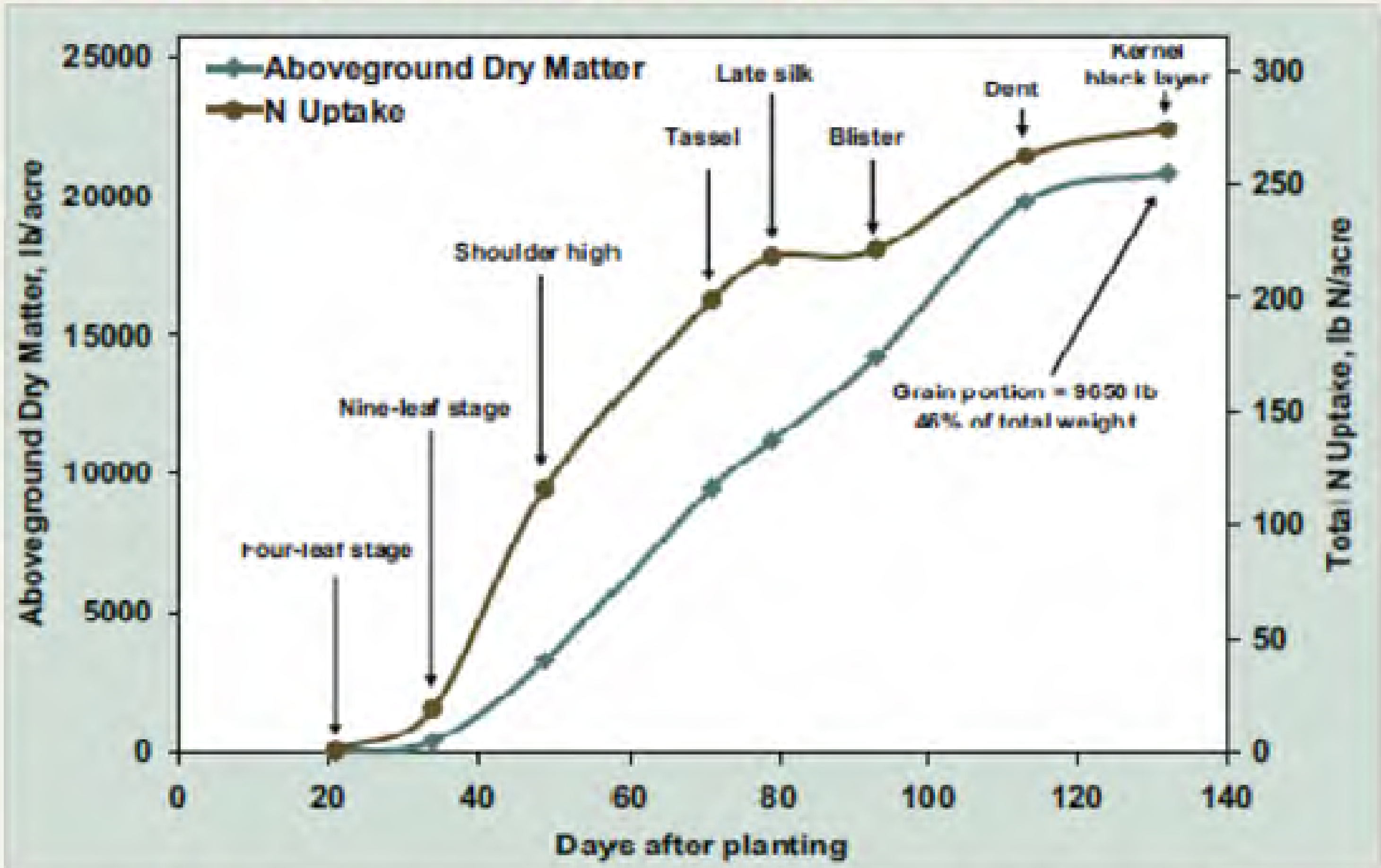


Figure 1. Corn aboveground dry matter accumulation and N uptake for a 204 bu/acre corn crop *(Mengel, 1995)*.

Early passion for high yield corn

Illinois 4-H High Yield Contest---1965

Iroquois County Winner

146 bu/A

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Maximum Yield Think Tank---Indiana mid-1970’s


"Fine tuning . . . removing the next limiting factor"
W. L. Nelson

Purdue 300/100 Project

After 3 years 235/85

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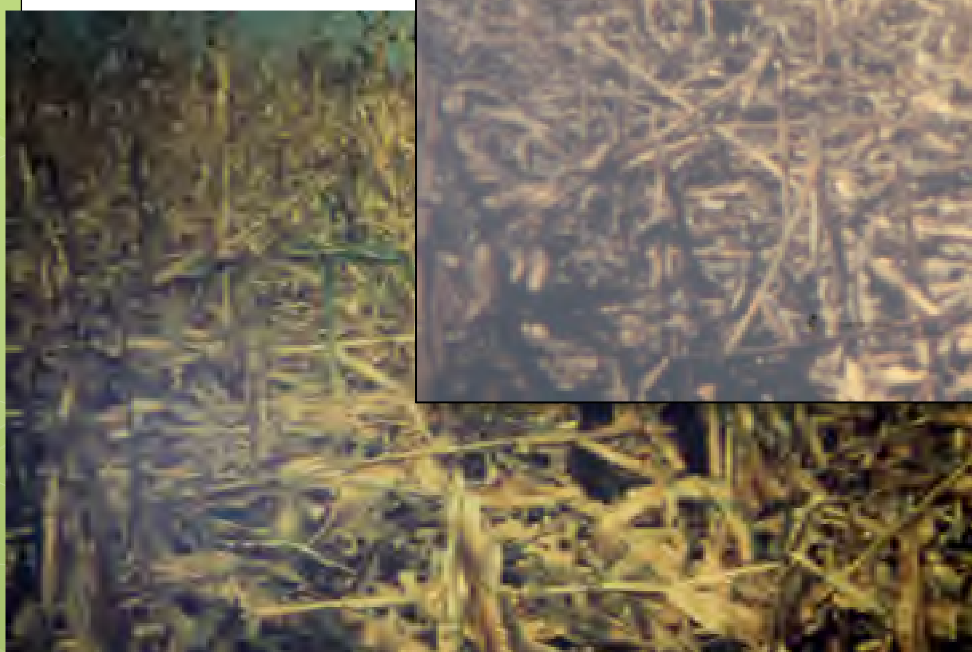

19th Annual National No-Tillage Conference

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185 bu/A 1st year
---previous high was 155 bu/A

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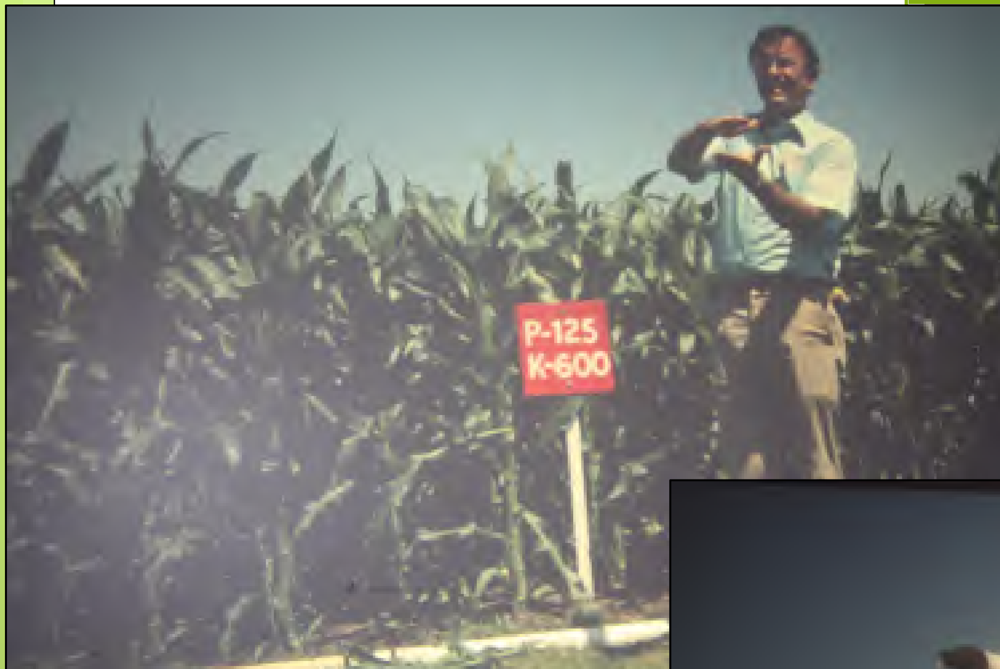

Fred Welch
University of Illinois

307 bu/A

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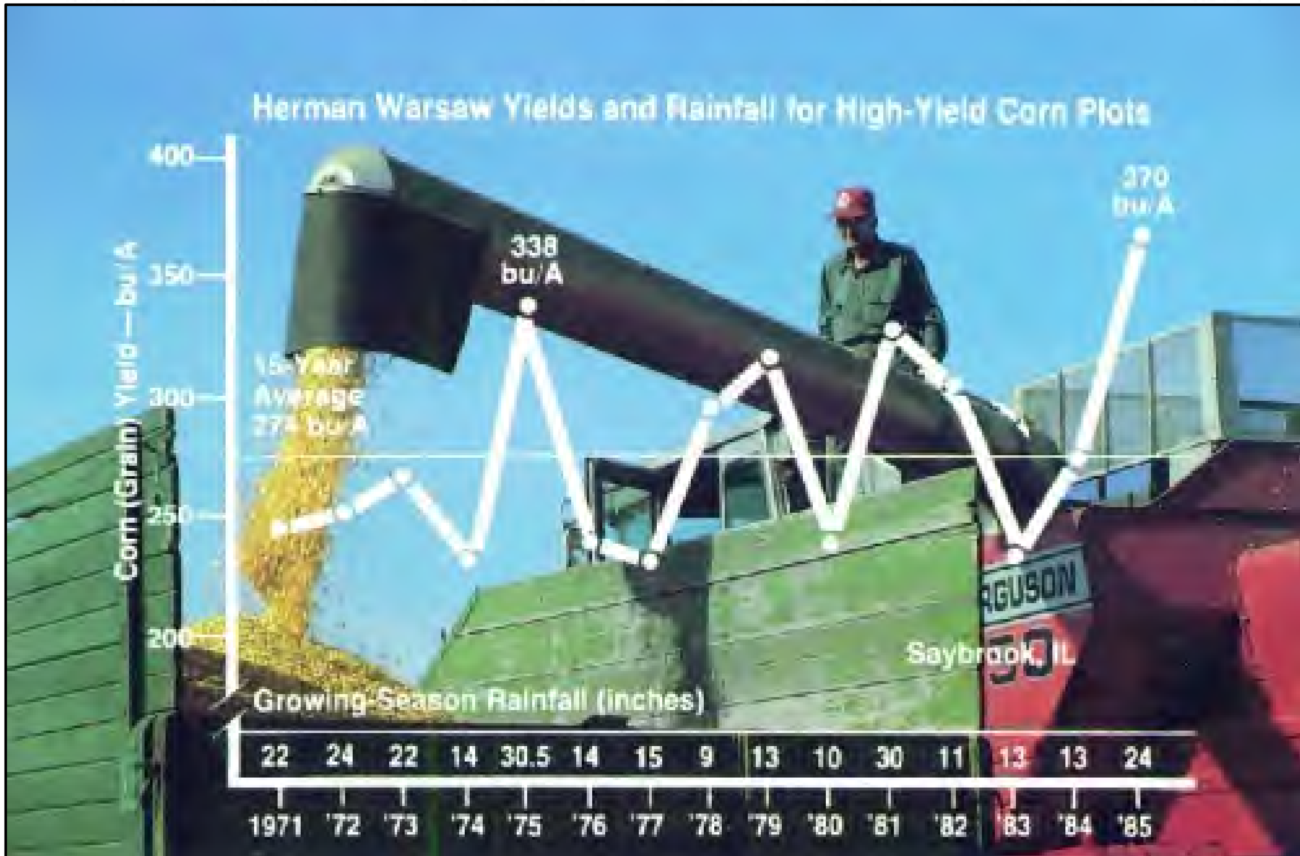
Herman Warsaw---
---World Record Corn Producer



370 bu/A = 23.2 metric tons/ha in 1985

Warsaw's Secret …

- Farm plan designed for specific soil, climate, and management system
- Plan was site-specific…doing the right things for the right reasons in the right place at the right time
- Concept fits anywhere in the world on any crop and soil management system
- "***There is no better fertilizer than a farmers footsteps***"

Reviving High Yield Management

- Increased world demand
- Increased farmer awareness
- Untapped research information
- Better awareness of opportunity through site-specific management
- Better-trained dealers and farmers
- On-farm research
- More efficient use of resources and inputs

Management "Team"

- Farmer
- Resource providers
  - Landowners, farm managers
  - Investors
- Input suppliers
  - Seed, fertilizer, chemicals, machinery
- Information suppliers
  - NRCS, Extension, industry
  - Publications, meetings, field days, <u>internet</u>
- Markets
  - Grain companies, other farmers, <u>consumers</u>

1960s and 1970s

- Build and maintenance
- Expansion of N fertilizer use
  - Started in 1960s---low rate per acre for corn
  - Rapid expansion and rate increase in 1970s

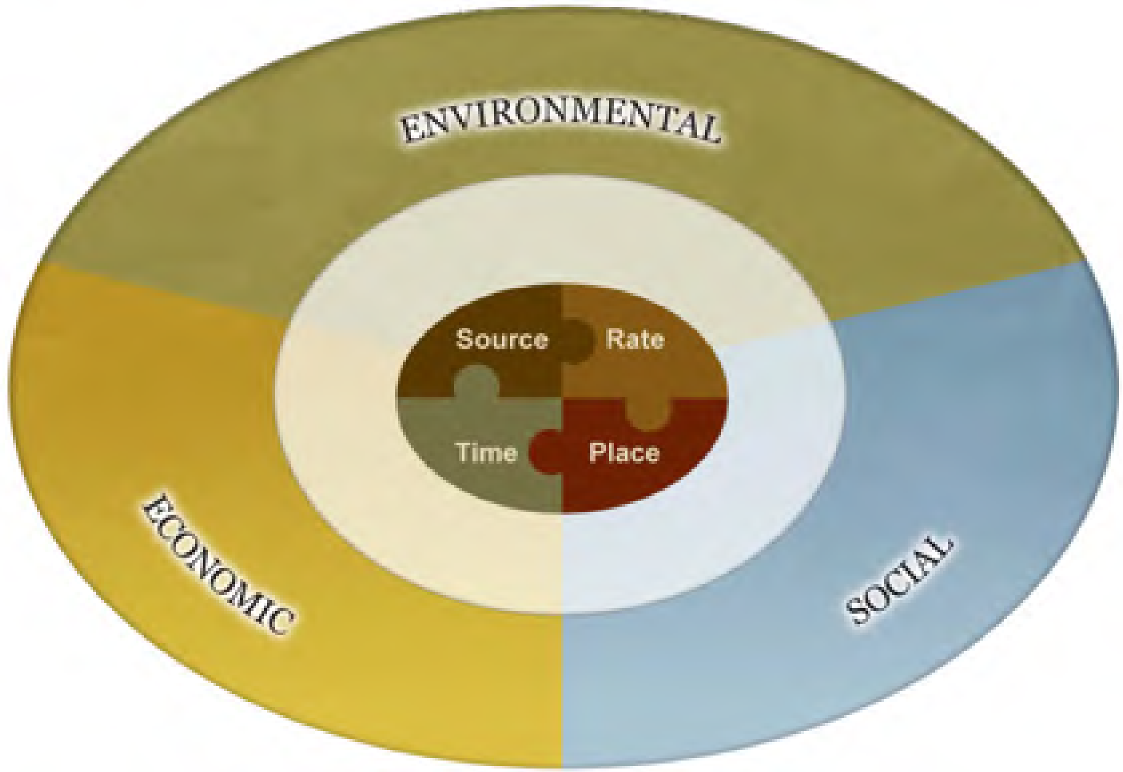
1980s

- "Surplus" production
- Low crop prices
- Cut-back on inputs

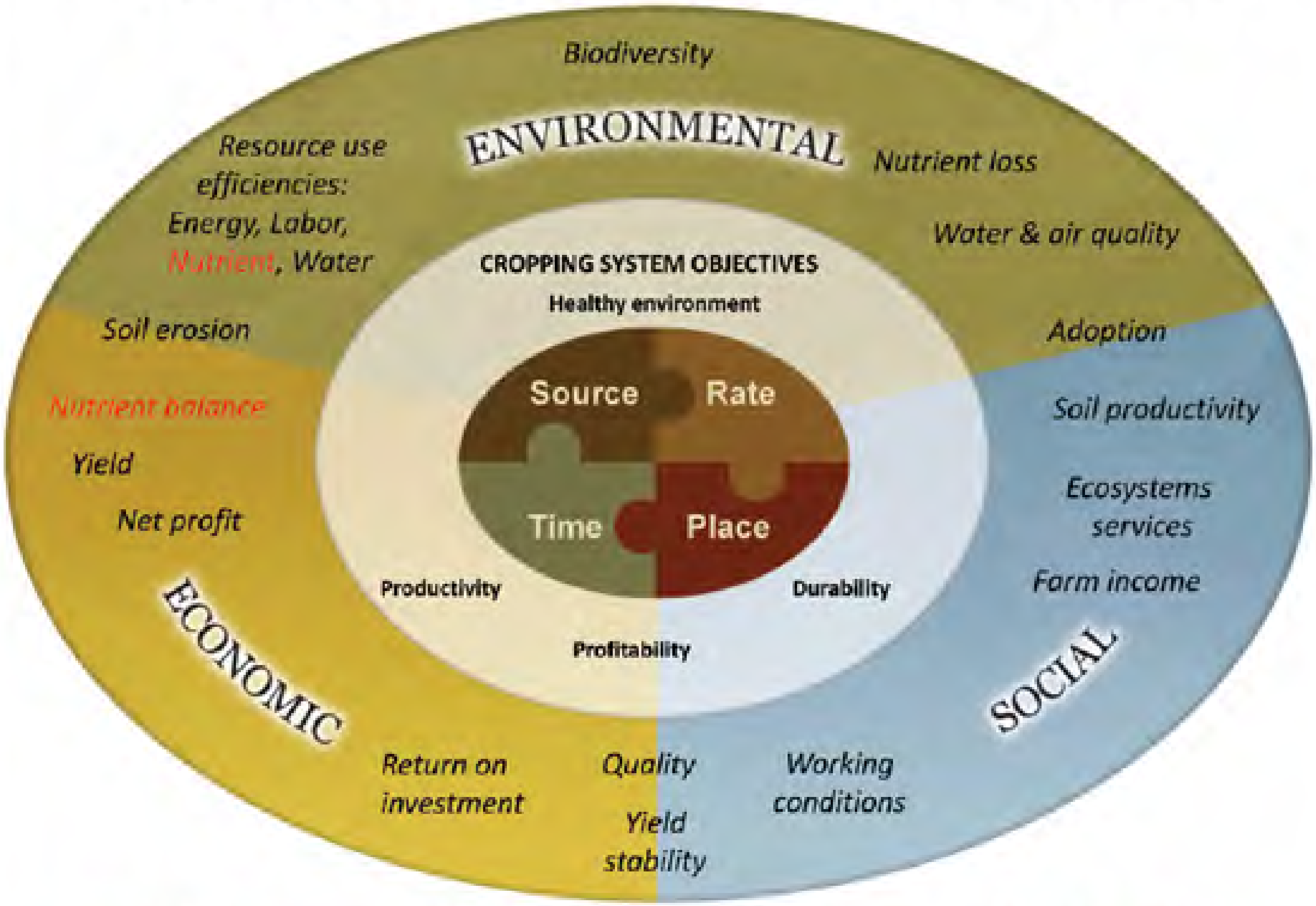
"Right" Nutrient Management

Precision farming …and the various component technologies of precision farming…are essential to "Right" management…to *the **4R System for Fertilizer BMPs***.

Right Source
Right Rate
Right Place
Right Time



4R Nutrient Stewardship: Performance Indicators

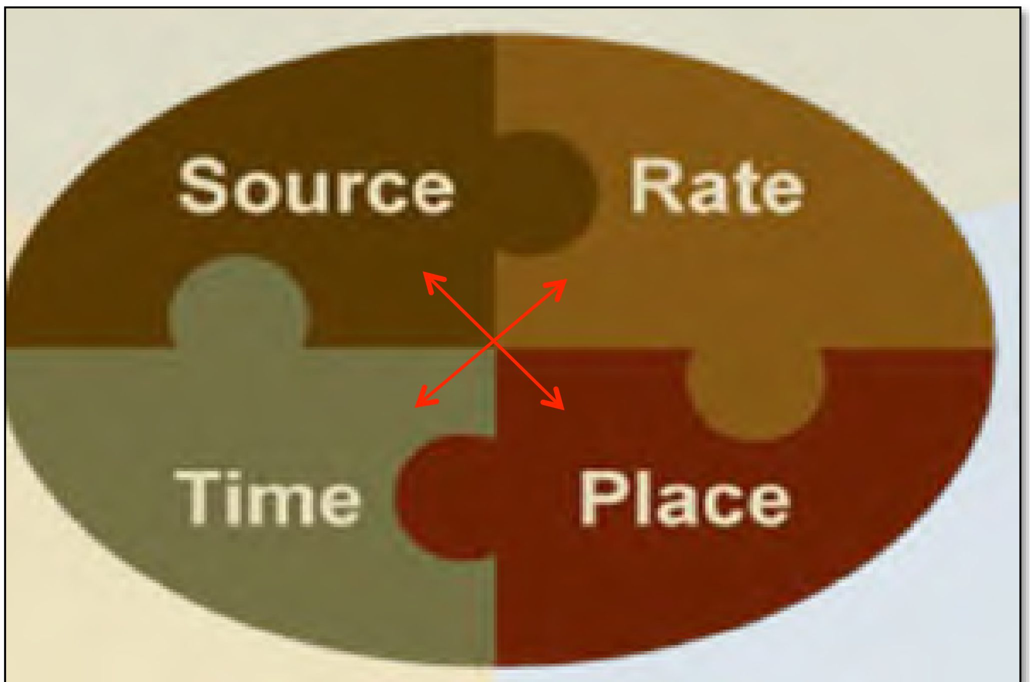


Right Source **at** ***Right Rate, Right Time, Right Place***

Interactions are Important

The right source, rate, time, and place are ***interdependent.***

The 4Rs interact---they **work together** for best management.



Implementing On-Farm Research for Your Farm

- *Every farm should have a research program*
- *Try new management ideas under <u>your</u> conditions*

Why do on-farm research

- Every farm should have an area devoted to research
  - *Locate close to operations center*
  - *Visit it every day*
  - *Take notes and photos*
- To learn more about your management
- To evaluate products and practices under your conditions
- Every field can be a research area

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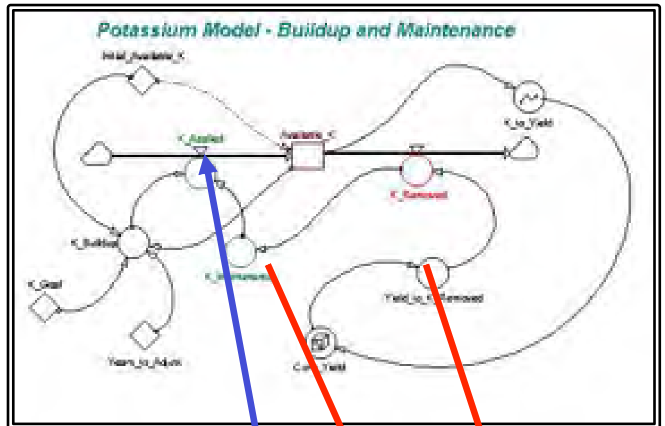
Traub Farm - West of Fairbury, North of 24. 4-6 treatment N Rate studies

Integrating Data from Precision Ag

Precision Agriculture tools include more than equipment. The real power of precision ag is in **decision support** --- integrating data, models, GIS maps, etc., to support better-informed management decisions.



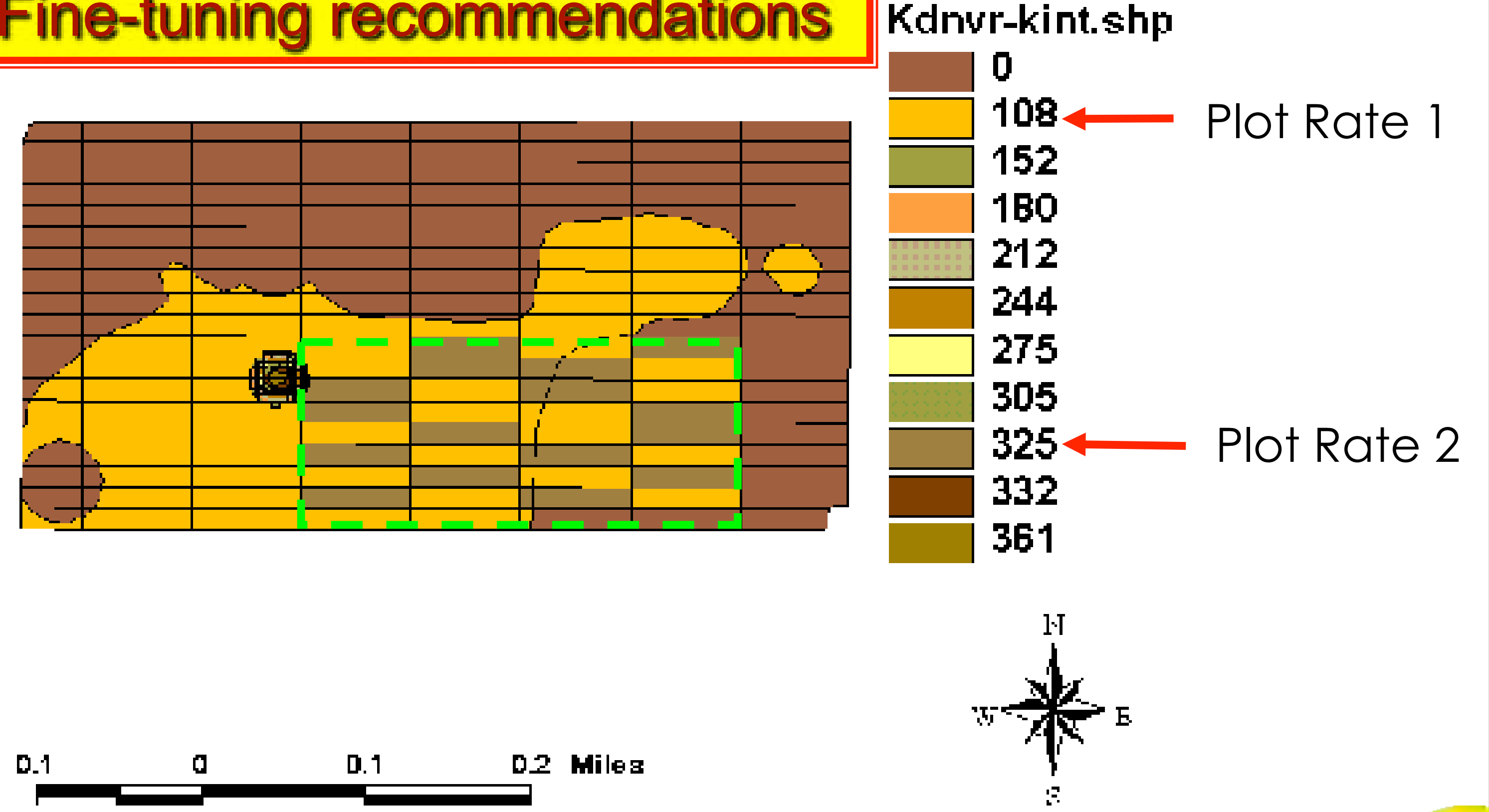
Potassium Model - Buildup and Maintenance

year	Available_K	K_Applied	K_Removed	Corn_Yield	K_Buildup	K_Maintenance
1	120.00	80.28	35.28	128.00	45.00	35.28
2	165.00	83.12	38.12	136.13	45.00	38.12
3	210.00	84.90	39.90	142.50	45.00	39.90
4	[illegible]	86.06	41.06	148.63	45.00	41.06
5	300.00	41.50	41.50	148.20	0.00	41.50
6	300.00	41.50	41.50	148.20	0.00	41.50
7	300.00	41.50	41.50	148.20	0.00	41.50
8	300.00	41.50	41.50	148.20	0.00	41.50
9	[illegible]	41.50	41.50	148.20	0.00	41.50
10	300.00	41.50	41.50	148.20	0.00	41.50

On-Farm Research

-Building a local database

-Fine-tuning recommendations



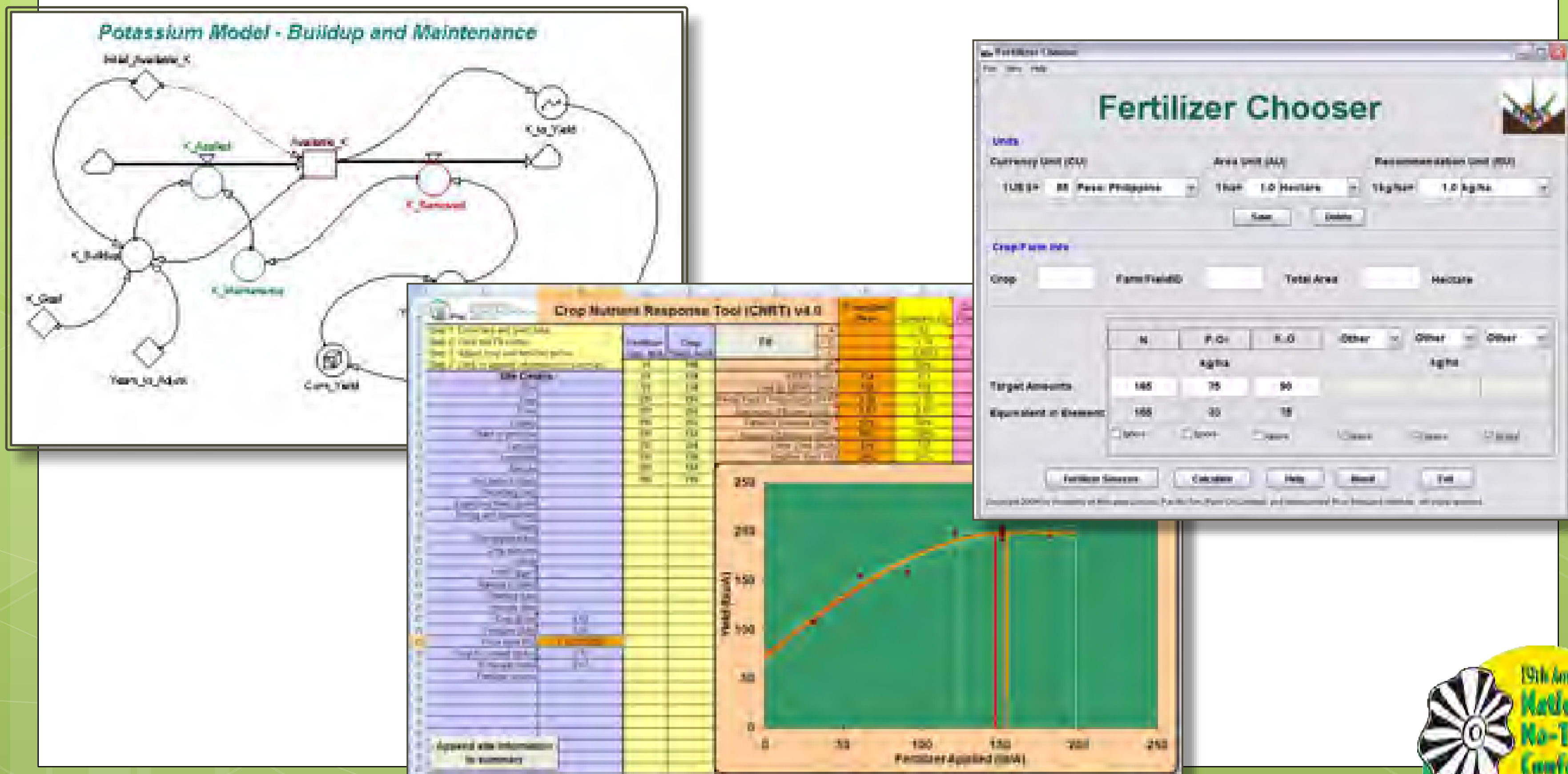
Are Our Soil Test Goals Adequate for High Yield Systems?

Treatment	P_1 Soil Test (ppm)	K Soil Test (ppm)	Corn Yield (bu/A)	P_1 Soil Test (ppm)	K Soil Test (ppm)	Soybean Yield (bu/A)
Standard P and K Soil Tests	20	161	152	32	184	57
High P and K Soil Tests	32	237	190	41	222	57

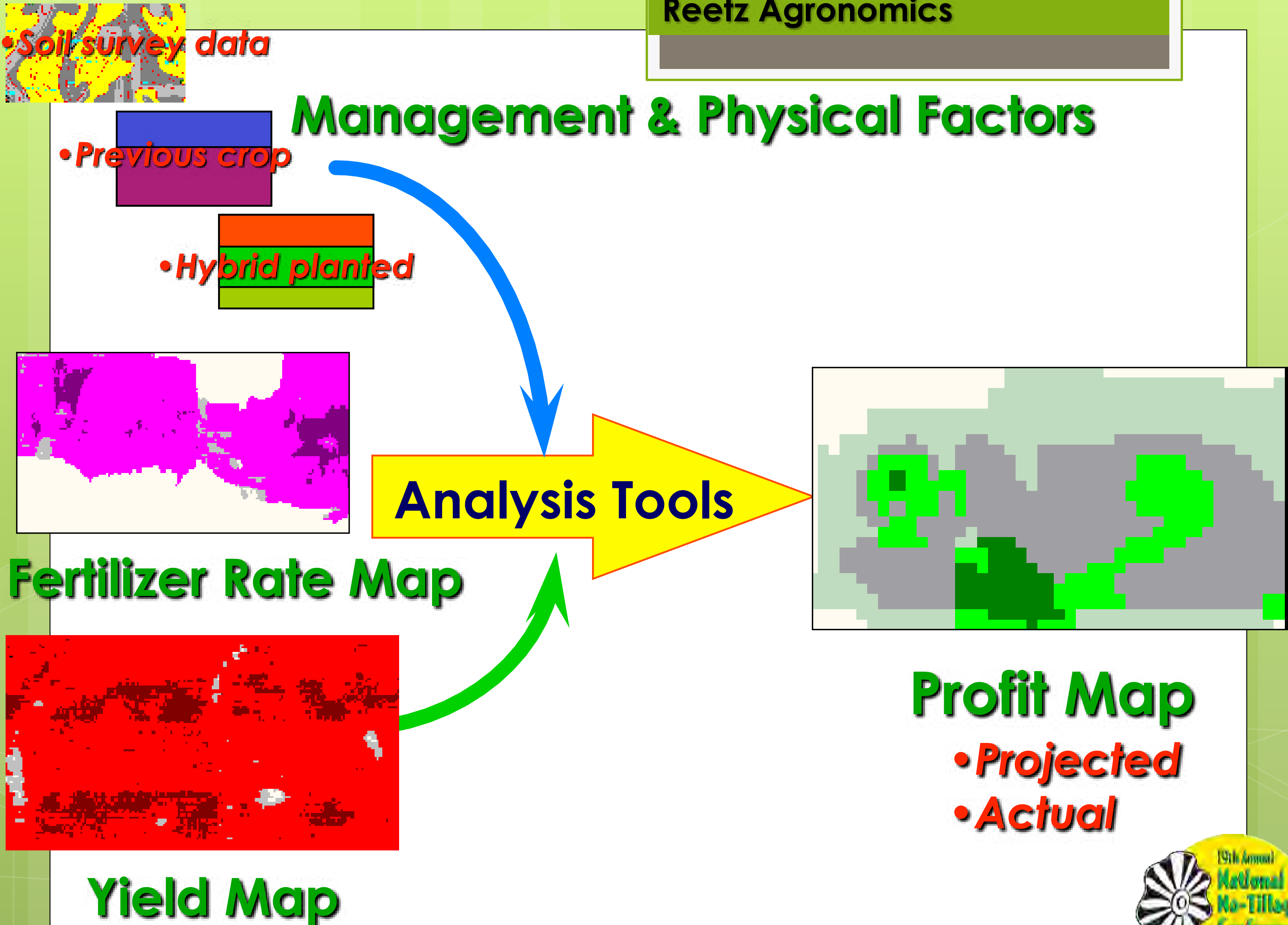
38 bu/A (2.3 T/ha) more corn!!

Decision Support Systems

- **Decision-support tools** help us to fully realize the value of the databases, whether generated on-farm or obtained from other sources.



Management & Physical Factors



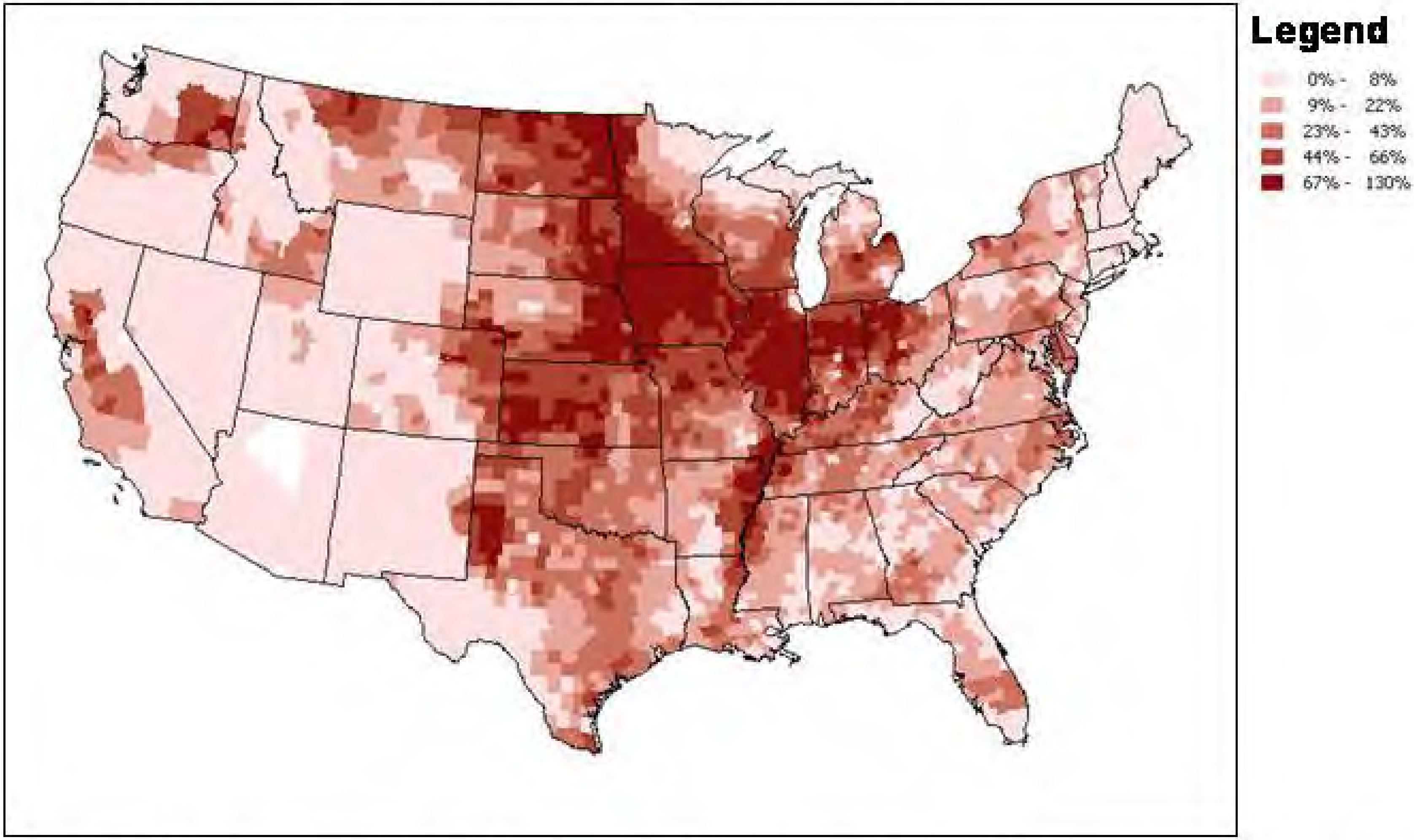
InfoAg 2011

July 12-14, 2010
Springfield, Illlinois
www.infoag.org

Speakers—Exhibits--Networking

Nutrient Use GIS

Acres of Total Cropland as a Percentage of Land Area



The acres of total cropland as a percentage of land area in acres. A value of zero may represent a zero data value or may mean that no data are available for the county. The percentage values may be greater than 100 because the land area in acres is calculated as the land within the county and the acres of total cropland are calculated for the entire farm, which may include parts of more than one county. (Source: National Atlas of the United States)

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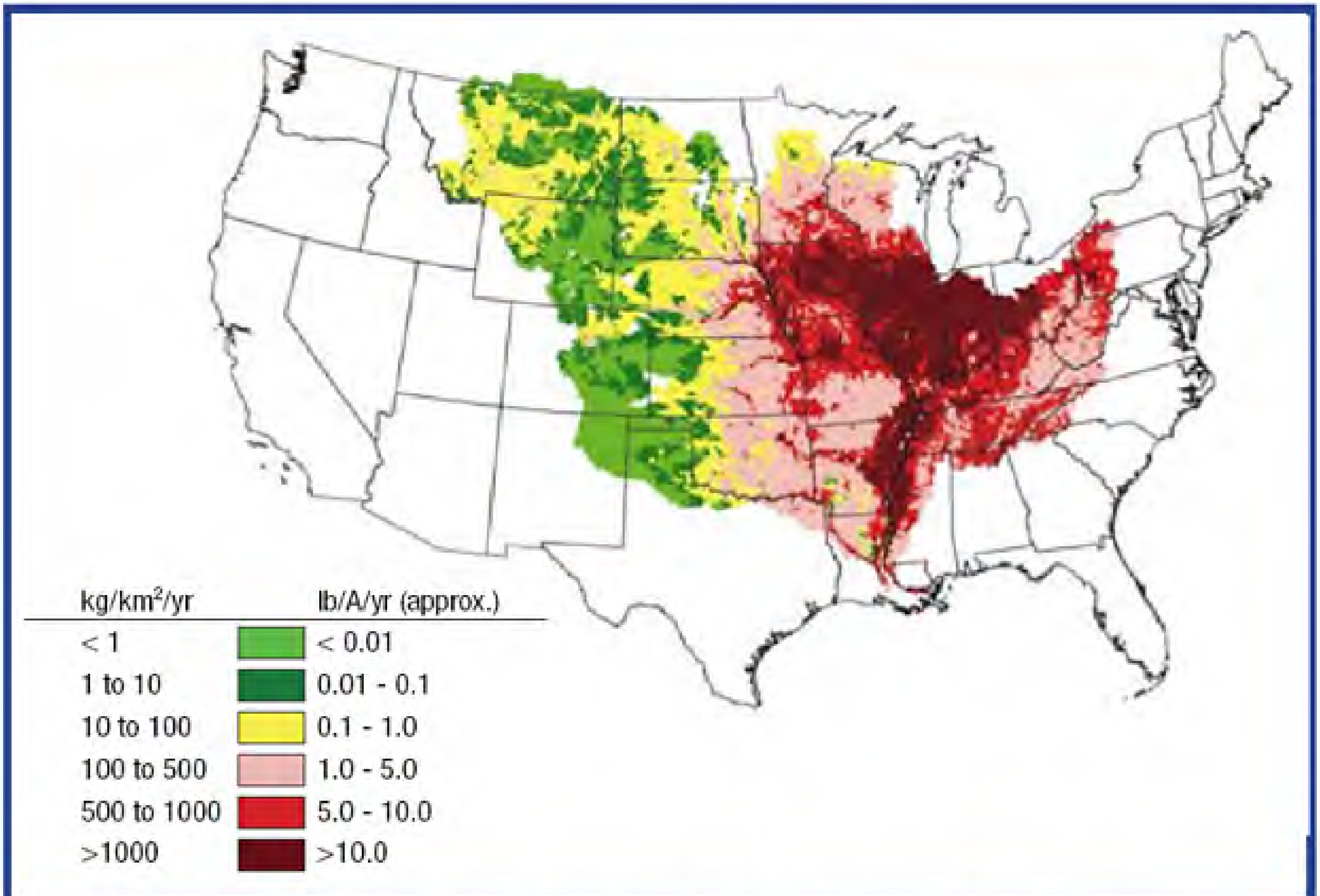

Figure 3.5. Estimated total N delivery to the Gulf of Mexico from different watersheds within the Mississippi River Basin. (Data source: USGS and Alexander et al., 2008).

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NuGIS

Nutrient Use Geographic Information System

Watershed P_2O_5 Nutrient Budget

Data Sources

- NASS — crop data (acres planted, acres harvested, yield, production)
- IPNI --- Crop removal rates
- NRCS --- recoverable manure
- AAPFCO --- county fertilizer sales

Calculations (by County)

- Total crop acres
- Acres by crop
- % acres by crop
- Ratio of cropland acres to total acres

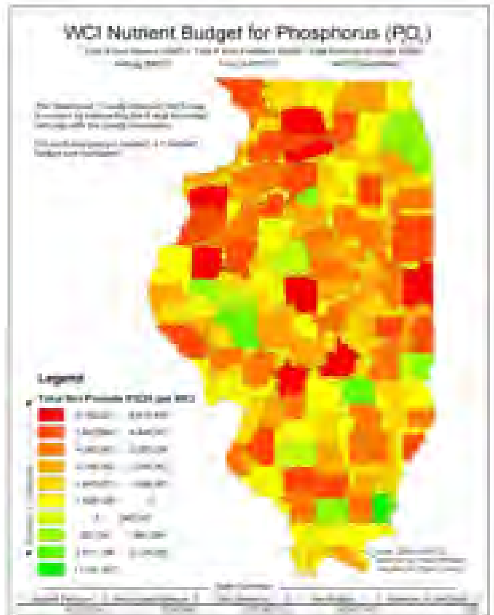
Spatial Analysis

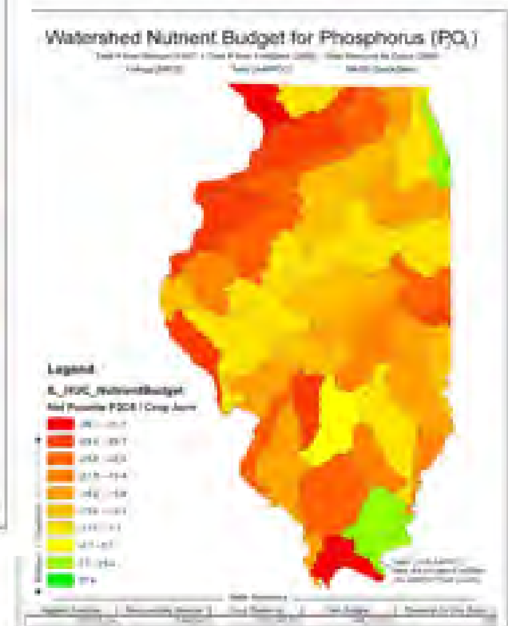
- Tabulate data and import into ArcGIS
- Join the data to the map
- Intersect with watershed map

Aggregating Data to Watershed Level

- Summing watershed county intersect (WCI) for fertilizer, manure, and removal
- Fertilizer + Manure - Removal

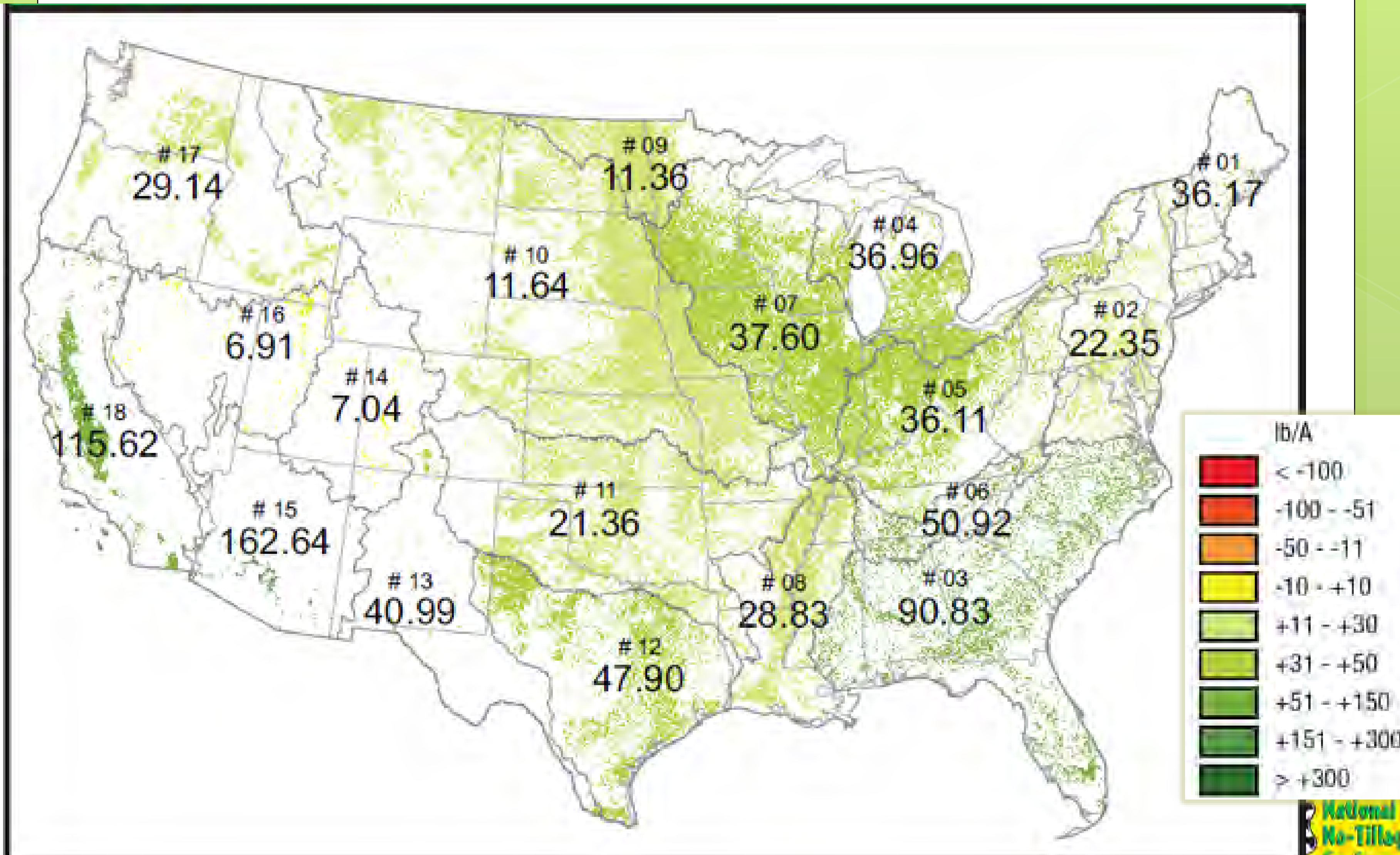
This is an example of the kind of nutrient use analysis that is possible where county-level data are available.





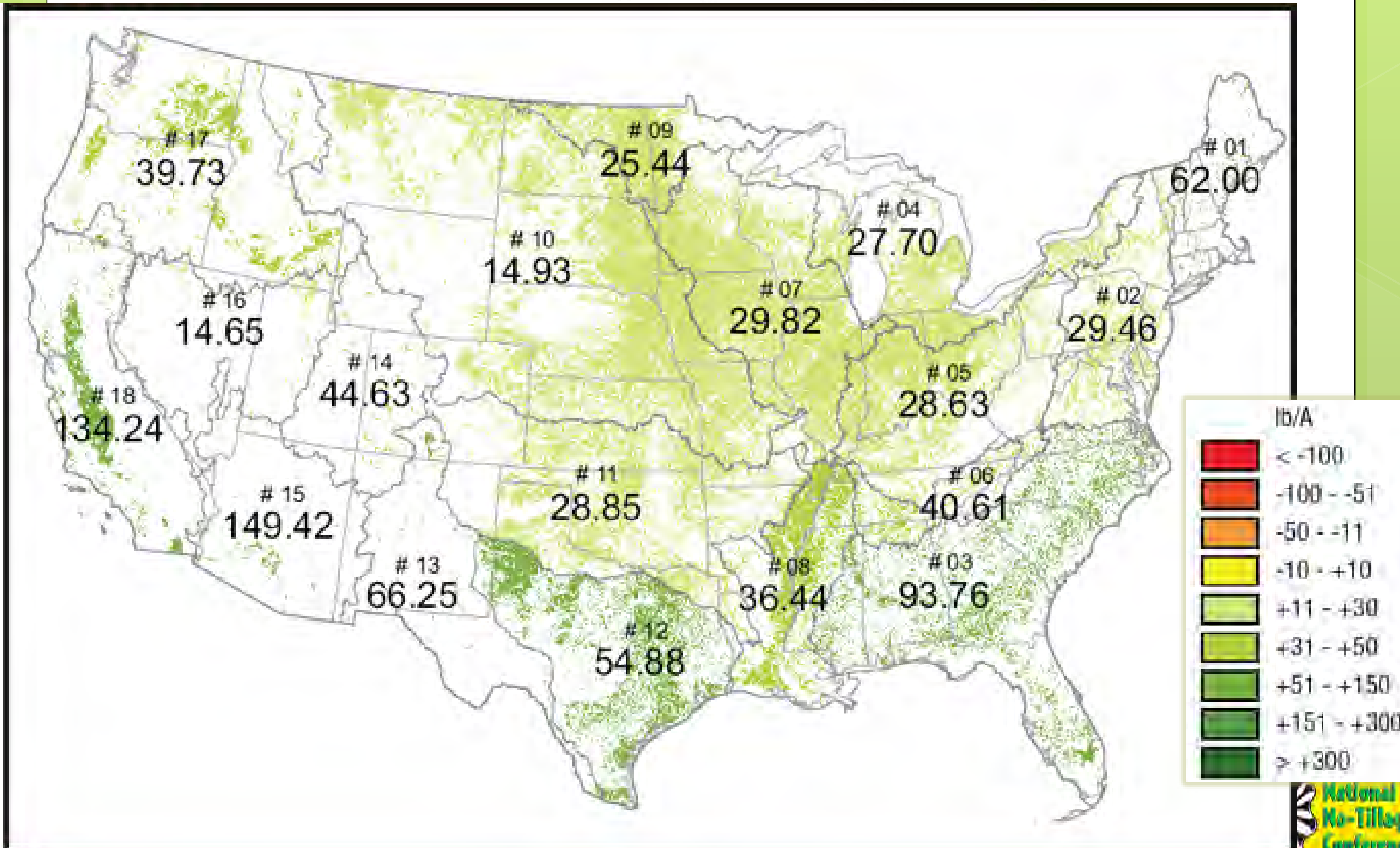
19th Annual National No-Tillage Conference

Partial N balance by hydrologic region, 1987.



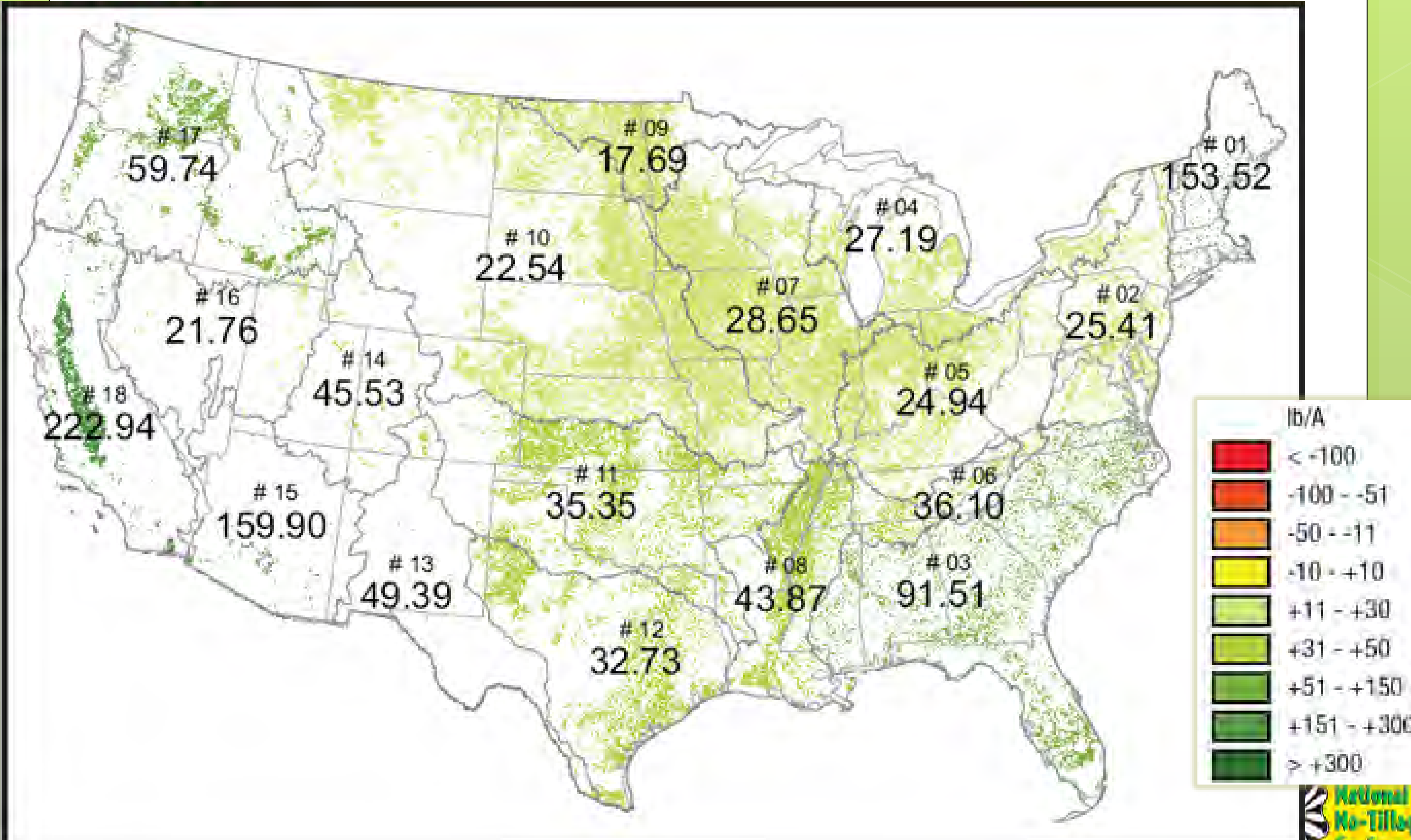
IPNI, 2010

Partial N balance by hydrologic region, 1997.



IPNI, 2010

Partial N balance by hydrologic region, 2007.



IPNI, 2010

Reetz Agronomics

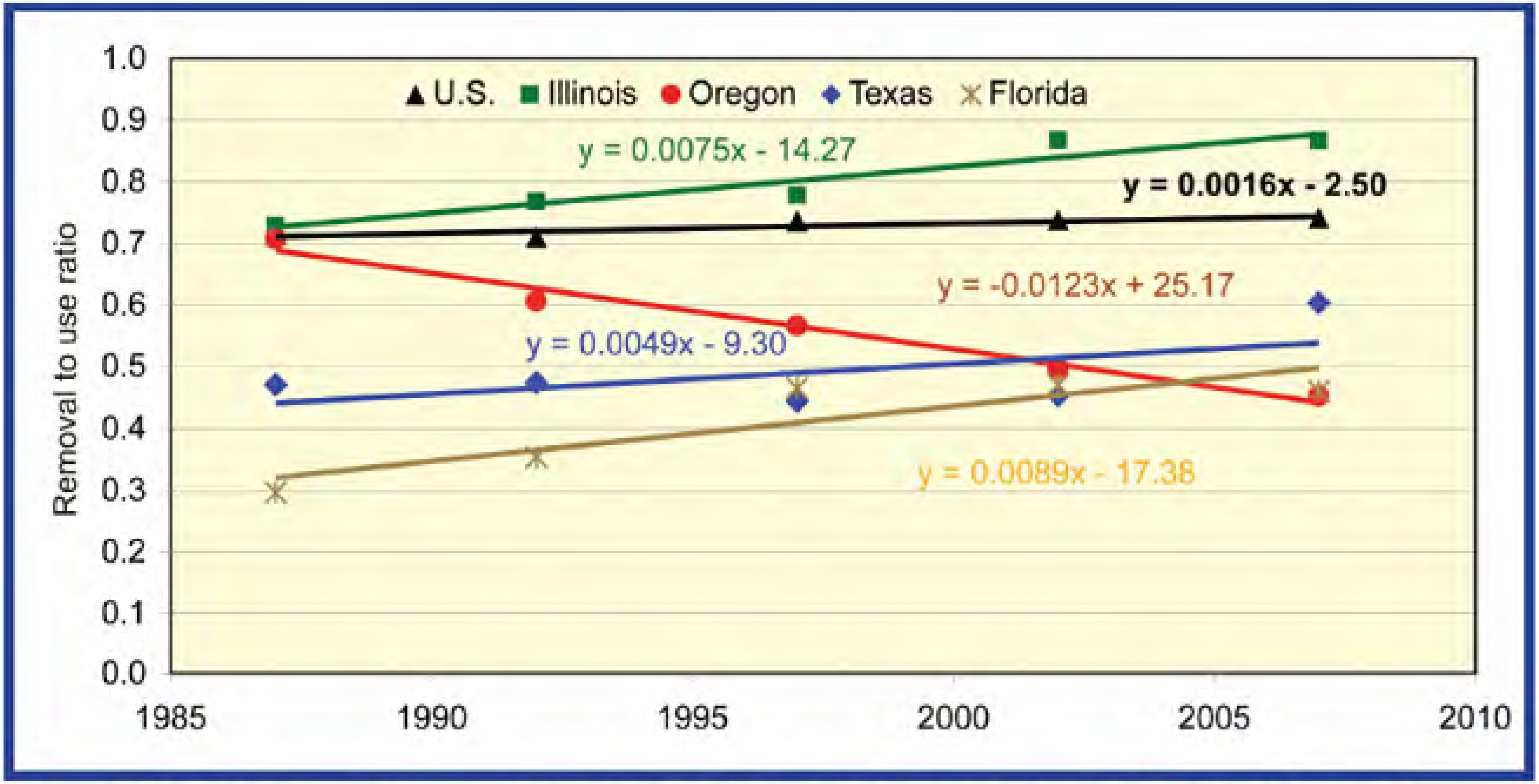


Figure 3.7. Nitrogen removal to use ratios for the U.S. and selected states, 1987-2007.

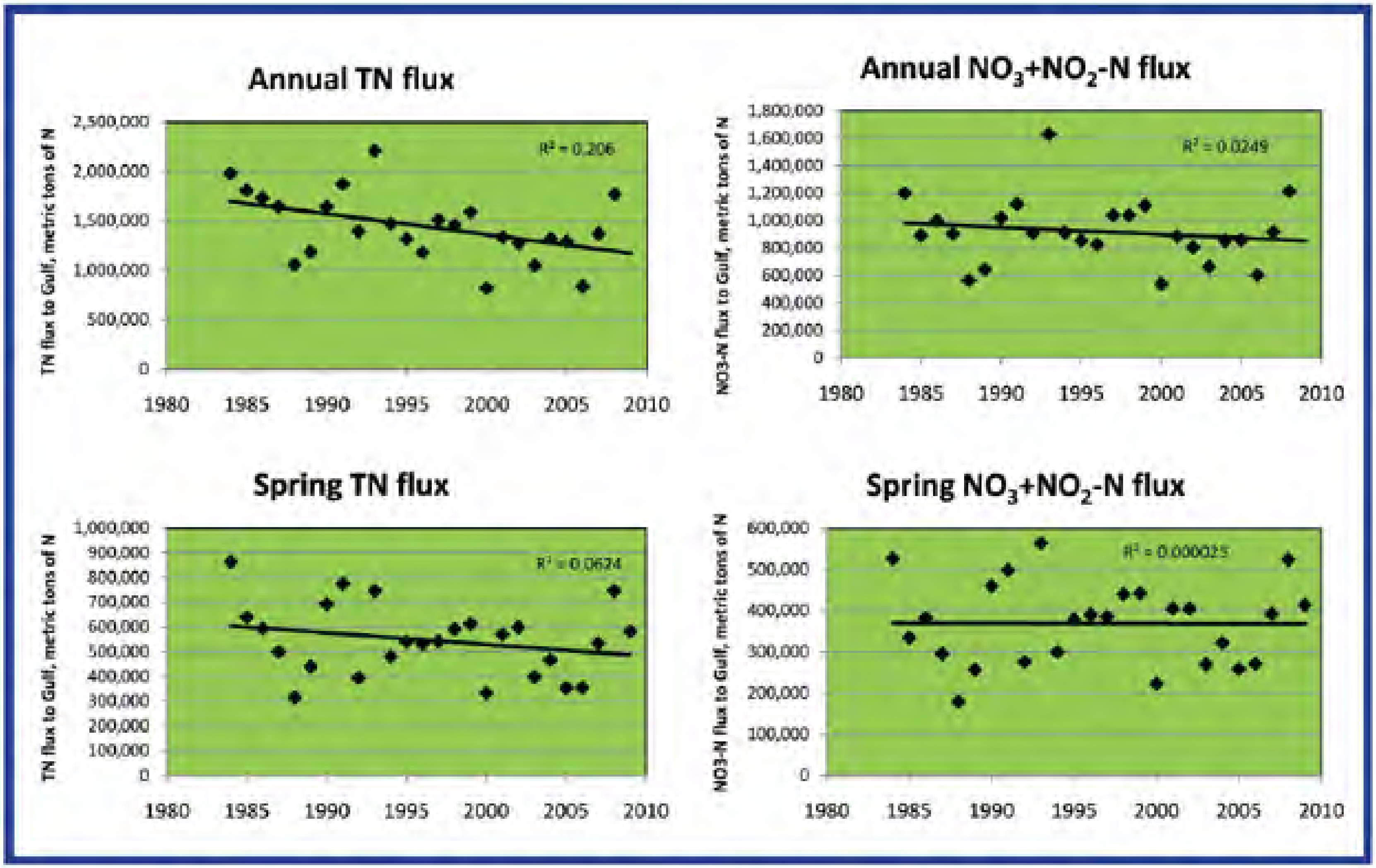


Figure 3.6. Trends in total N (TN) and nitrate N ($NO_3 + NO_2$ - N) flux to the Gulf of Mexico, annually and during the spring (April-June).

(Data source:

USGS, http://toxics.usgs.gov/hypoxia/mississippi/nutrient_flux_yield_est.html)

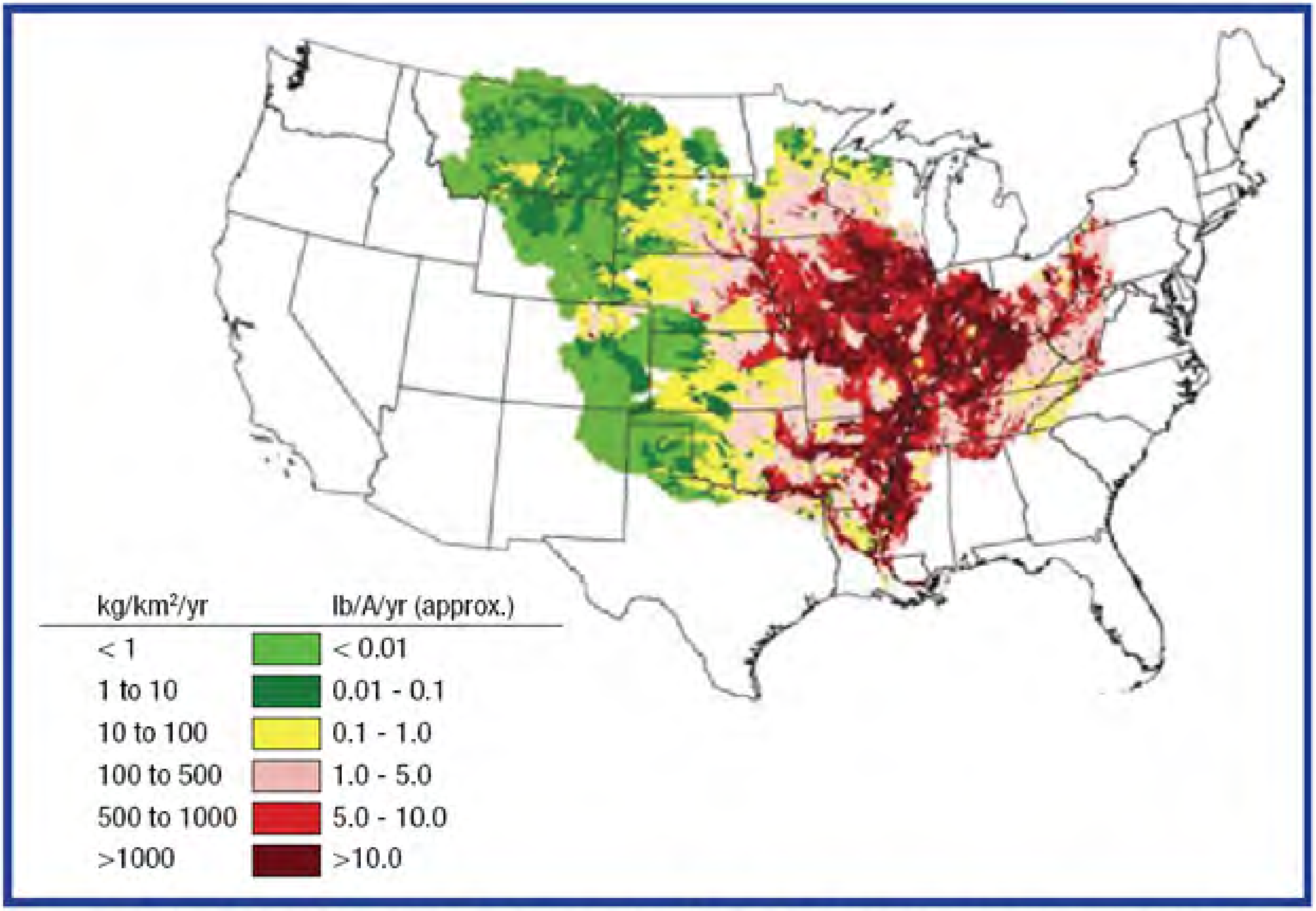


Figure 4.8. Estimated total P delivery to the Gulf of Mexico from different watersheds within the Mississippi River Basin. (Data source: USGS and Alexander et al., 2008).

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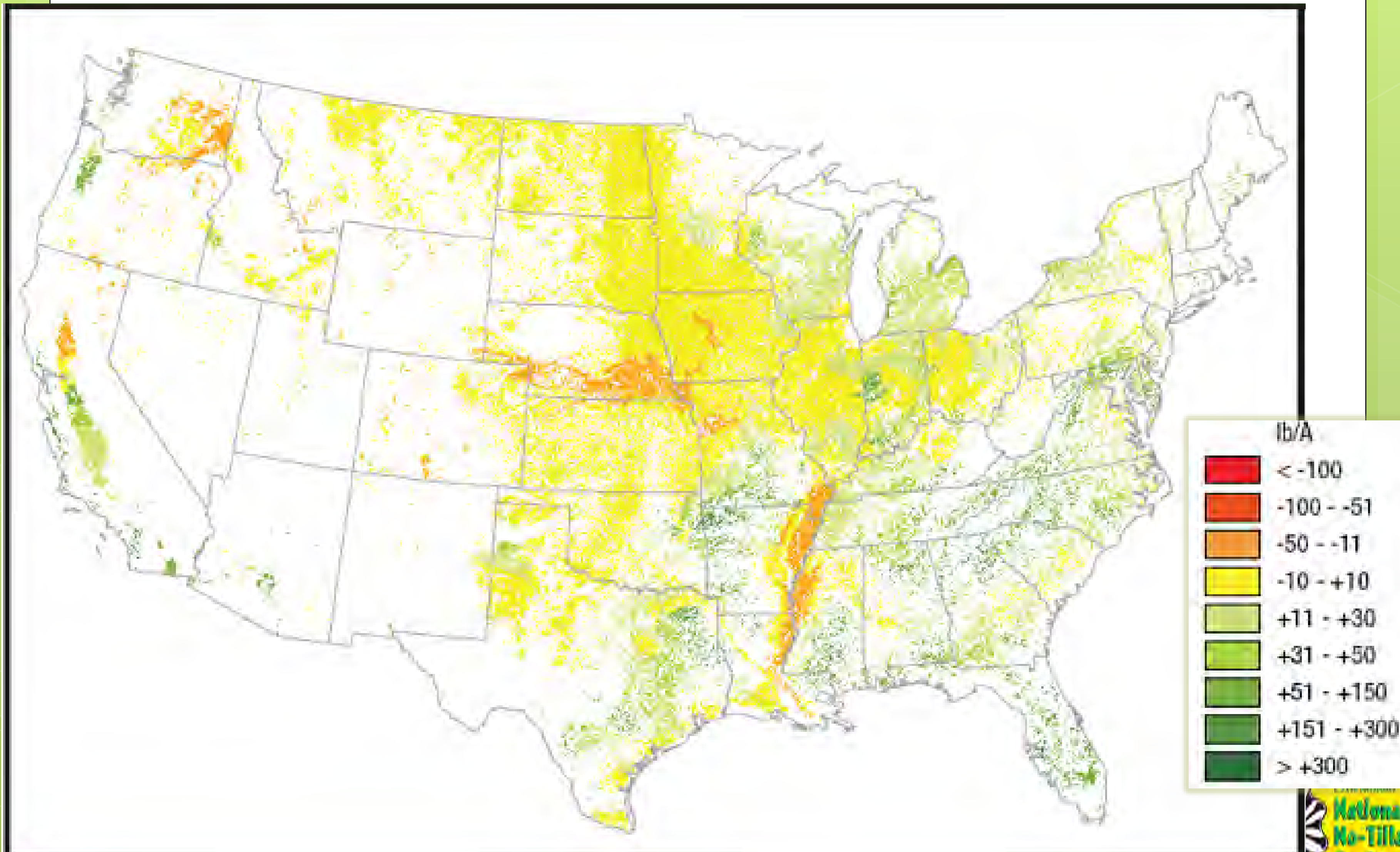
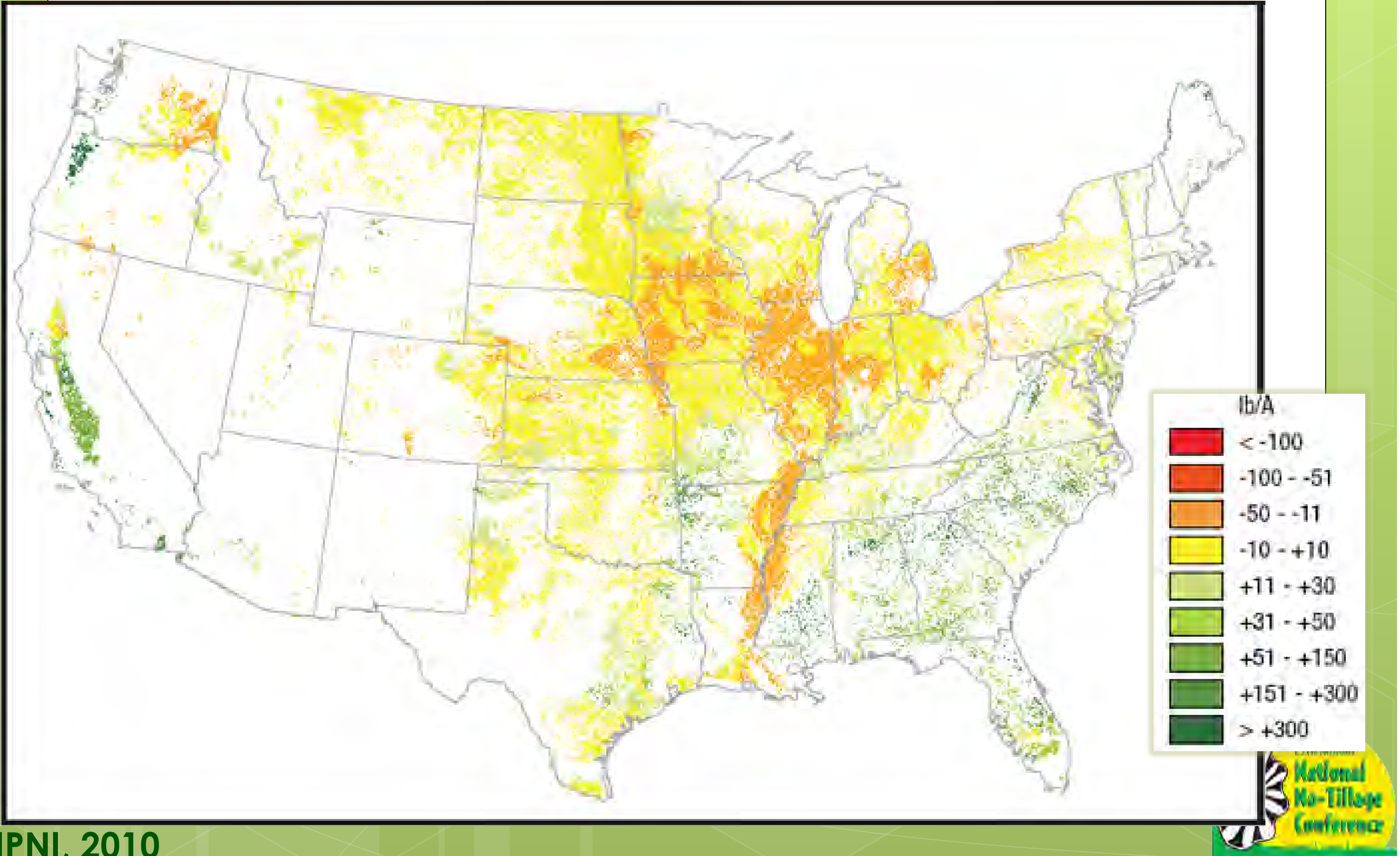
Estimated P balance by watershed, 1987 as lb/planted acre.



IPNI, 2010

Reetz Agronomics

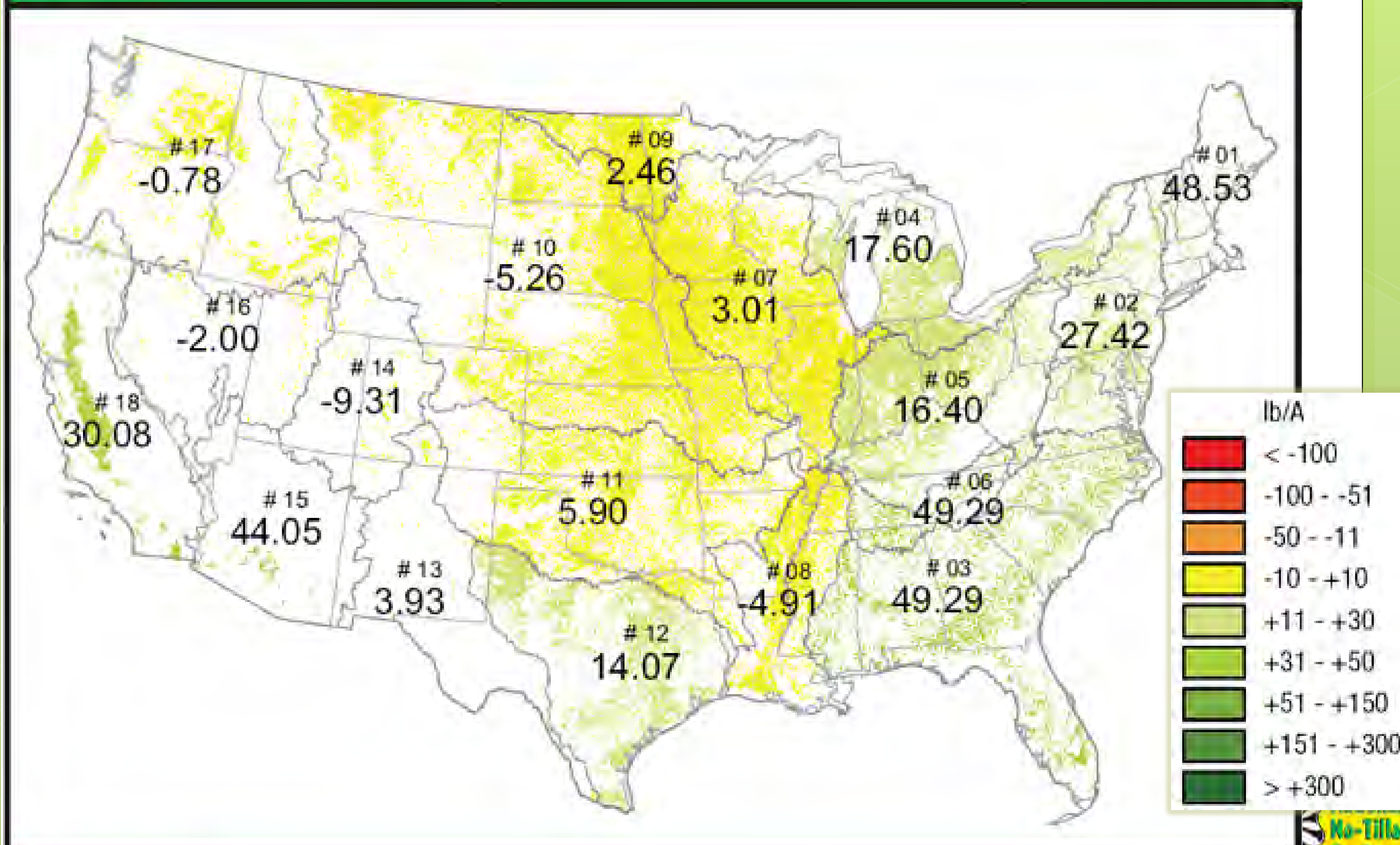
Estimated P balance by watershed, 2007 as lb/planted acre.



IPNI, 2010

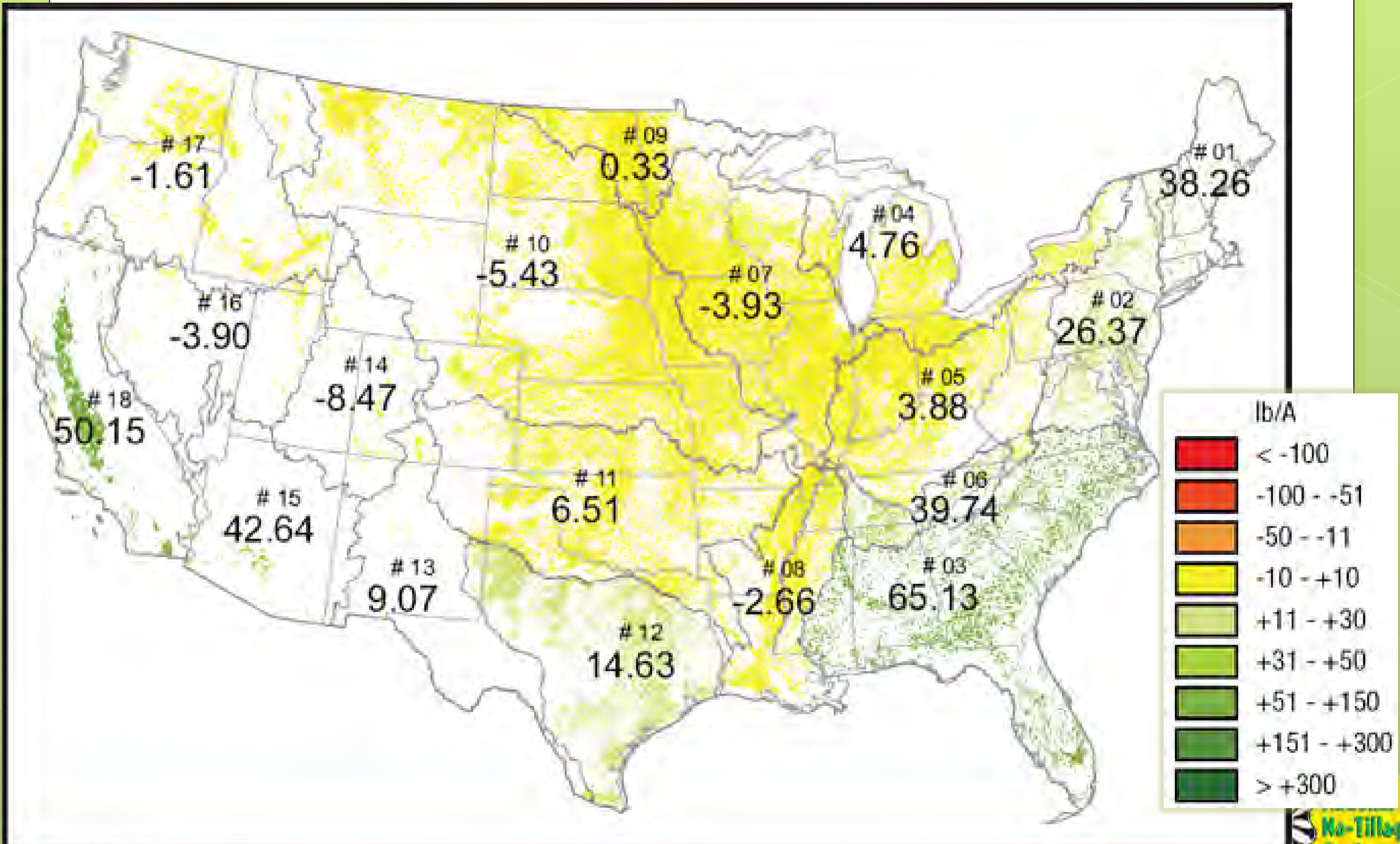
Reetz Agronomics

Partial P balance by hydrologic region, 1987.



IPNI, 2010

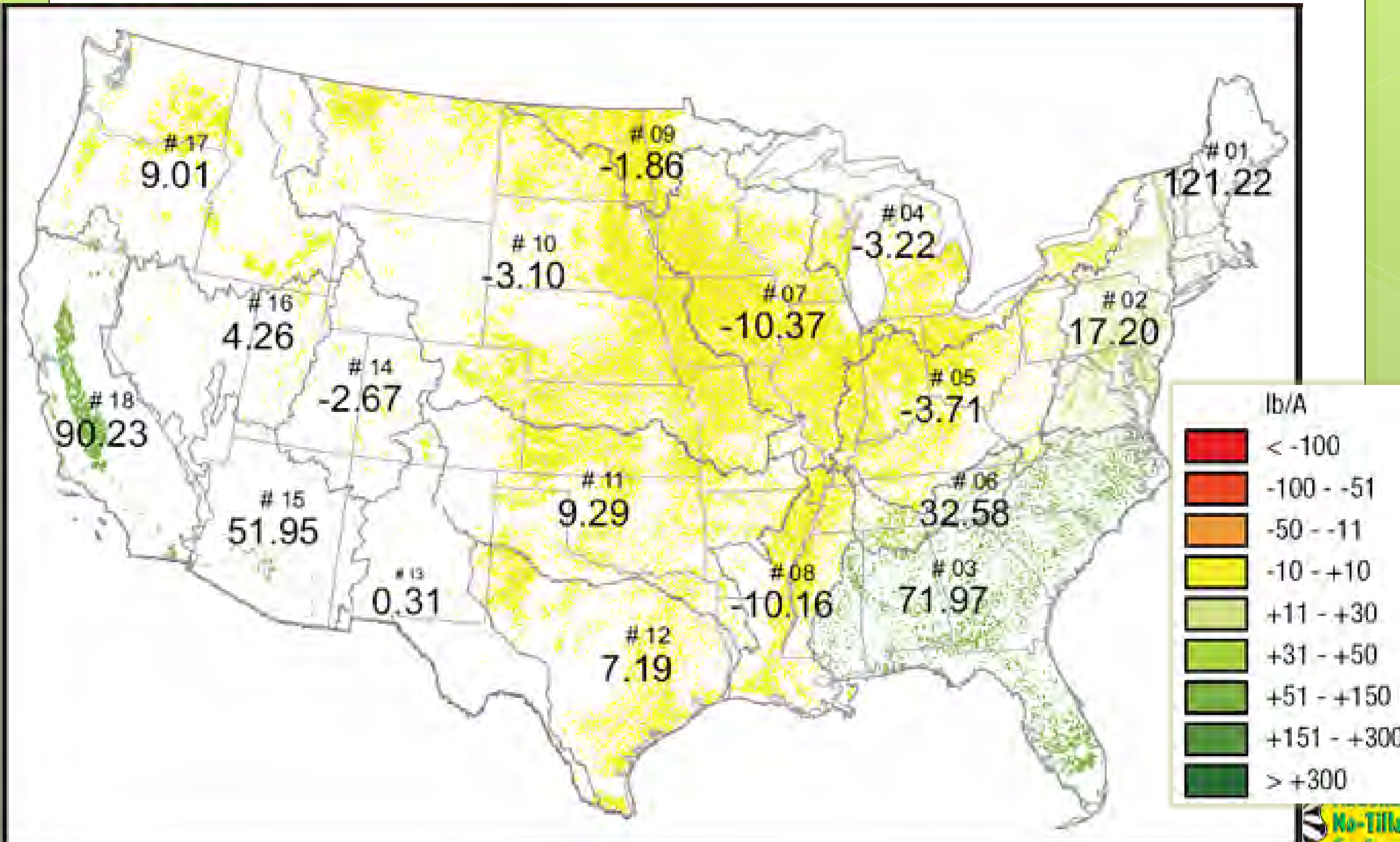
Partial P balance by hydrologic region, 1997.



IPNI, 2010

Reetz Agronomics

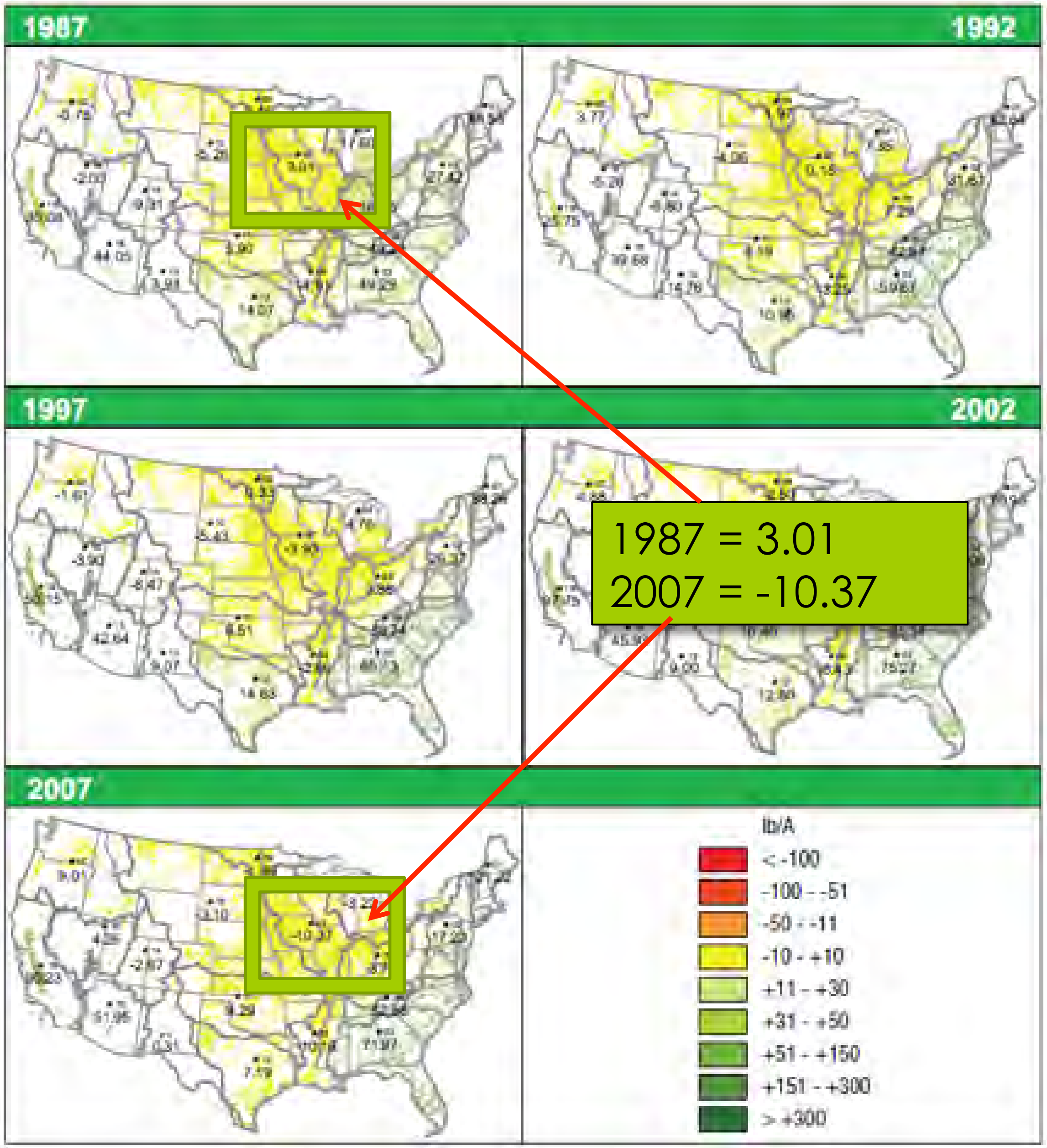
Partial P balance by hydrologic region, 2007.



IPNI, 2010

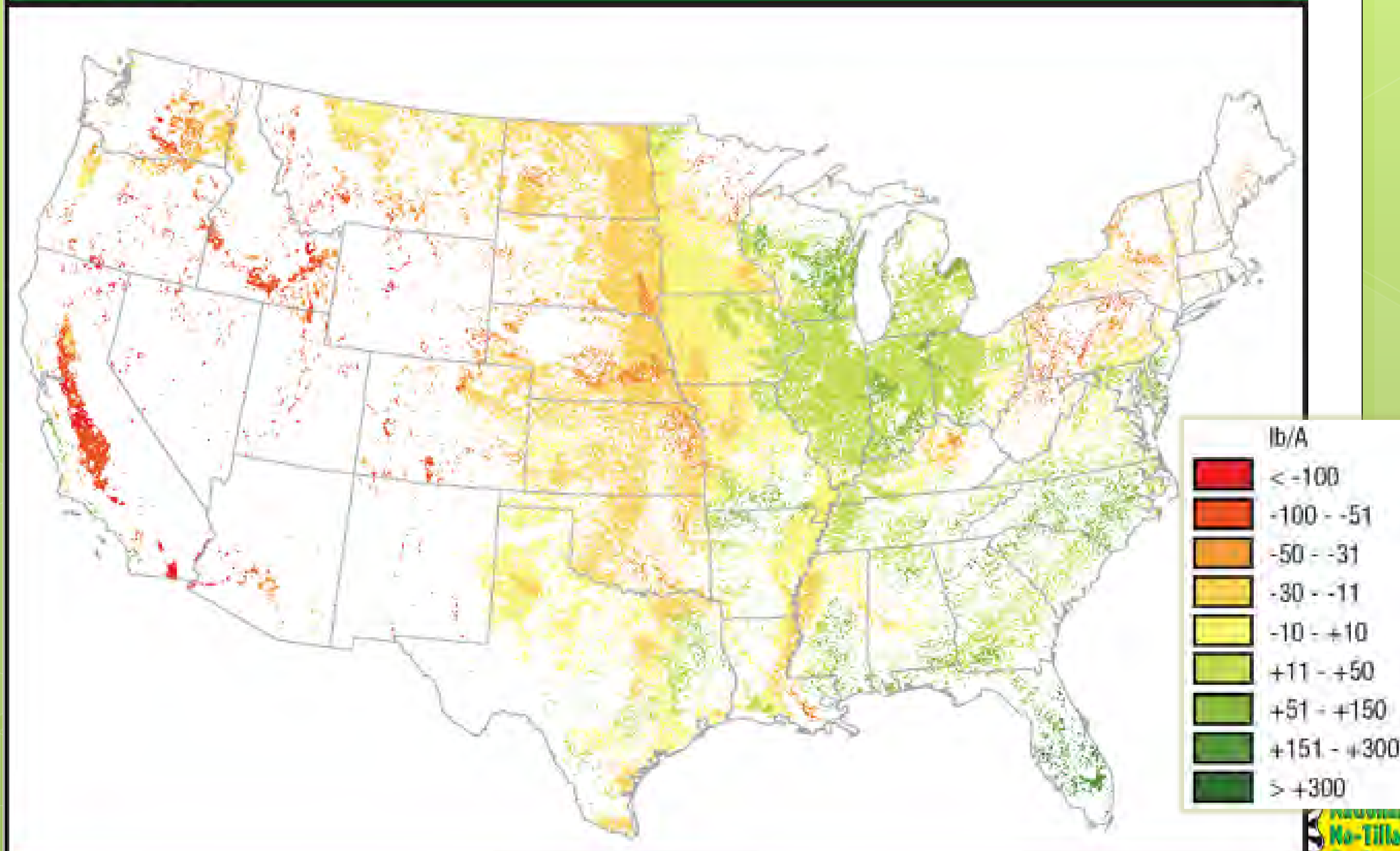
Figure 4.3. Partial P balance by hydrologic region, 1987-2007

(fertilizer + recoverable manure nutrients - nutrient removal by crops, expressed as lb P_2O_5/planted acre)



1987 = 3.01
2007 = -10.37

Estimated K balance by watershed, 1987.



IPNI, 2010

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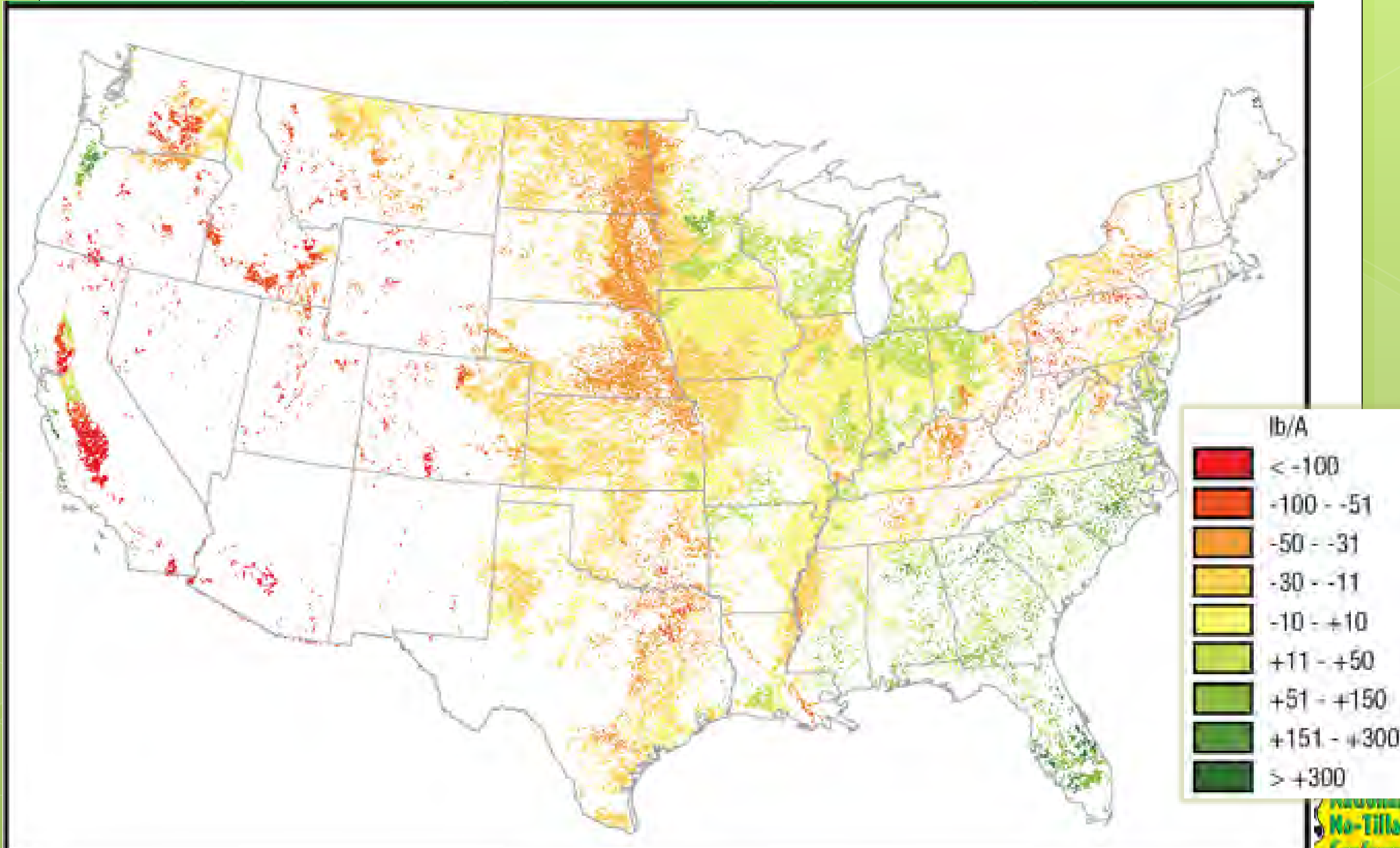
Estimated K balance by watershed, 2007.



IPNI, 2010

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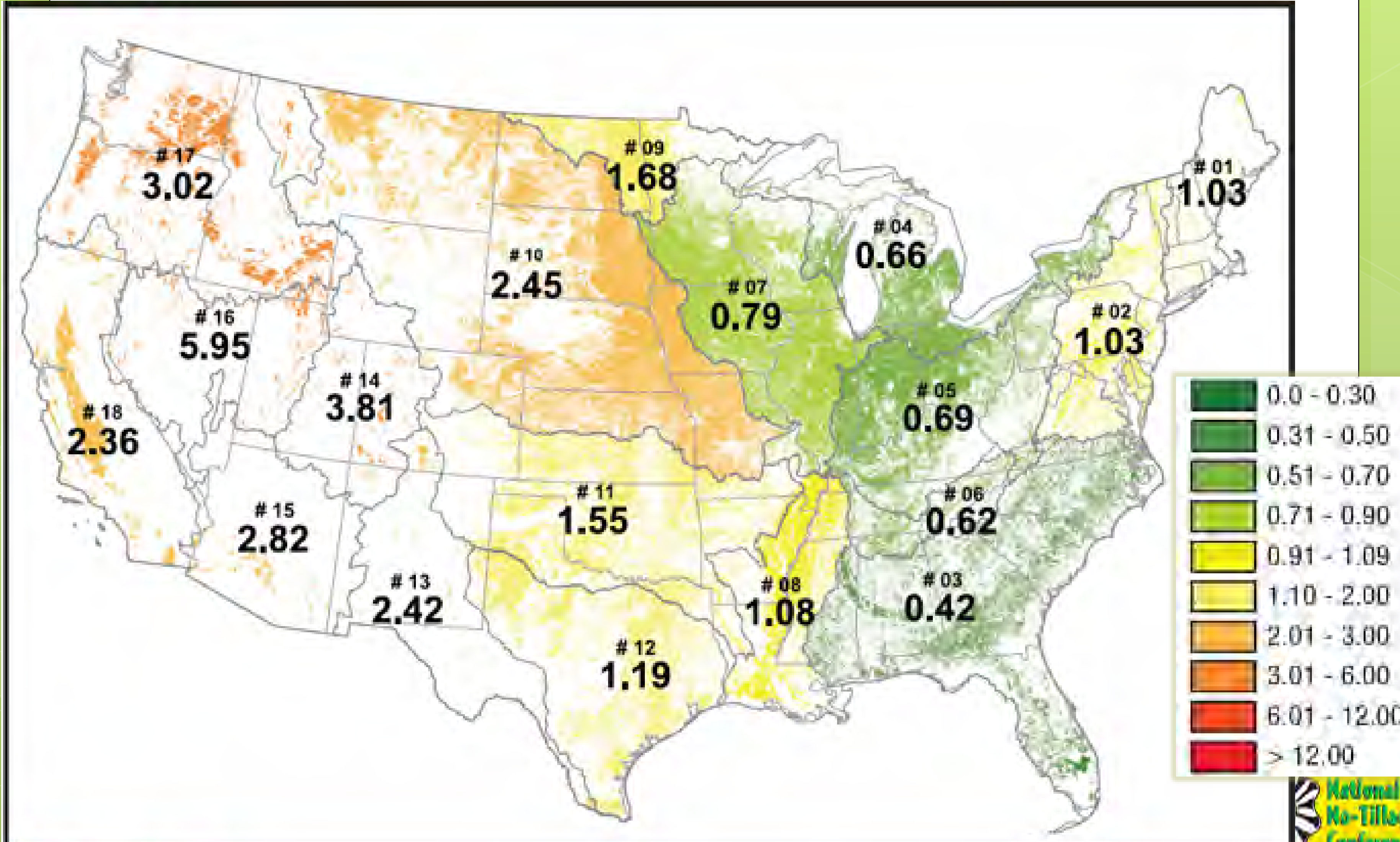
Estimated K removal to use ratio by hydrologic region, 1987.



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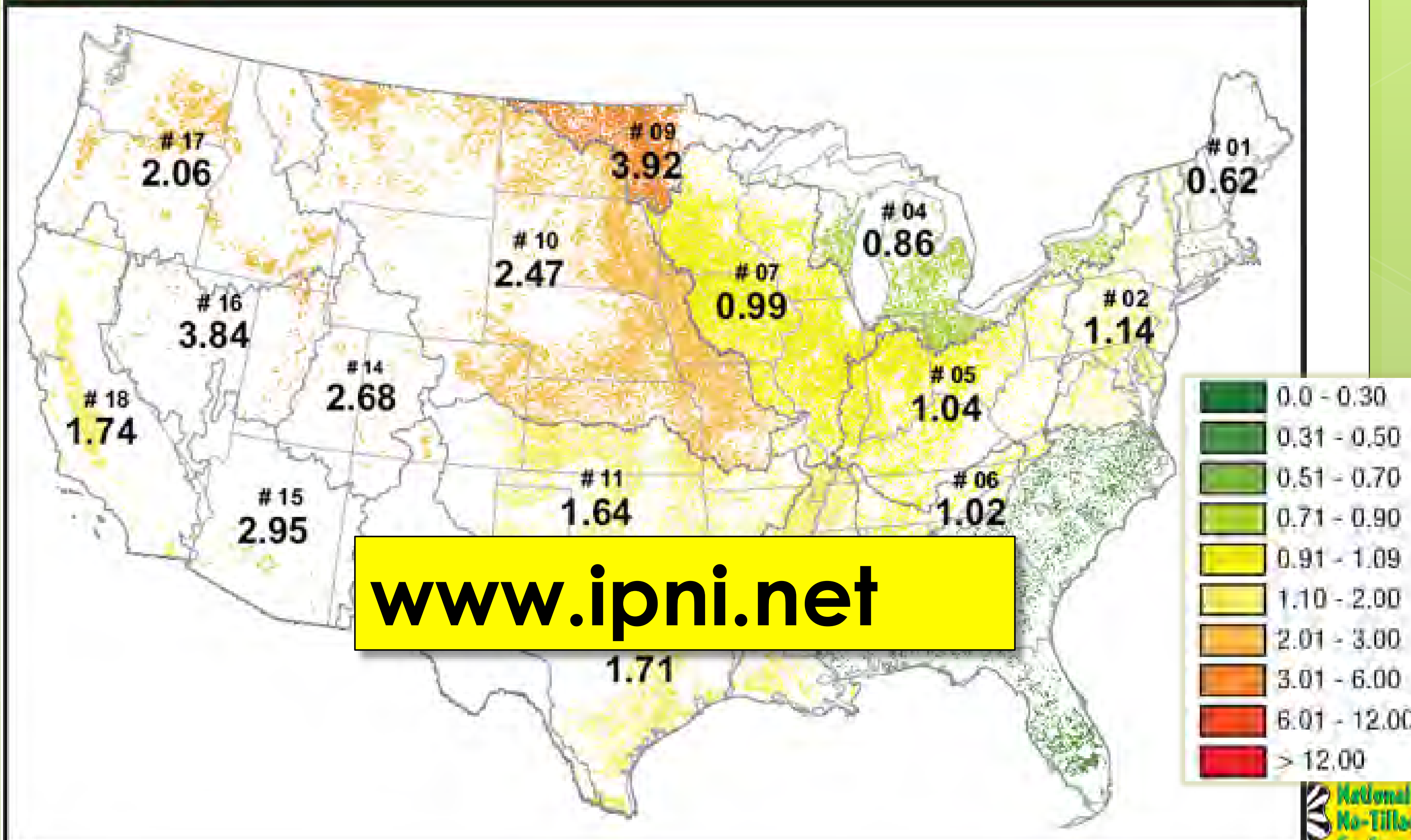

www.ipni.net

IPNI, 2010

National No-Tillage Conference

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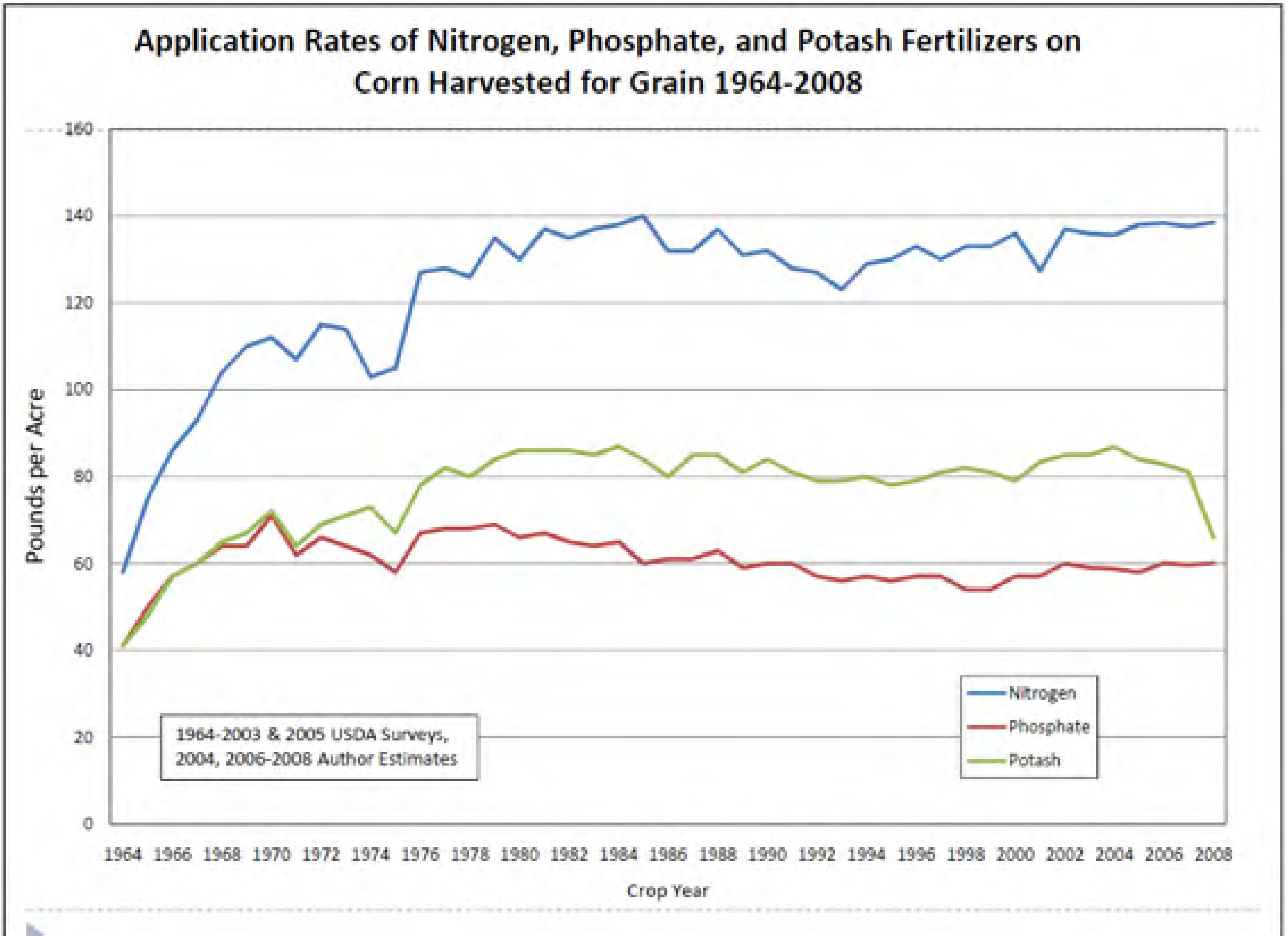
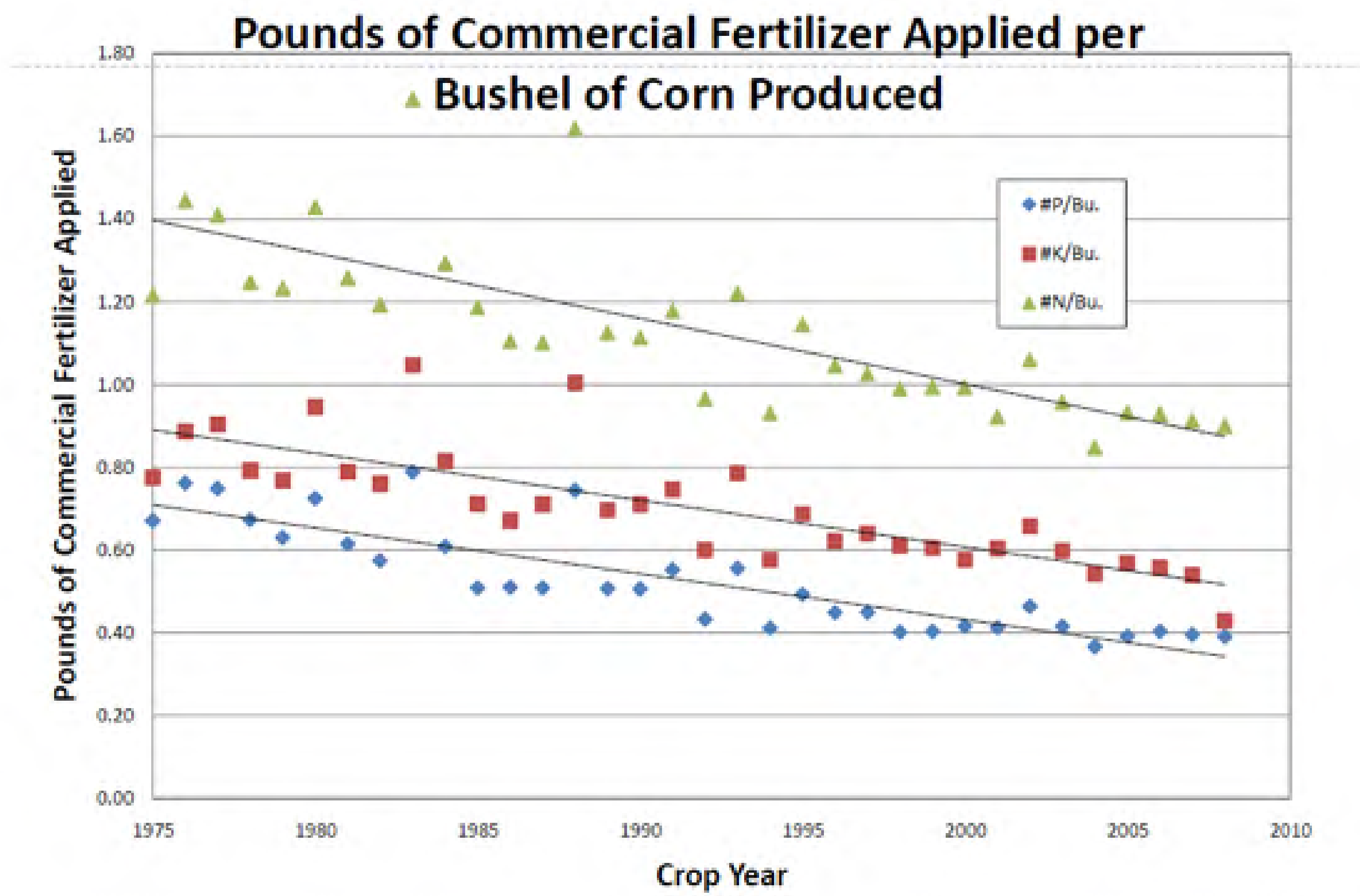
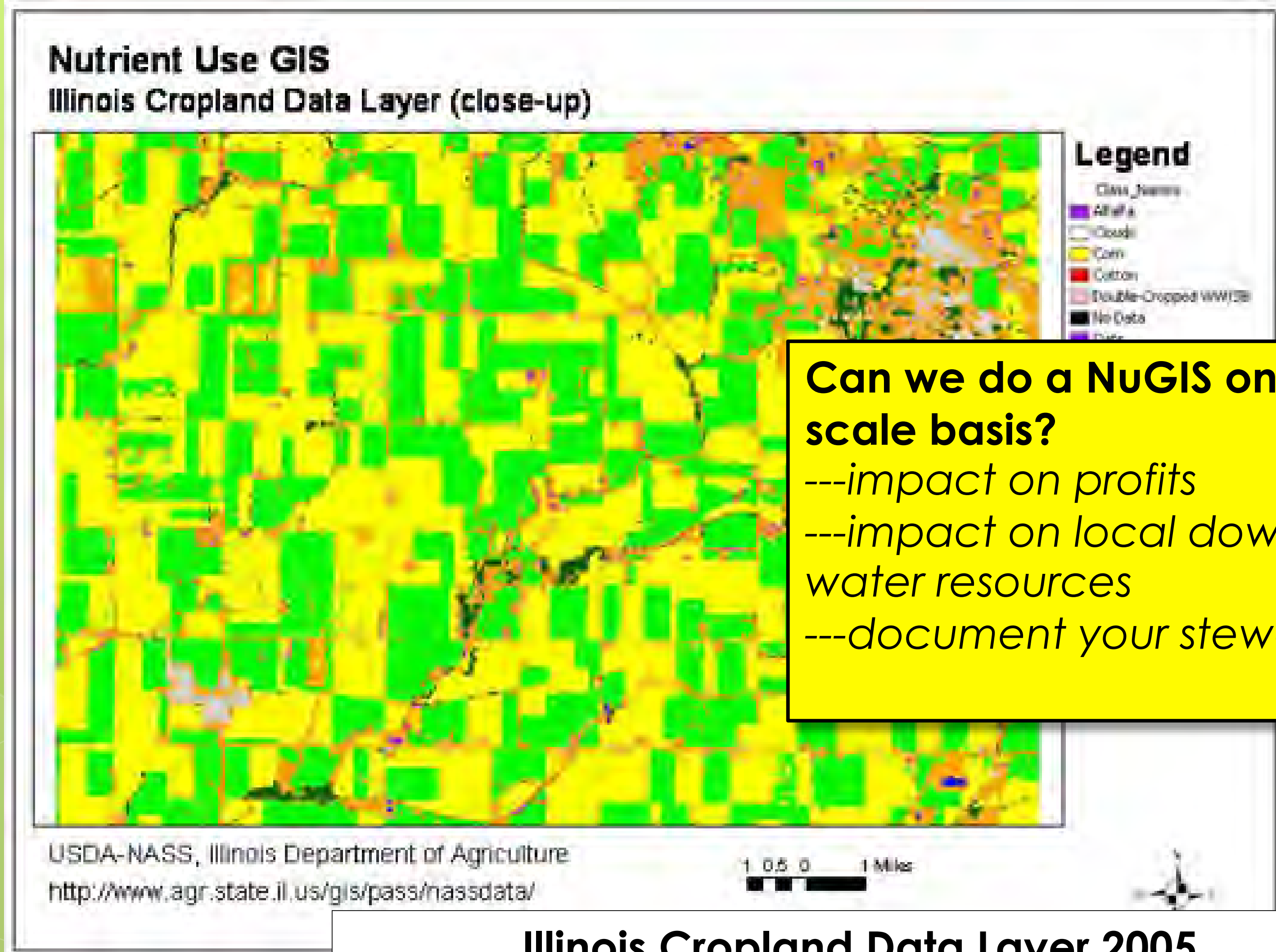


Reerz Agronomics





Can we do a NuGIS on a field-scale basis?

---impact on profits

---impact on local downstream water resources

---document your stewardship

Illinois Cropland Data Layer 2005

The Cropland Data Layer (CDL) contains crop specific digital data layers, suitable for use in geographic information systems (GIS) applications. This Program annually produces CDLs of the following States: Arkansas, Illinois, Indiana, Iowa, Mississippi,

http://www.agr.state.il.us/gis/pass/nassdata/

Think "Systems" Management

- **Right management**
  - Components interact for management decisions.
- "**System**" considers:
  - all component **practices**,
  - the **data** (information).
  - **Results** of the management decisions.
    - ***Agronomic*** *responses (yield) .*
    - ***Economic*** *evaluation.*
    - ***Environmental*** *consequences.*

Strip-Till Alternative

- Leaves most of the soil undisturbed
- Allows fertilizer placement below the surface
    - Reduced runoff and volatilization loss
- RTK allows specific placement relative to crop row
- High-speed systems available

Stratification

- Plants move nutrients to the surface
- Reduced tillage leaves nutrients near the surface
- Nutrient levels lower in the profile may be depleted

- Natural channels (soil structure) may help
- Earthworm burrows may help
- Tillage may be needed in some cases

Surface-Applied Nutrients

- Susceptible to run-off loss
- More denitrification or volatilization loss
- May be positionally unavailable to crop

Plant Uptake Varies with Depth

Percentage of Phosphorus Uptake by Corn
from Different Depths in Selected Soils.

Soil Depth (in)	Miami Silt loam	Dodge Silt Loam	Parr Silt loam	Kewaunee Silty-clay loam
	----% of total P Uptake---			
0-6	36.4	43.1	27.0	19.4
6-12	45.9	33.3	23.7	41.8
12-18	6.0	11.7	12.1	21.8
18-24	5.1	8.4	6.5	17.0
24-30	6.6	3.5	30.8	---

Source: Murdock a

35 to 64% of P comes from 6-18"

1. **Affected by tillage, moisture/drainage, fertilizer placement, etc.**
2. **Genetic modification of root system since this research was done.**

Long-Term Changes in Mollisol Organic Carbon and Nitrogen

Mark B. David,* Gregory F. McIsaac, Robert G. Darmody, and Rex A. Omonode. 2009.
***J Environ Qual*. 38 (1): 200.**

Conclusions

Sampling of prairie remnants and neighboring cultivated fields in central Illinois confirmed a large reduction in organic C and total N pools from poorly drained Mollisols undergoing cultivation (as well as artificial drainage).

Resampling of fields that had been sampled in two earlier time periods with varying land uses:

- Some decline occurred after 1908.
- No changes during the period of synthetic fertilizer use (1957–2002)

The reduction in organic matter stored by prairies occurred mostly in the top 50 cm of soil, although significant reduction in total N was observed in the 50- to 100-cm depth.

After 1957, significant increase in C and N in the subsoils that had been under cultivation,

- May be evidence of translocation of C and N from these upper layers to the 50- to 100-cm depth,
- Possibly enhanced by tile drainage.
- Smaller reduction (compared with prairie remnants) in C and N pools than in upper soil layers alone.

The most productive agricultural soils of Illinois are greatly altered from their prairie beginnings.

- **The major declines in organic matter were likely completed by the 1950s**.
- **These soils seem to have been in a steady state from the late 1950s through 2002**.

1967-1969 Soil Profile Survey

- 75 Counties
- Soil and plant analysis
- Set a baseline of nutrient levels in the profile
- Micronutrient focus
- 20 corn/soybean fields per county
- 0-6"   12-18"   24-30"
- Retest planned to monitor changes

Counties where plant and soil samples were taken in 1967, 1968, and 1969.

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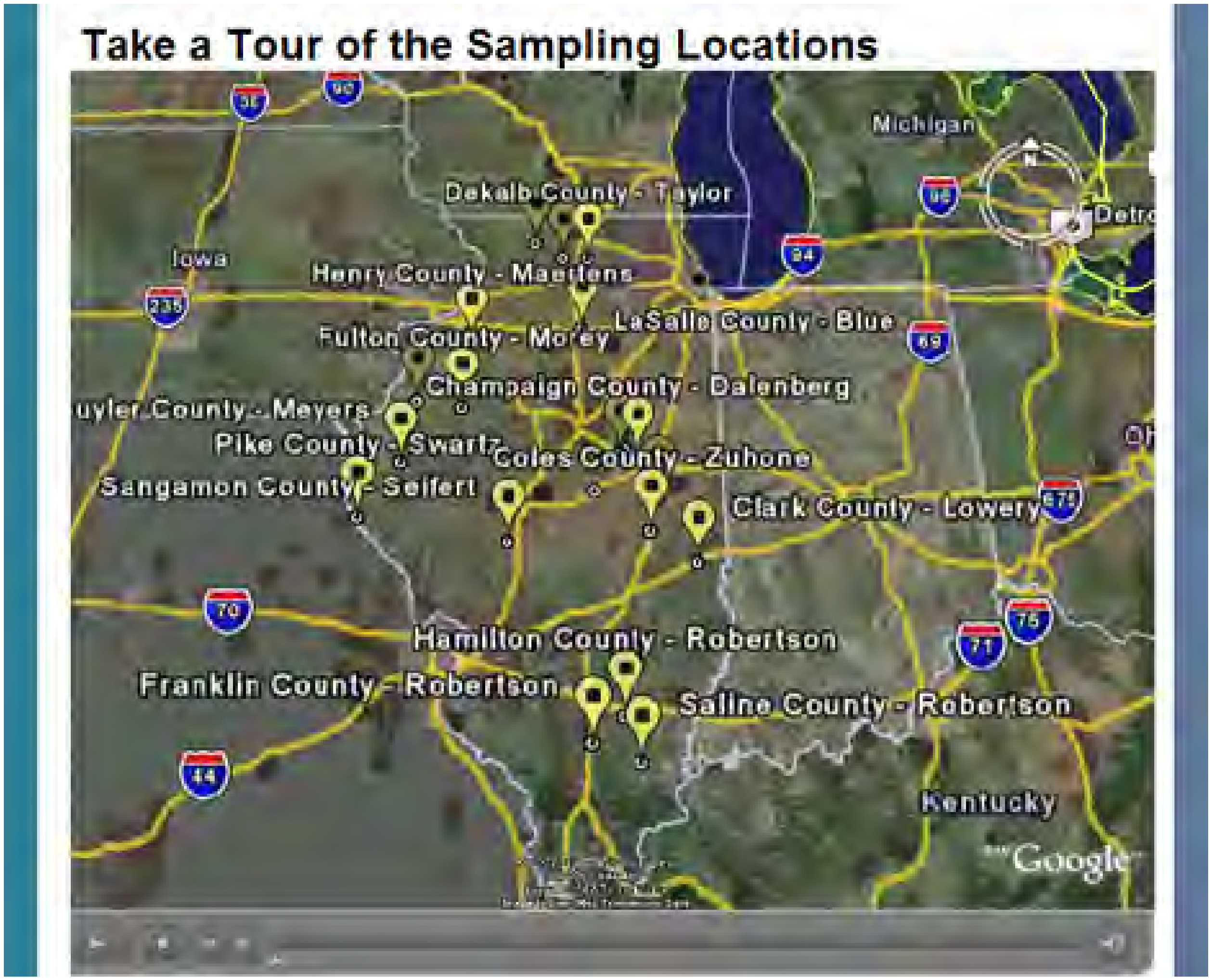
www.FARmresearch.com/FREC313



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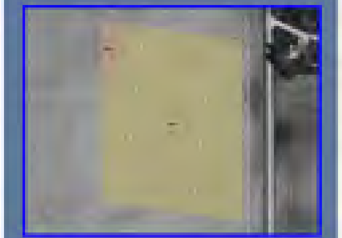
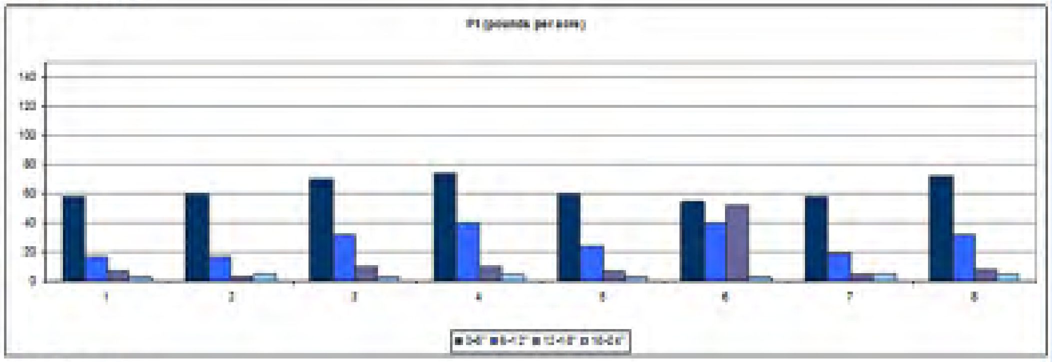
Douglas County

Eric Rund

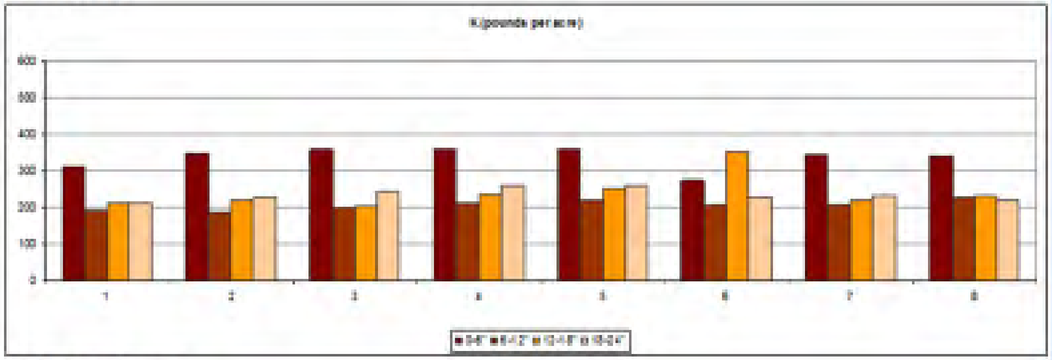
Pesotum, IL



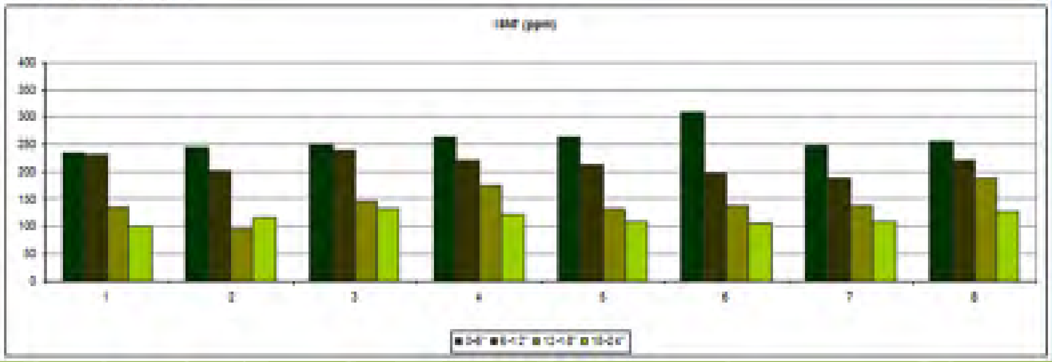
P1 Chart



K Chart



ISNT Chart



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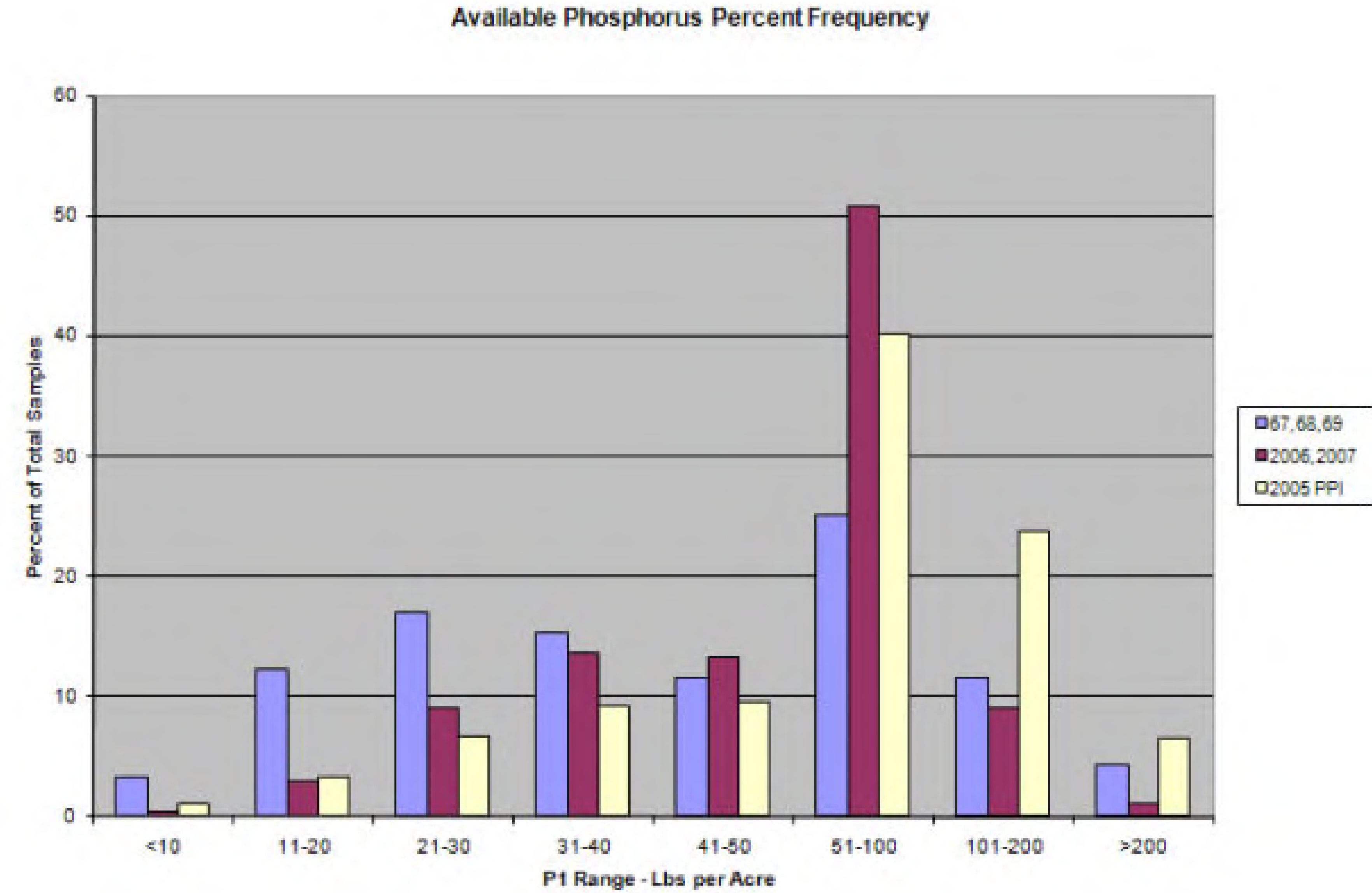


New Challenges

- Deeper, more vigorous roots
- Subsoil nutrient depletion (?)

Long-Term Research -- Morrow Plots, etc.

Difficult to Support

Essential to Maintain

Long-term studies are an important scientific resource that should be protected… …and used.

Rothamsted

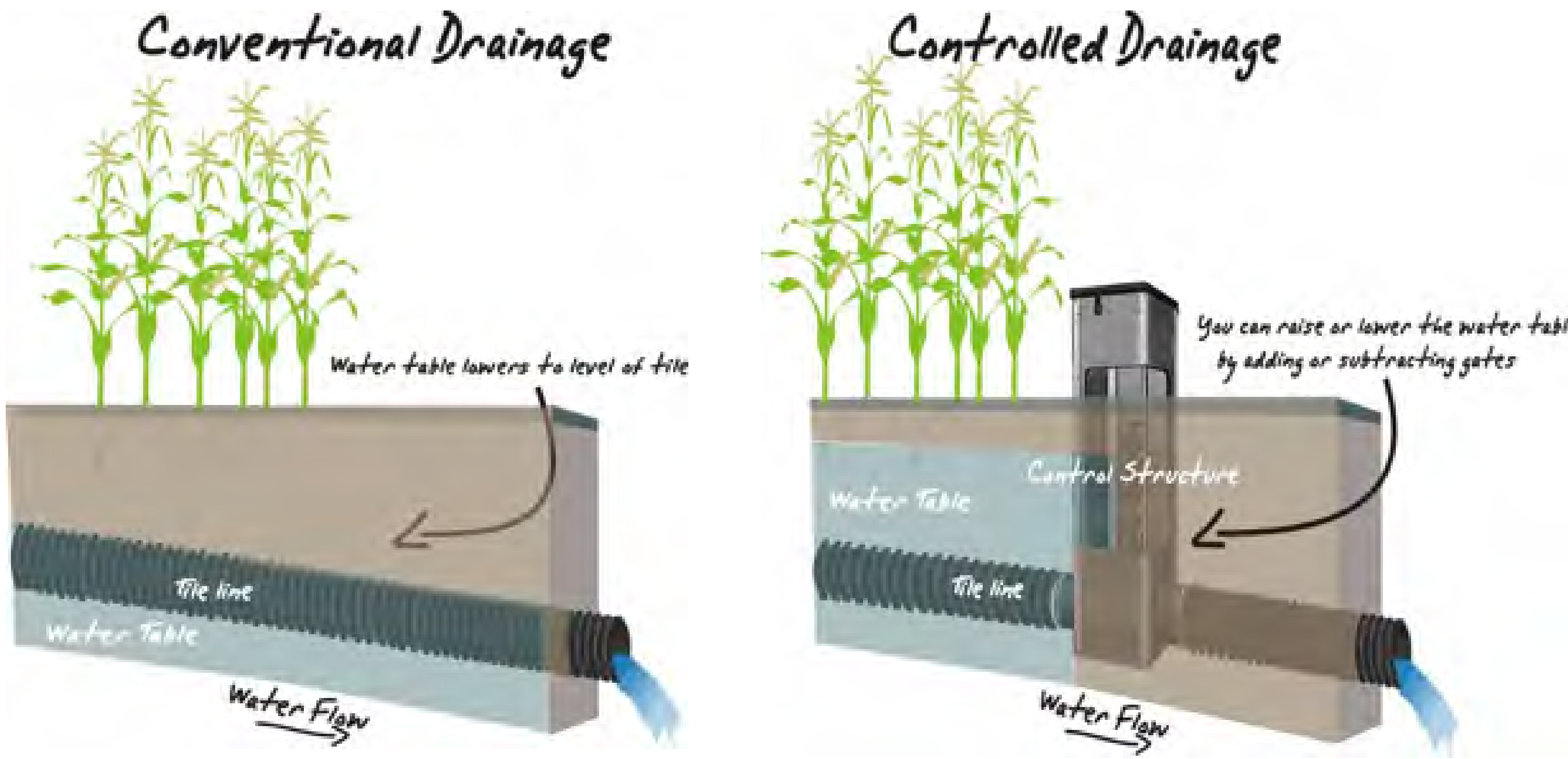
New Options from New Technology

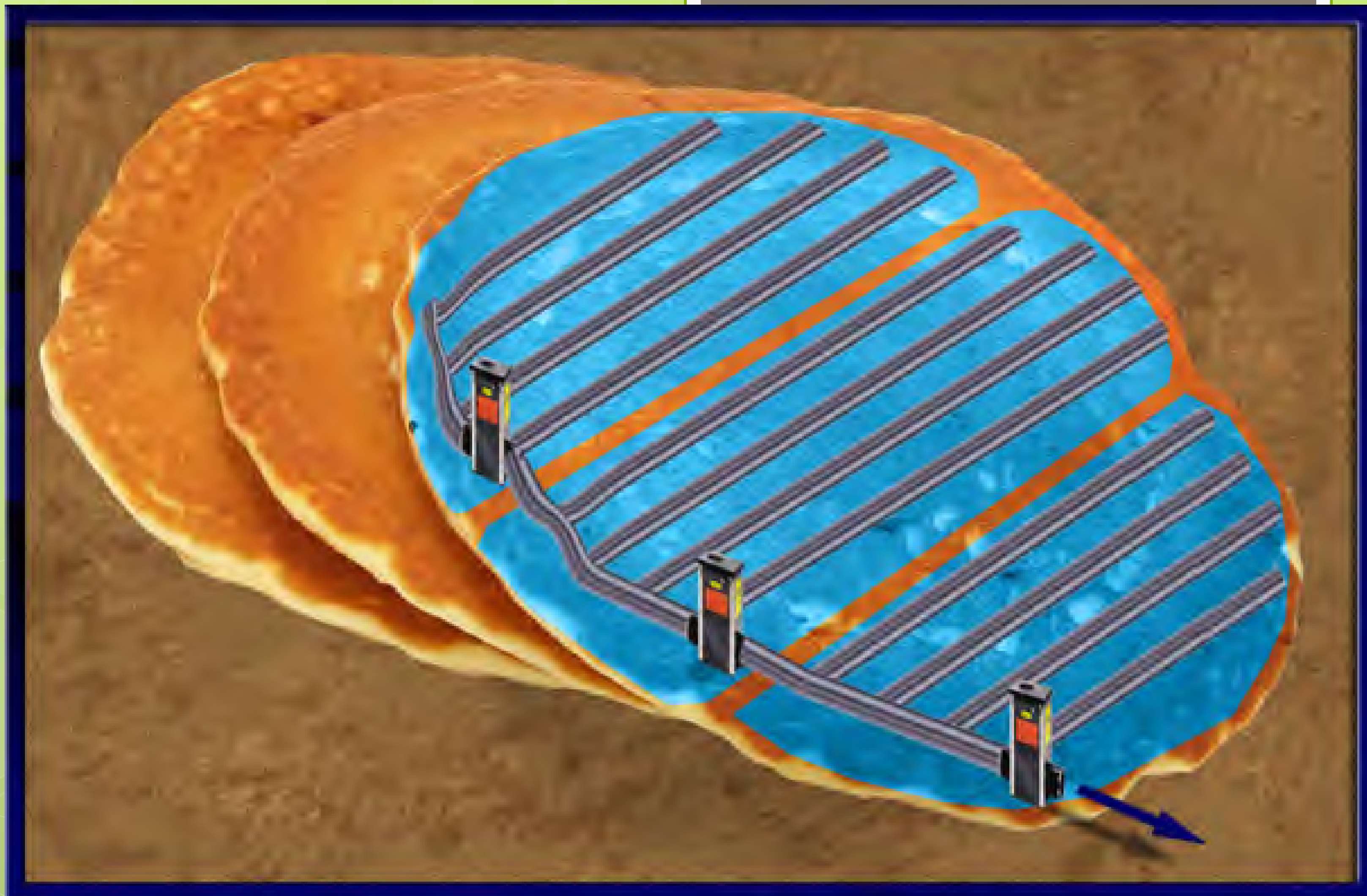
- RTK—positioning of nutrients relative to seed.
- Controlled-traffic with RTK
- Drip irrigation with RTK
- Split application of nutrients
  - Base rate + sensor based VRT rate
- Detailed monitoring and mapping of rates
- Within-field Economics

Nanotechnology

- New options for sensors and reporting
- Plant health
- Water status of soil and plant
- Nutrient content of soil, plant, water resources

Drainage Water Management





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Building a Local Management Database

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Field-Average Management Is Not Good Enough

- Over-fertilize low yielding areas
- Under-fertilize high yielding areas
- Each year of field average management increases variability and potentially decreases productivity

Major Hurdles Ahead

- Lack of research on interactions
  - Correlation among layers of GIS
- Shortage of trained agronomists
  - Education
  - Continuing education
    - *“Hands-on” field training*
    - *“Hands-on” computer training*
    - *Multi-tiered approach needed*
  - CCA program is helping

Objectives of a Nutrient Management Plan

- Provide nutrients required for crop production.
- Manage economics to improve profits.
- Minimize your “environmental footprint”.

Managing Spatial Variability

- Applying nutrients only where needed improves productivity and profitability, and protects environmental quality.
- Leads to a more sustainable system.

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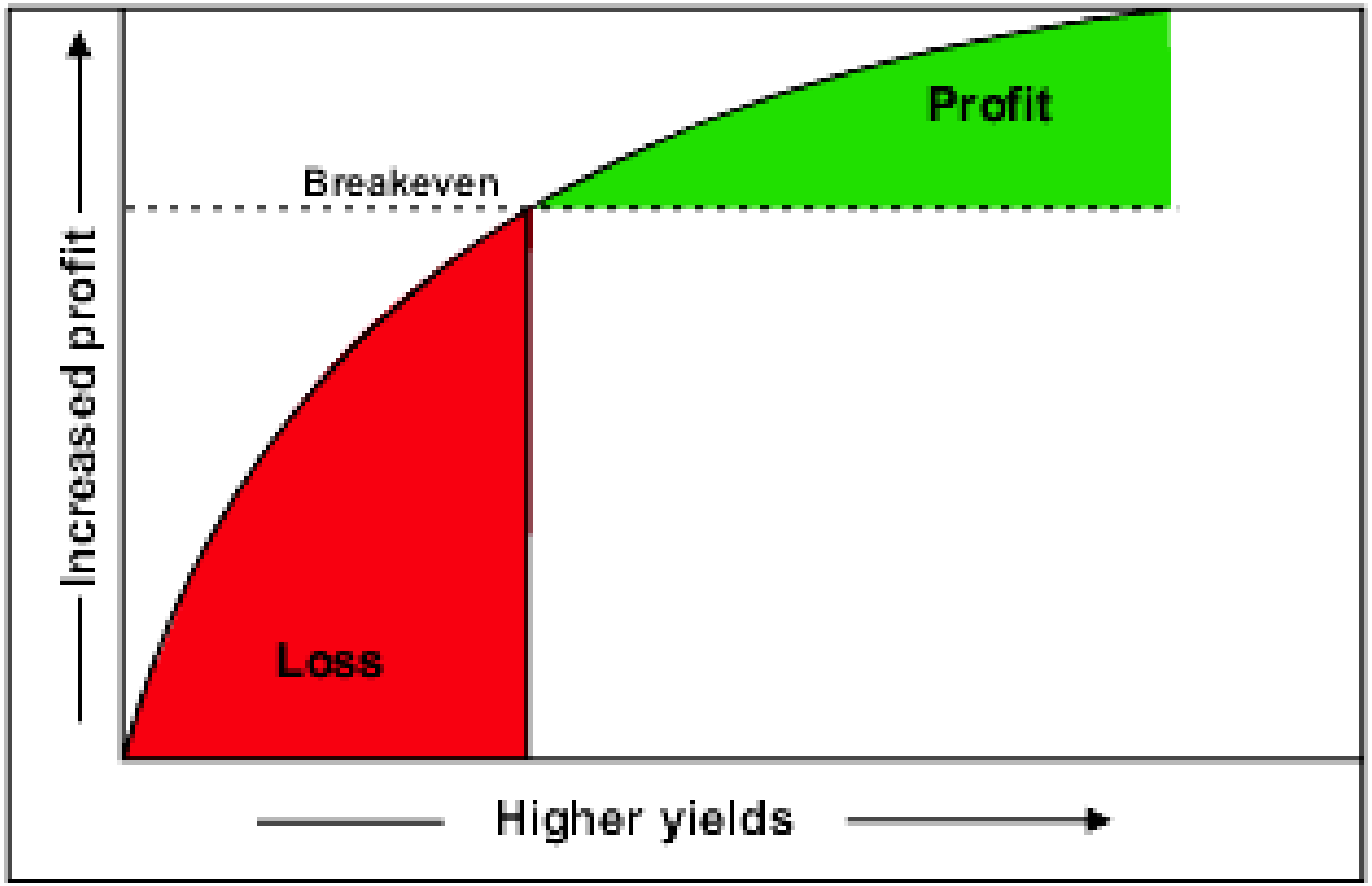

Provide nutrients required for crop production

- Meet plant requirements at all times.
- Right nutrients, right rate, right place, right time…

  …every day…all day
- Any shortage at any time potentially limits yield.

Manage economics to improve profits.

- To be **sustainable**, a production systems must be **profitable**.
- Profits can be increased by **reducing inputs** or **increasing output**.
- Build toward a **more productive** management system, with **higher yields**, to produce more, spread resources and fixed costs over more bushels to **improve efficiency** and **sustainability**.

Minimize your "environmental footprint".

- Use **4R Nutrient Management**
- Set **reasonable yield goals**; manage for optimum use of resources
- Use **precision farming technology**
- **Keep records-**--include nutrient balance as part of your plan.
- **High yields** make best use of all resources and provide more residue to help reduce water quality problems.

Building a Local Management Database

Better Technology – Better Data

Site-specific decision making	
Sensors	Guidance systems
Monitors	Historical records
Sampling	Mapping systems
Controllers	GIS analysis

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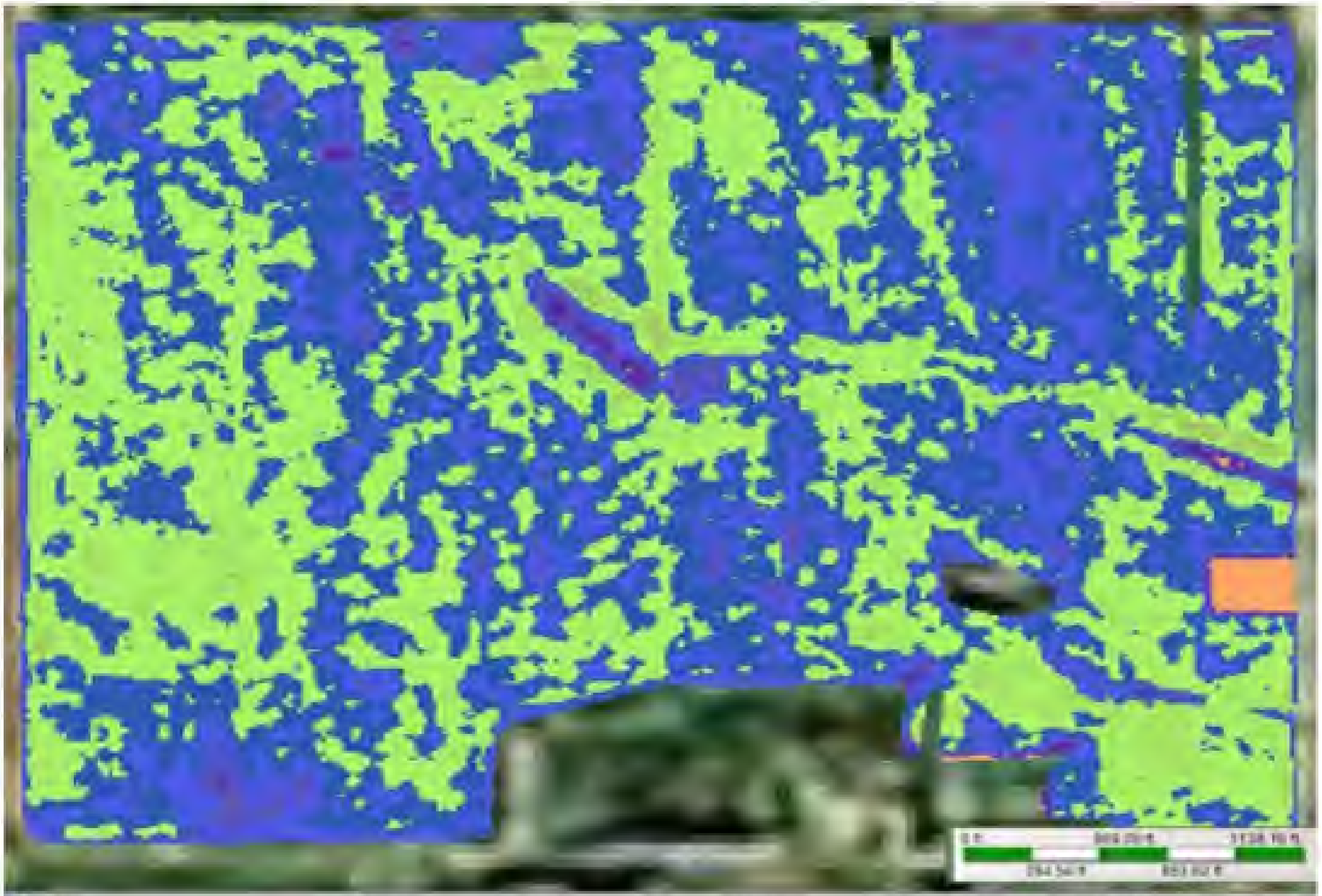
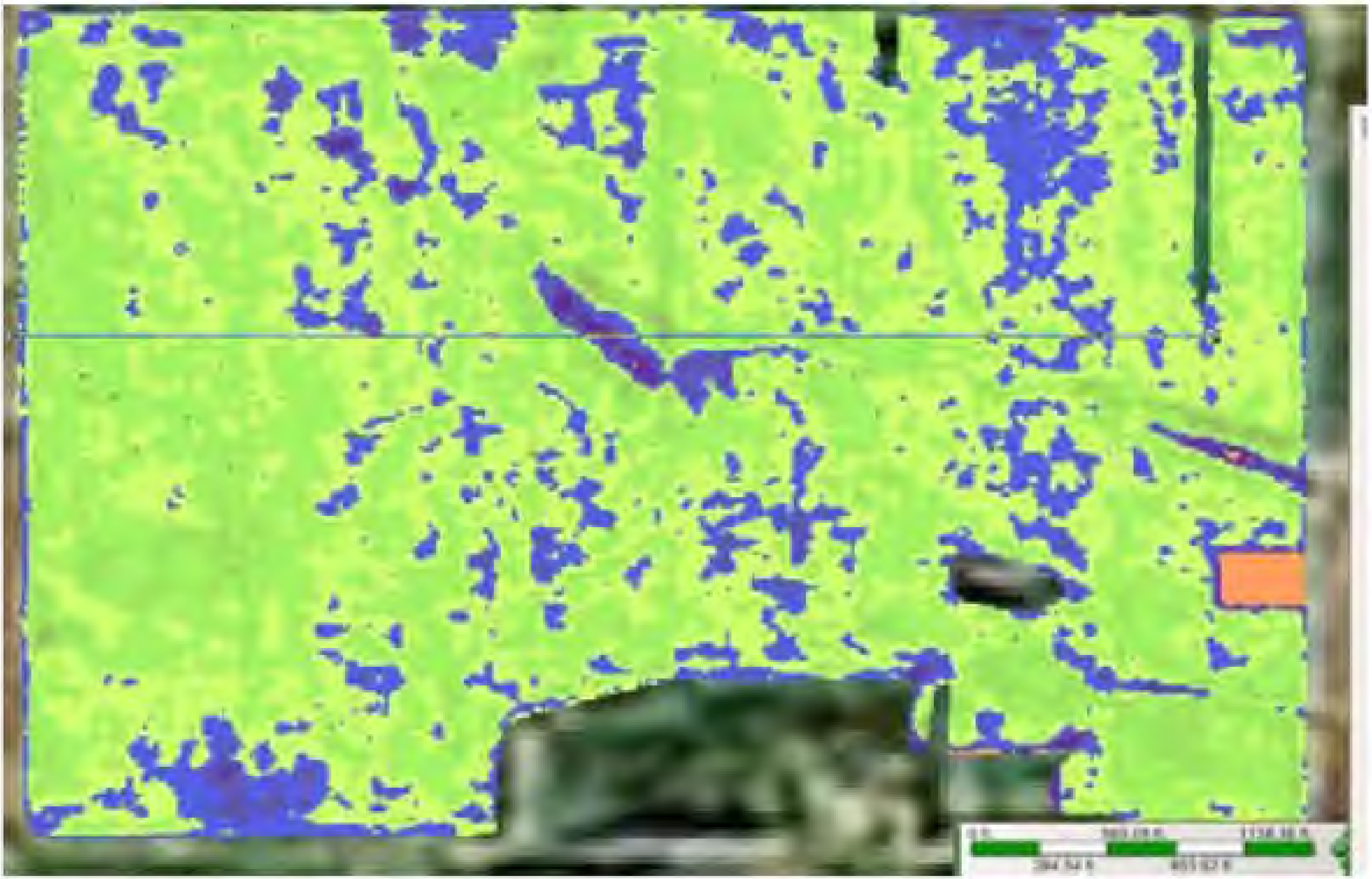
Imagery Map for Chlorophyll



N Application Map



Field Scale to Global Scale
---*One Field at a Time*

- Adopting this approach at the field scale helps contribute to the outcome of providing sustainable cropping systems at state, regional, national, and even global scales. ***Site-specific management applied at the local scale throughout the world creates aggregated benefits at the global scale.***
- As more farmers adopt better practices through site-specific management and ***better-informed decision-making on each field***, the larger-scale results can be realized for *agriculture* and *society* in general, **locally** and **globally**.

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Thank you!

Websites for more information

- www.ReetzAgronomics.com
- www.infoag.org
- www.farmresearch.com
- www.ipni.net
- www.ADMCoallition.com

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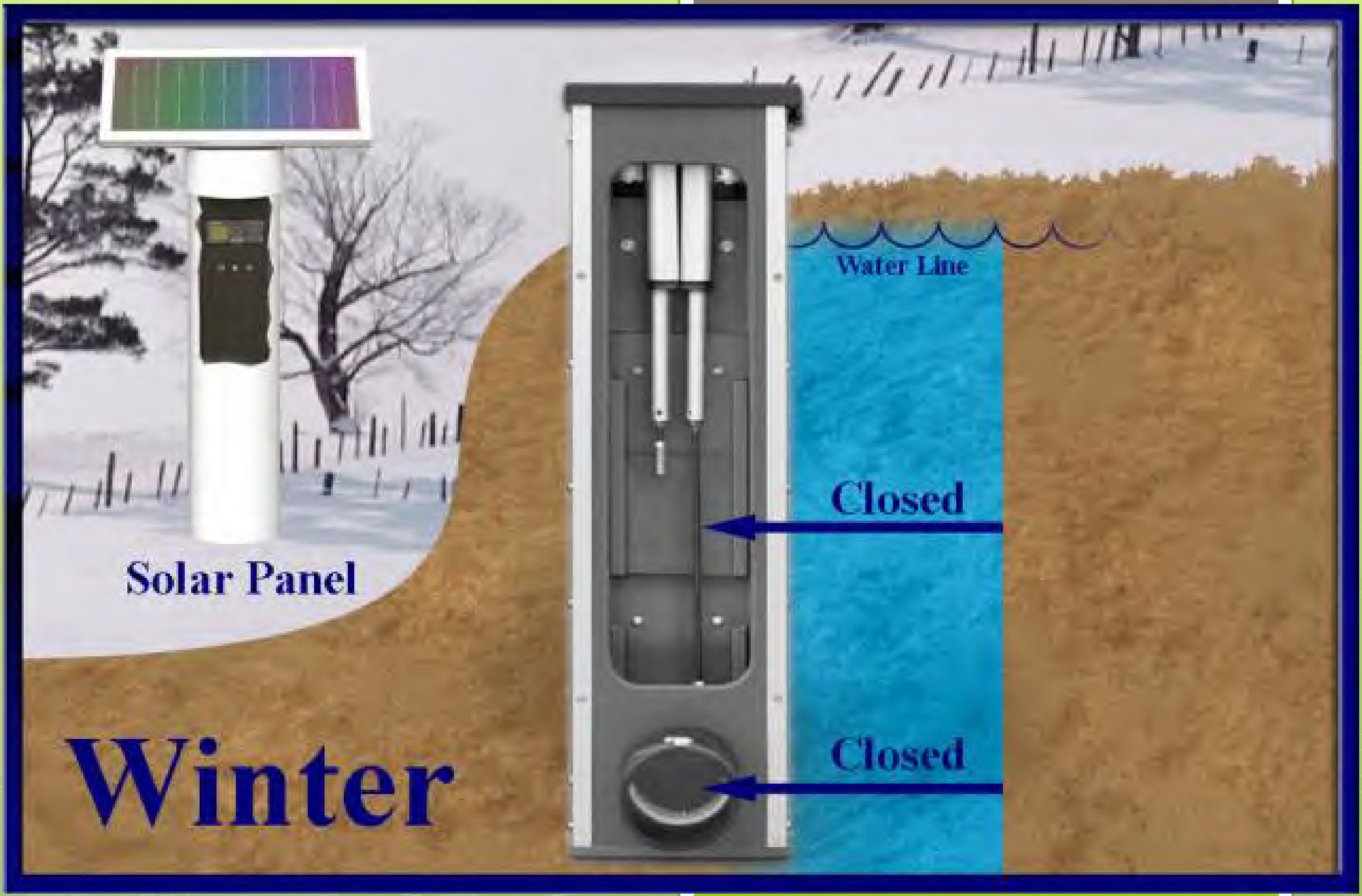
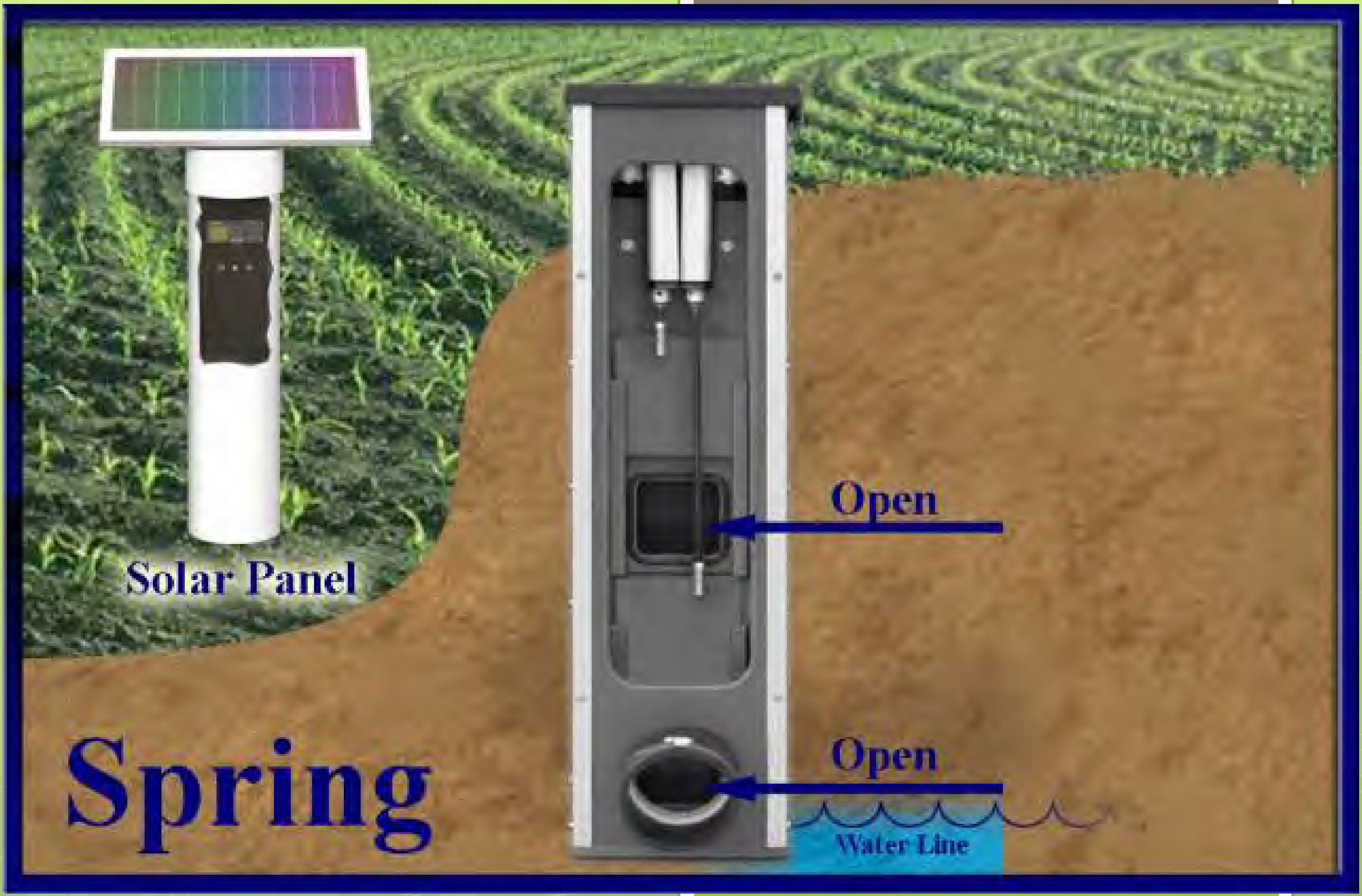
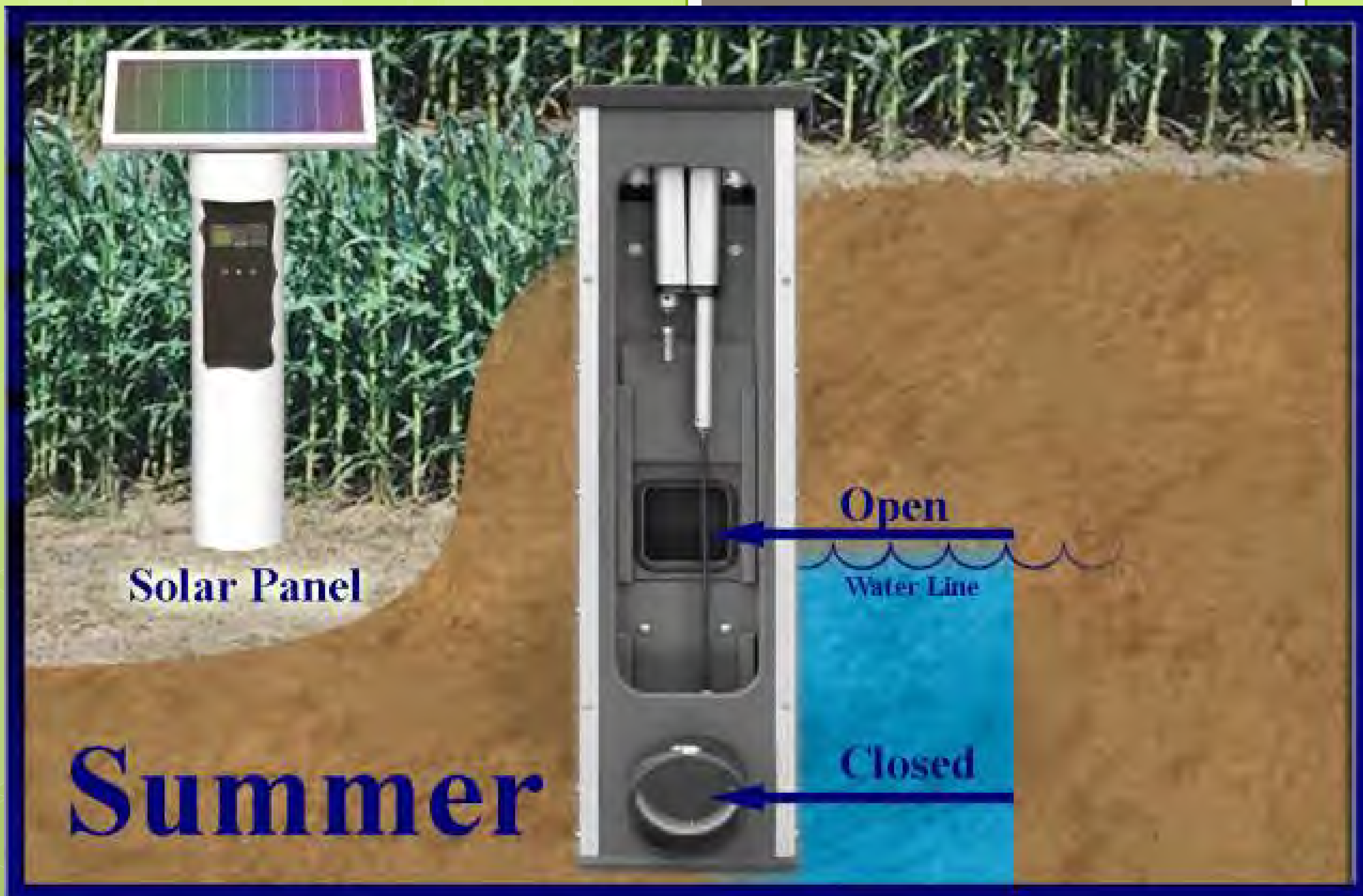

Water Line
Closed
Closed
Solar Panel
Winter


Solar Panel
Open
Open
Water Line
Spring



Solar Panel
Open
Water Line
Closed
Summer


Solar Panel
Open
Open
Water Line
Fall

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Annual water Table Profile