2017 Fluid Forum

35 Years of Positive Impact and Progress … What's Next?

Paul Fixen and Dale Leikam
IPNI & FFF

IPNI INTERNATIONAL PLANT NUTRITION INSTITUTE

Fluid Fertilizer Foundation

Why 35 years?

1982 | Today

Millennials: a life time


Baby Boomers: a career


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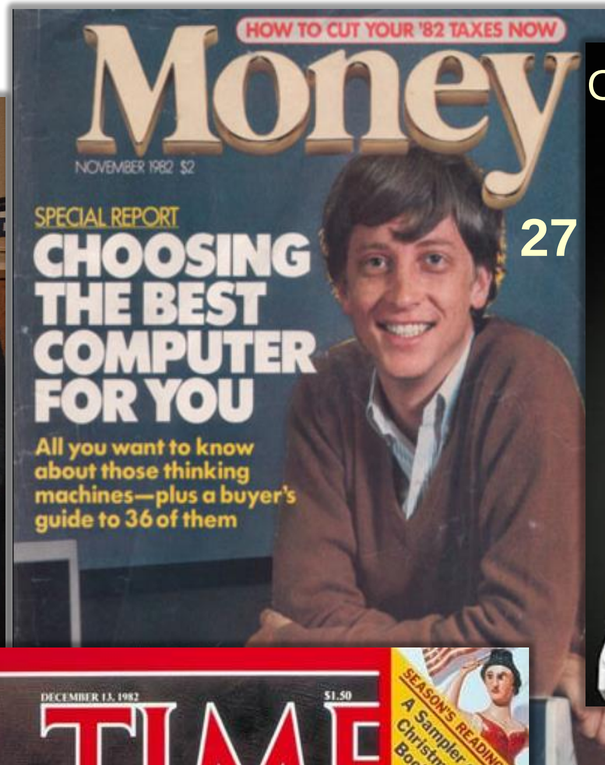
Why focus on impact & progress??

We tend to focus on the half empty glass … on not being perfect

Predicting needs for individual **fields** in individual **years is hard**!

Life in 1982



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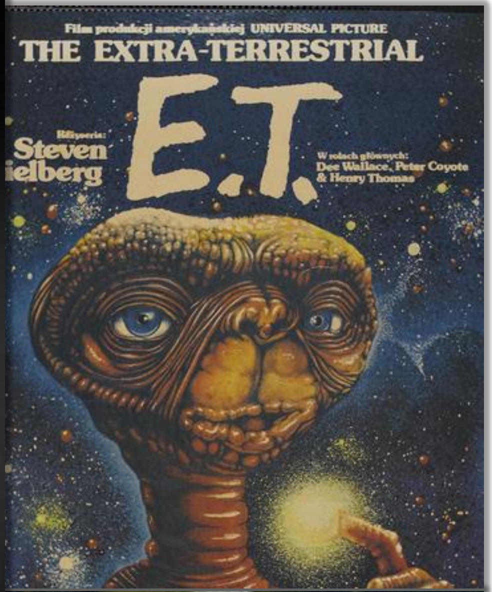
Commercial cell phone



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The Wave of The Future

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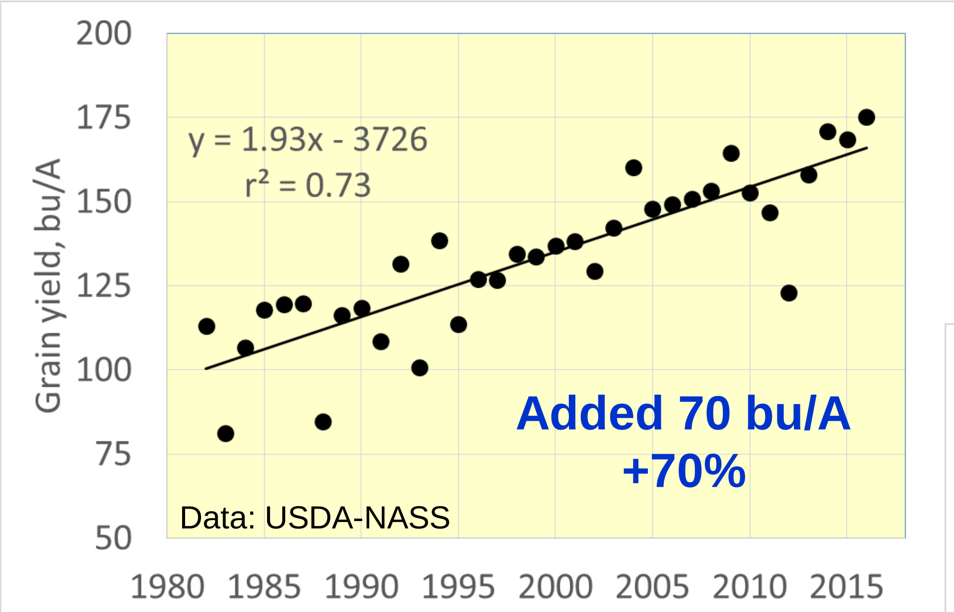
Progress in crop yields

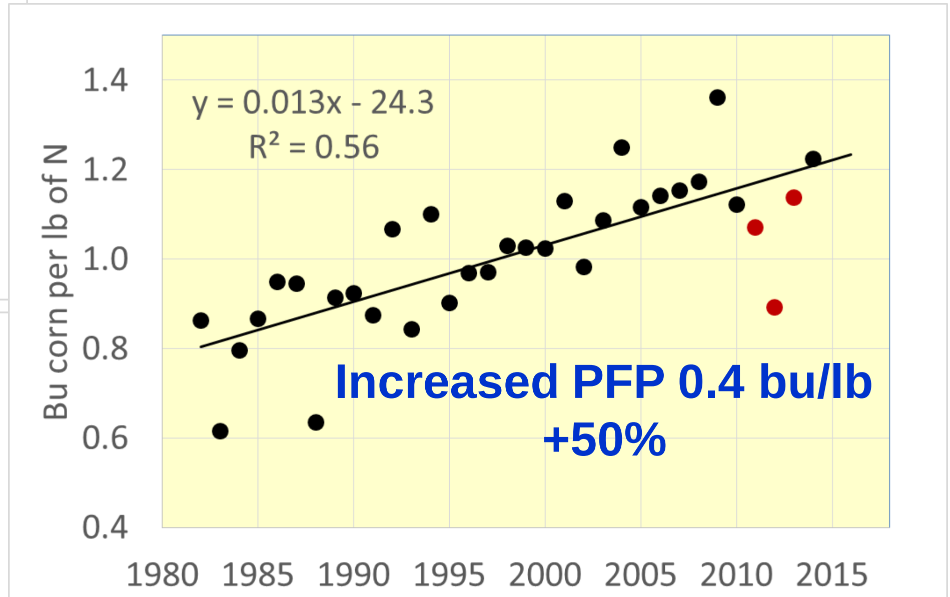
Crop	1982	2016	**Change, %**
Corn, bu/A	101	172	**70**
Soybean, bu/A	29.3	49.3	**69**
Wheat, bu/A	36.5	46.6	**28**
Cotton, lb/A	547	808	**48**

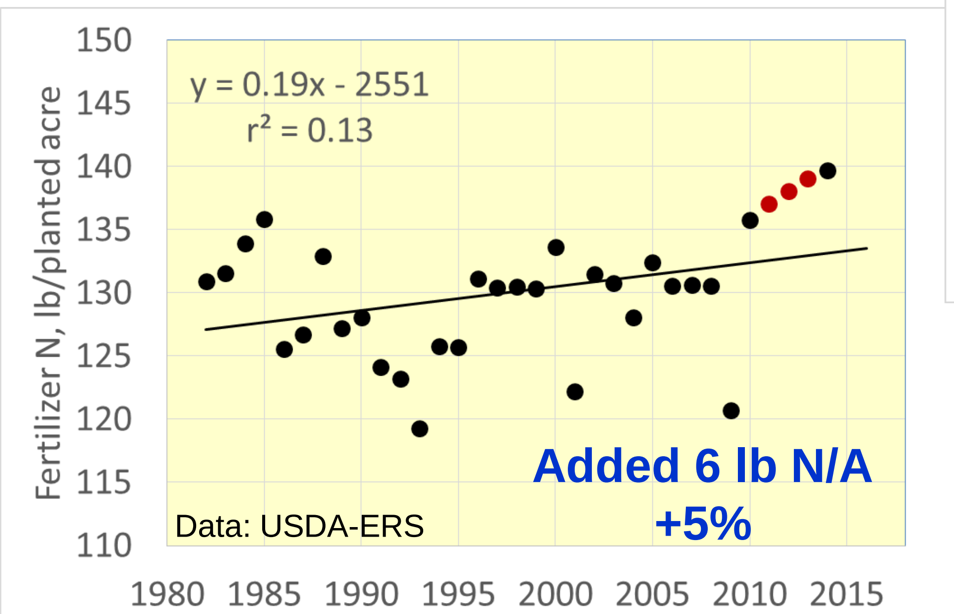
1982 = avg of 81-83; 2016 = avg of 14-16.

Data: USDA-NASS

Progress with corn yield and NUE, 1982 -2016







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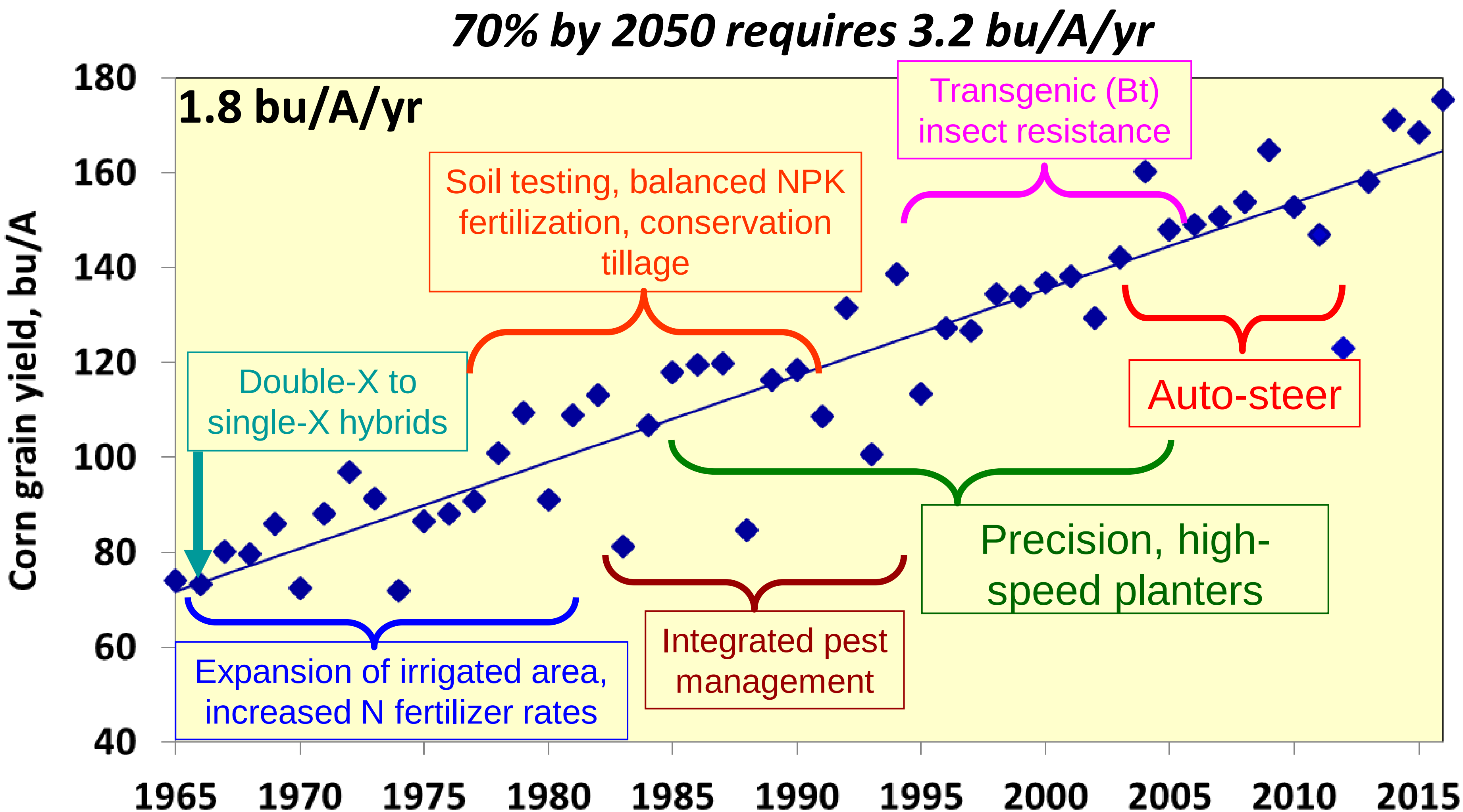
US Average Corn Yields



Updated w/ permission: Cassman et al., 2006

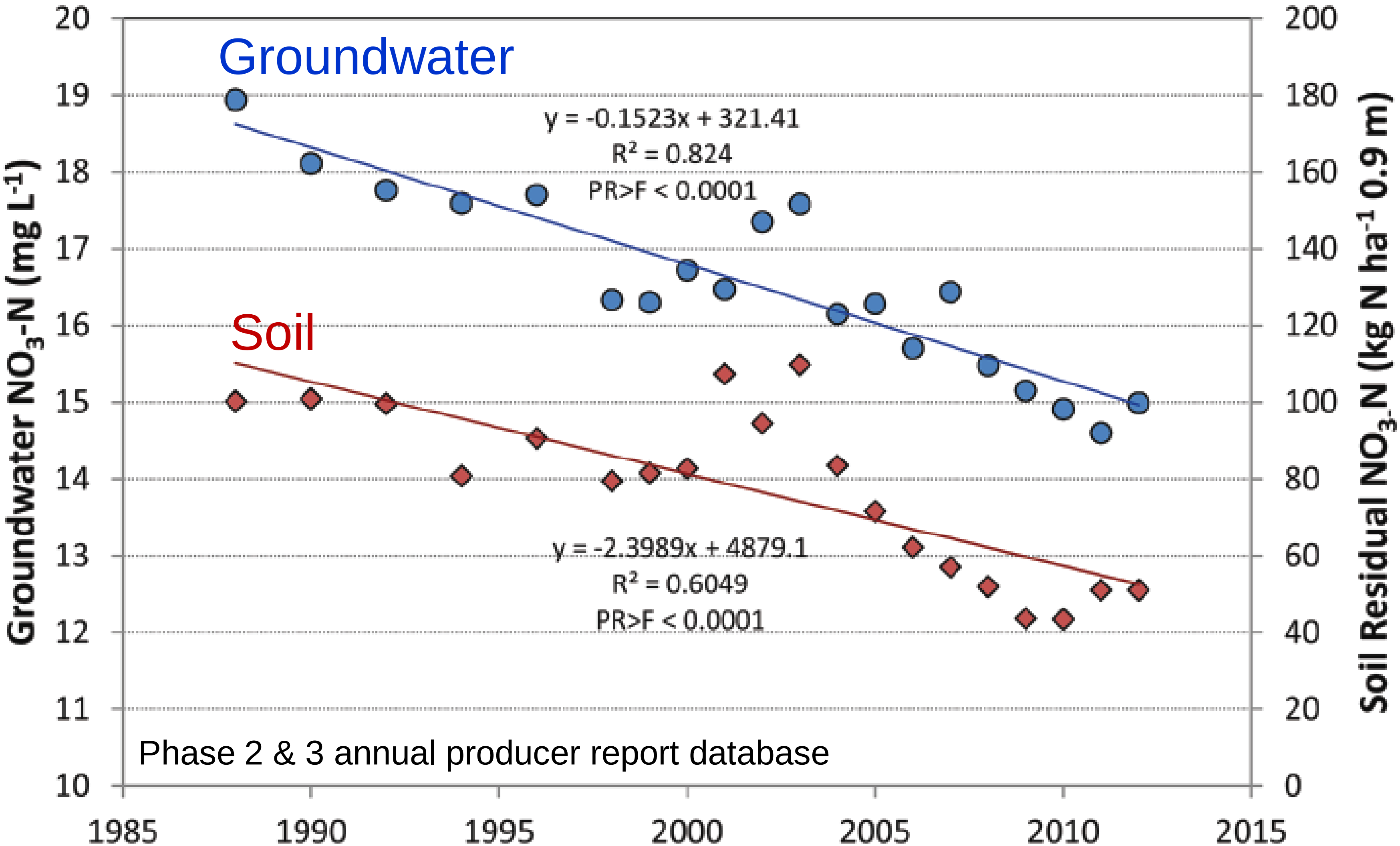
Corn Nitrogen Management Ladder (High Plains)

Efficiency Rating

	lbs N/Bu	
Step 5	0.8	Pre-plant + Starter + Side-Dress/V6 Fertigation + Brown Silk Fertigation
Step 4	0.9	Pre-plant + Starter + Sidedress/V6 fertigation
Step 3	1.0	50% Pre-plant + 50% Sidedress
Step 2	1.1	100% Fertigation
Step 1	1.2	100% Pre-plant Band
Floor	1.3	100% Pre-plant Broadcast

Russell French

Groundwater nitrate and soil nitrate in the Central Platte Natural Resources District



Ferguson, 2015 (JEQ).

Corn yield potential

Tollenaar, **1985**
U of Guelph
"Therefore, my guess for the current upper limit of corn productivity at a Corn-Belt location is **500 bu/A**."

David Hula: Charles City, VA

2015 532 bu/A

2014 476 bu/A

Randy Dowdy: Valdosta, GA

2014 504 bu/A

(NCGA Yield Contest Winners)

Efficient use of inputs and appropriate practices without sacrificing yield potential: A CHALLENGE

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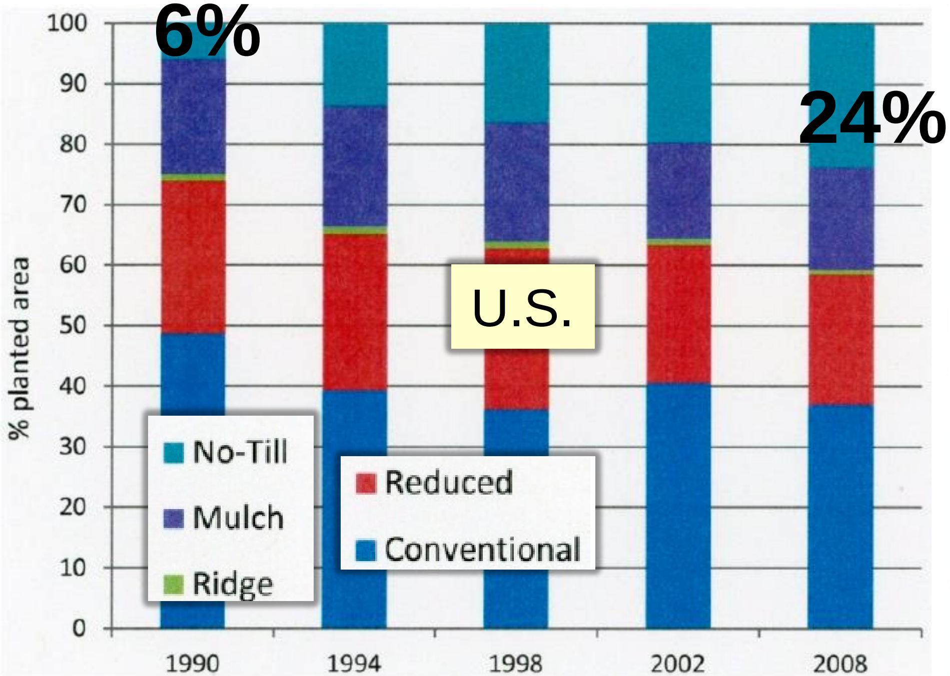
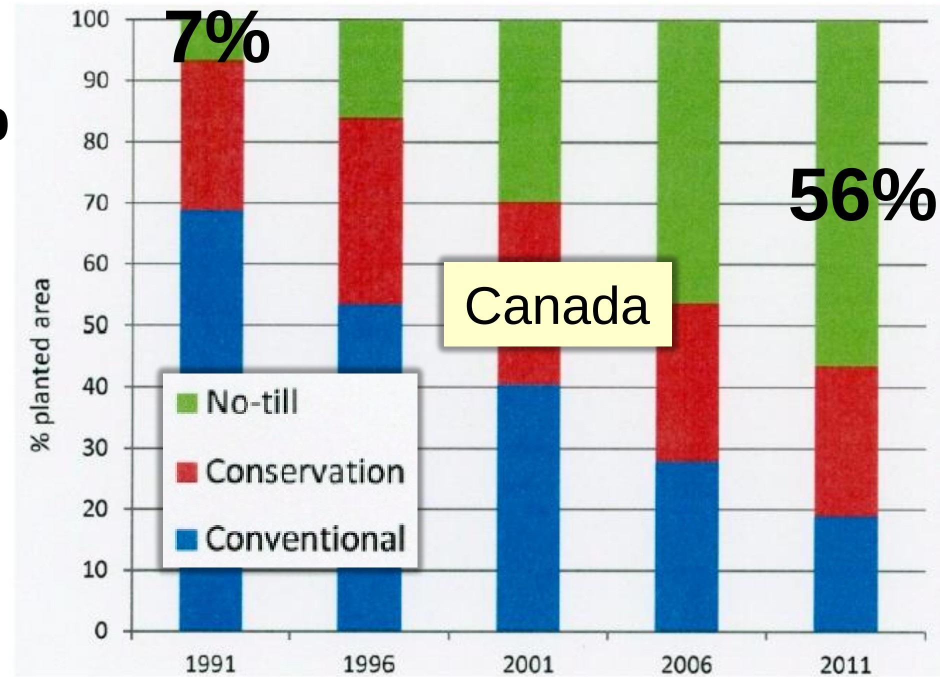
Progress in conservation tillage



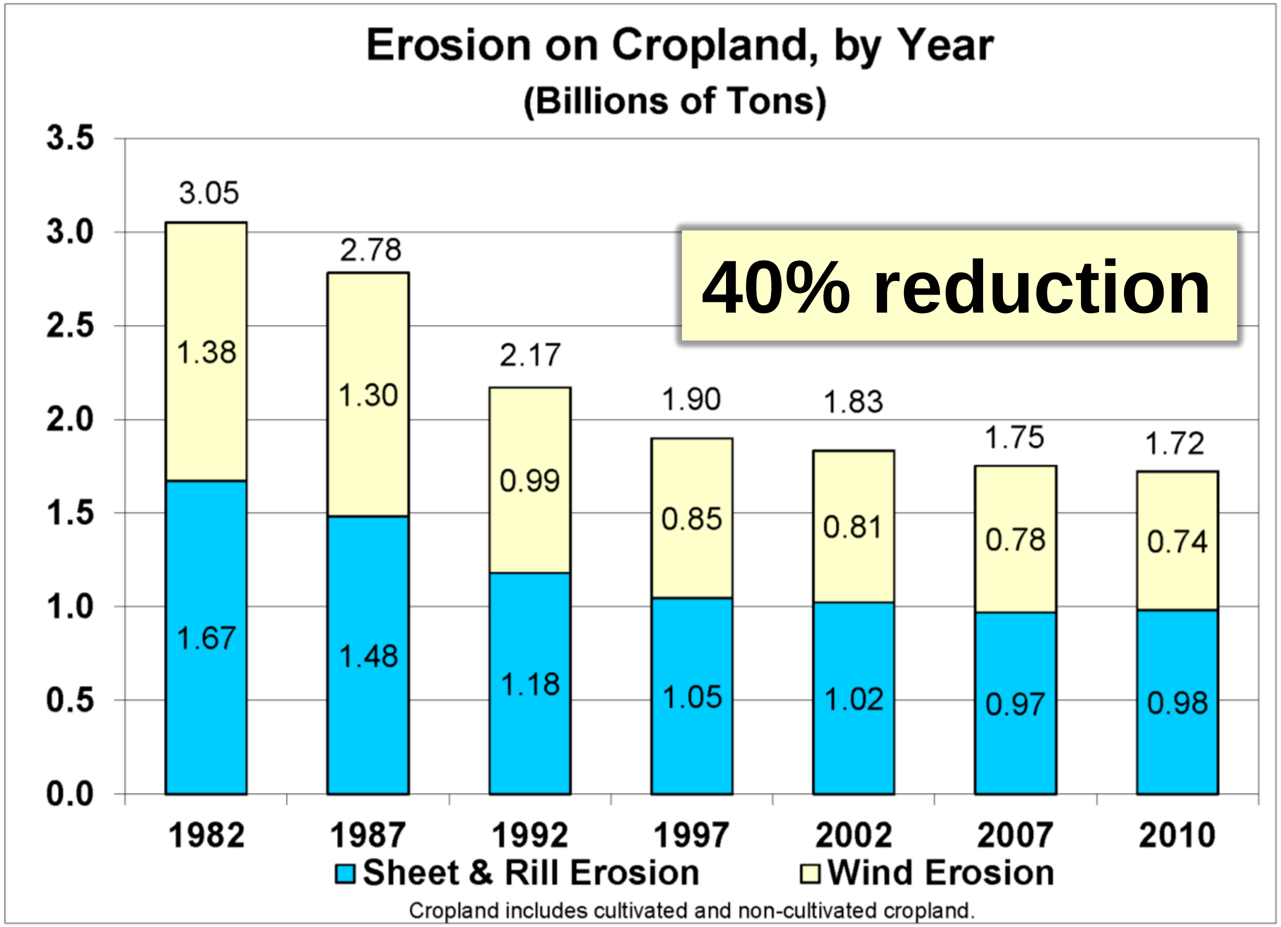


1982	1989	2008
% in conservation tillage		
18	26	42

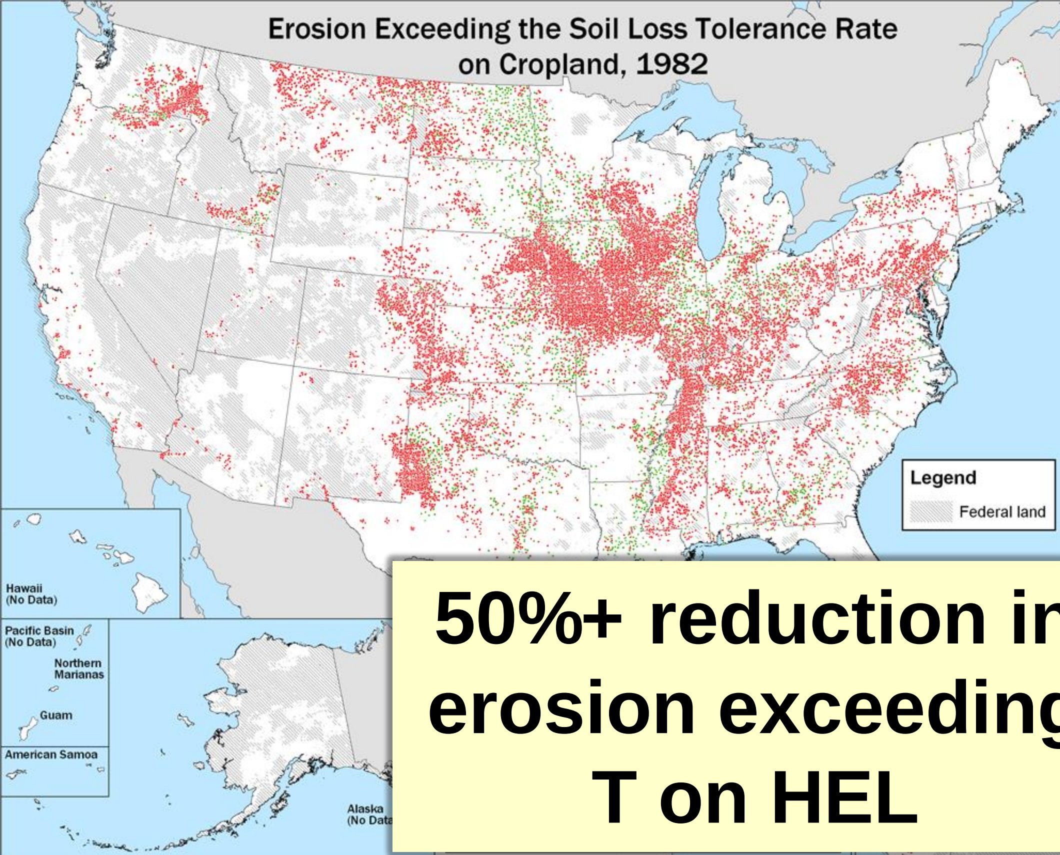
CTIC & Schertz, 1988.

Graphs from Baumhardt et al., 2015.

Progress in erosion reduction in the U.S.

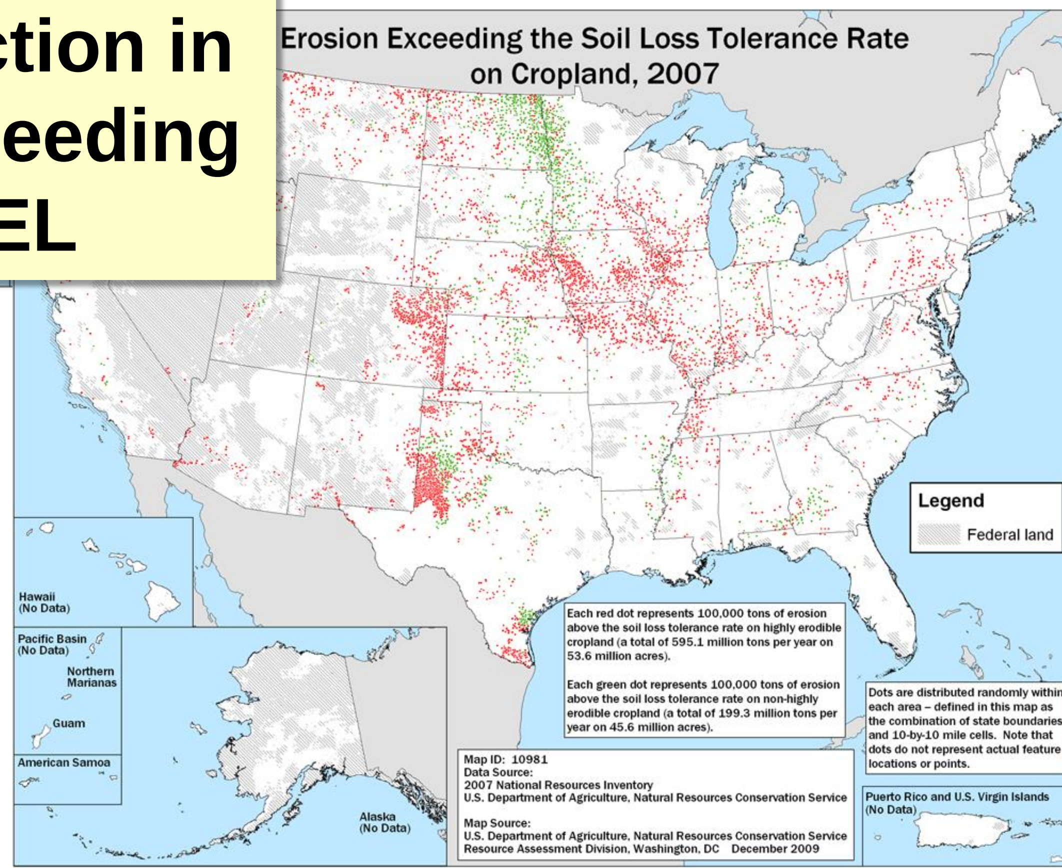


Baumhardt et al., 2015.



Good progress, but erosion rates exceeding T remain

50%+ reduction in erosion exceeding T on HEL

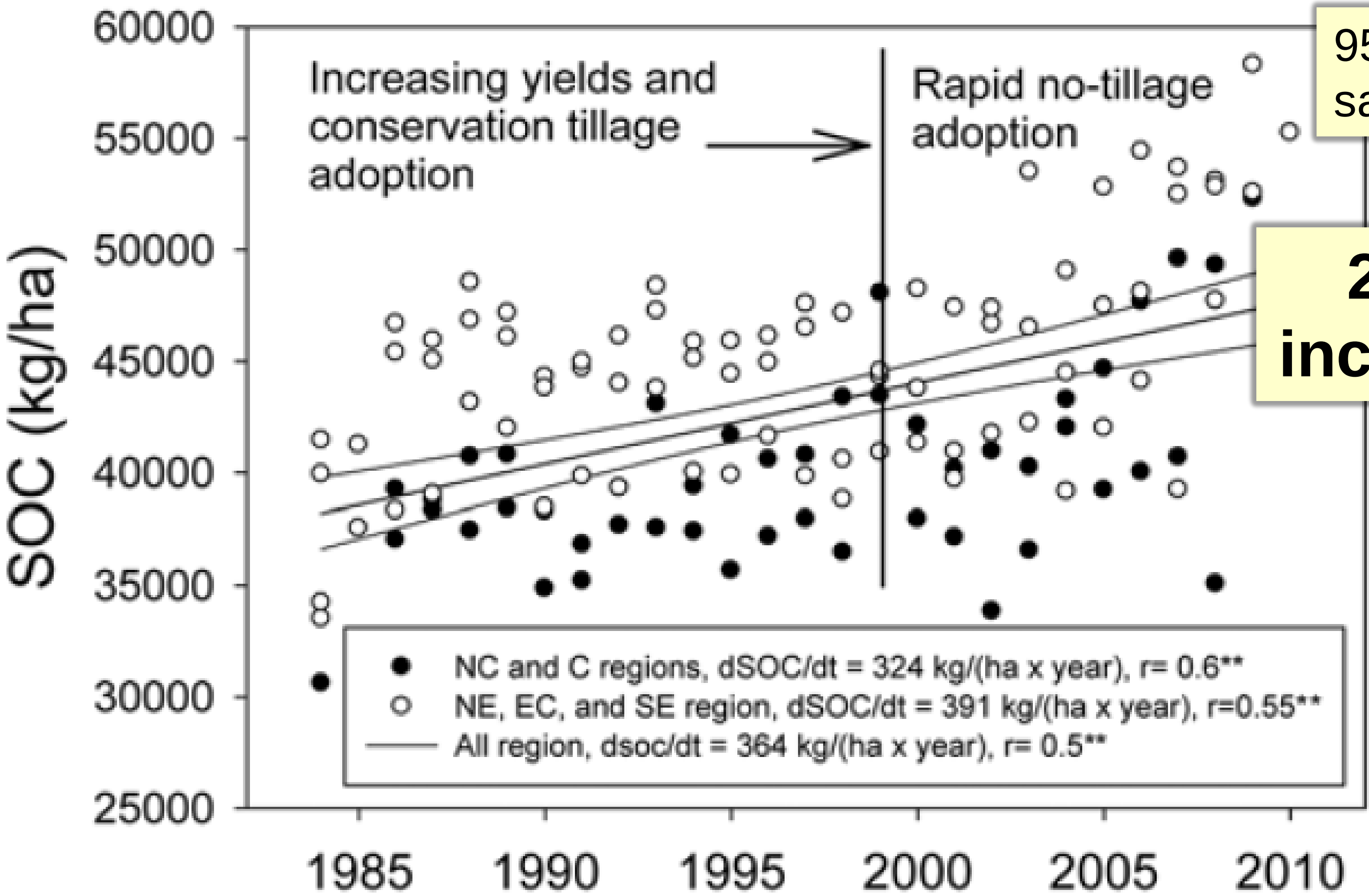


Erosion above T

Land class	1982	2007
	million tons/yr	
Highly erodable (HEL)	1322	595
Non-HEL	422	199

USDA-NRCS

Organic carbon content of surface 6 inches based on producer soil samples submitted to the SDSU soil testing lab

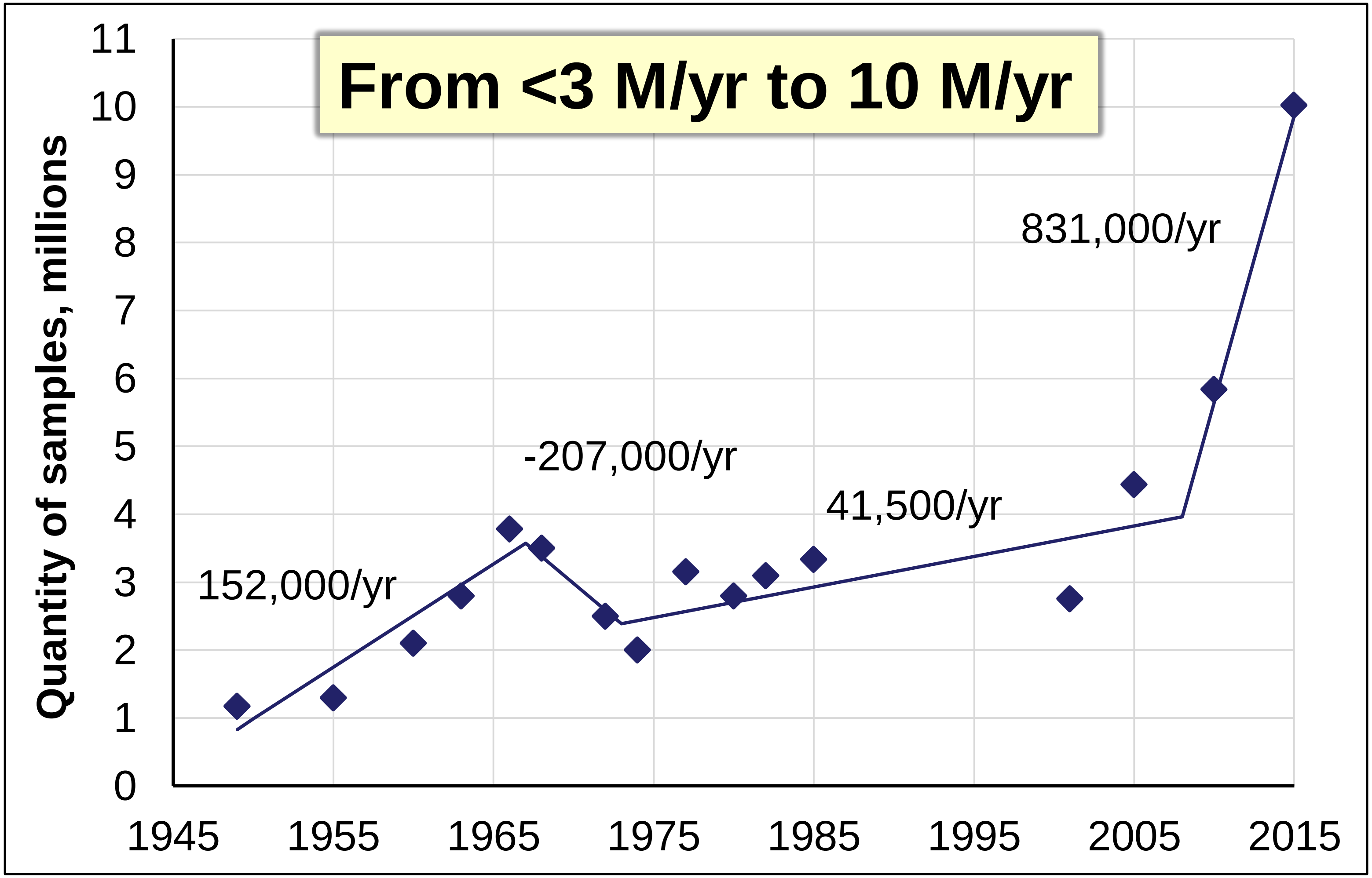


95,214 samples

25% increase

Clay et al., 2012.

Progress in soil testing in the U.S. 1949-2015



Nutrient use has never been as measurement-guided as it is today

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Nutrient balance on US cropland

NUE Expression	1987	2012
N removal/use	0.74	0.75
N balance, lb/cropland A	19	27
P_2O_5 removal/use	0.78	0.92
P_2O_5 balance, lb/cropland A	5.2	2.2
K_2O removal/use	1.13	1.44
K_2O balance, lb/cropland A	-3.7	-13.6

Considers, legume fixation, recoverable manure nutrients, and fertilizer; IPNI, NuGIS (1/5/2017).

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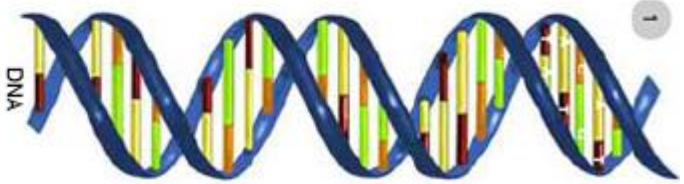
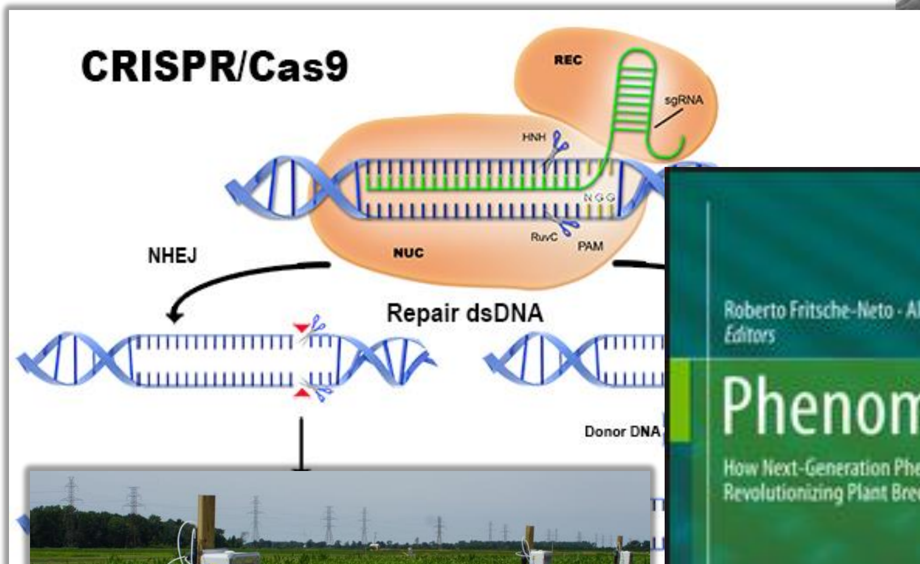
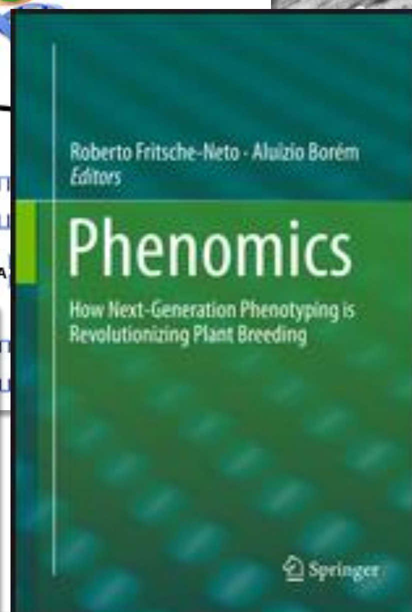
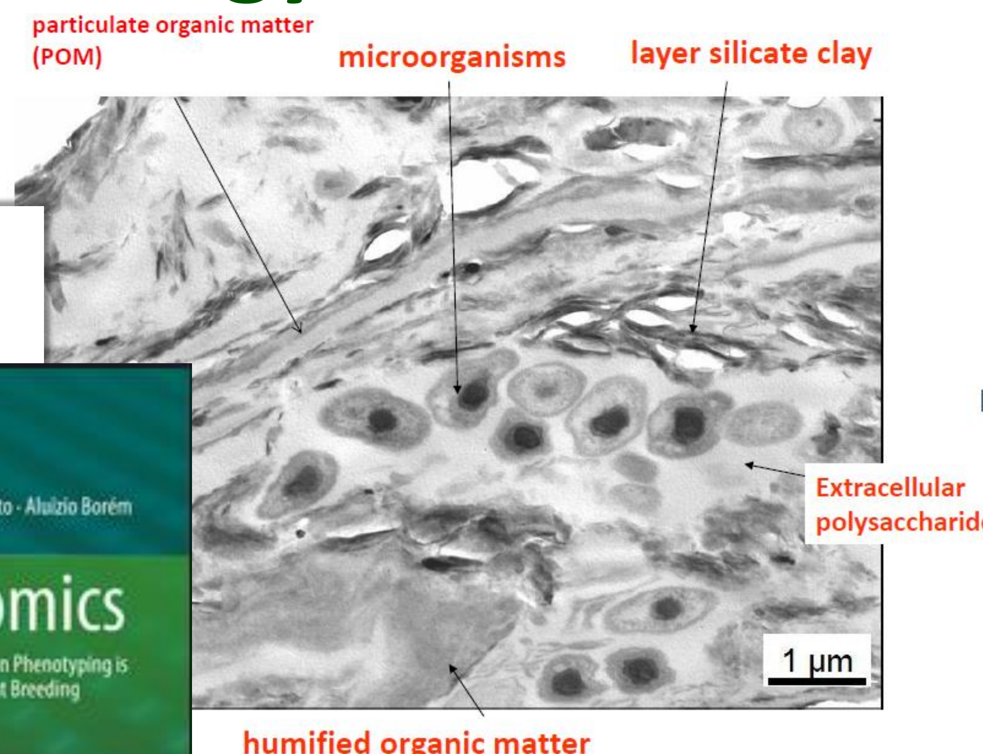
Advances in Technology in the Field

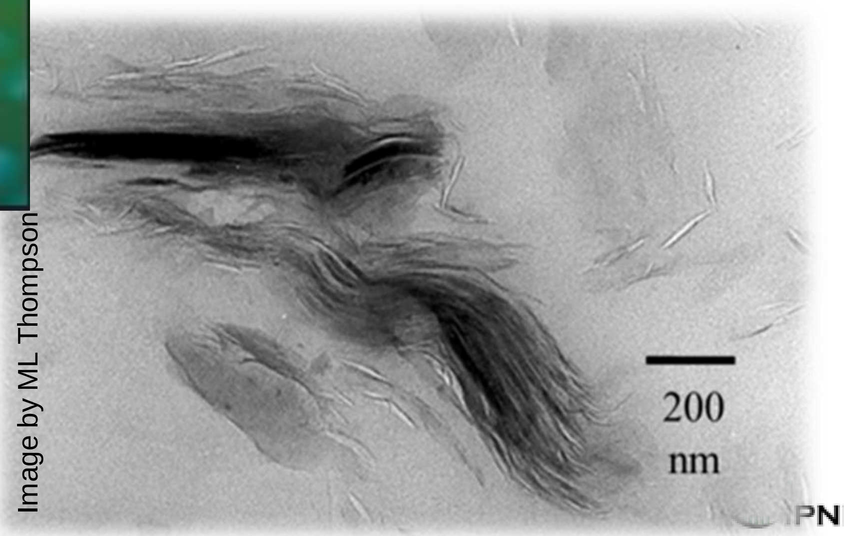
Advances in Technology in Research



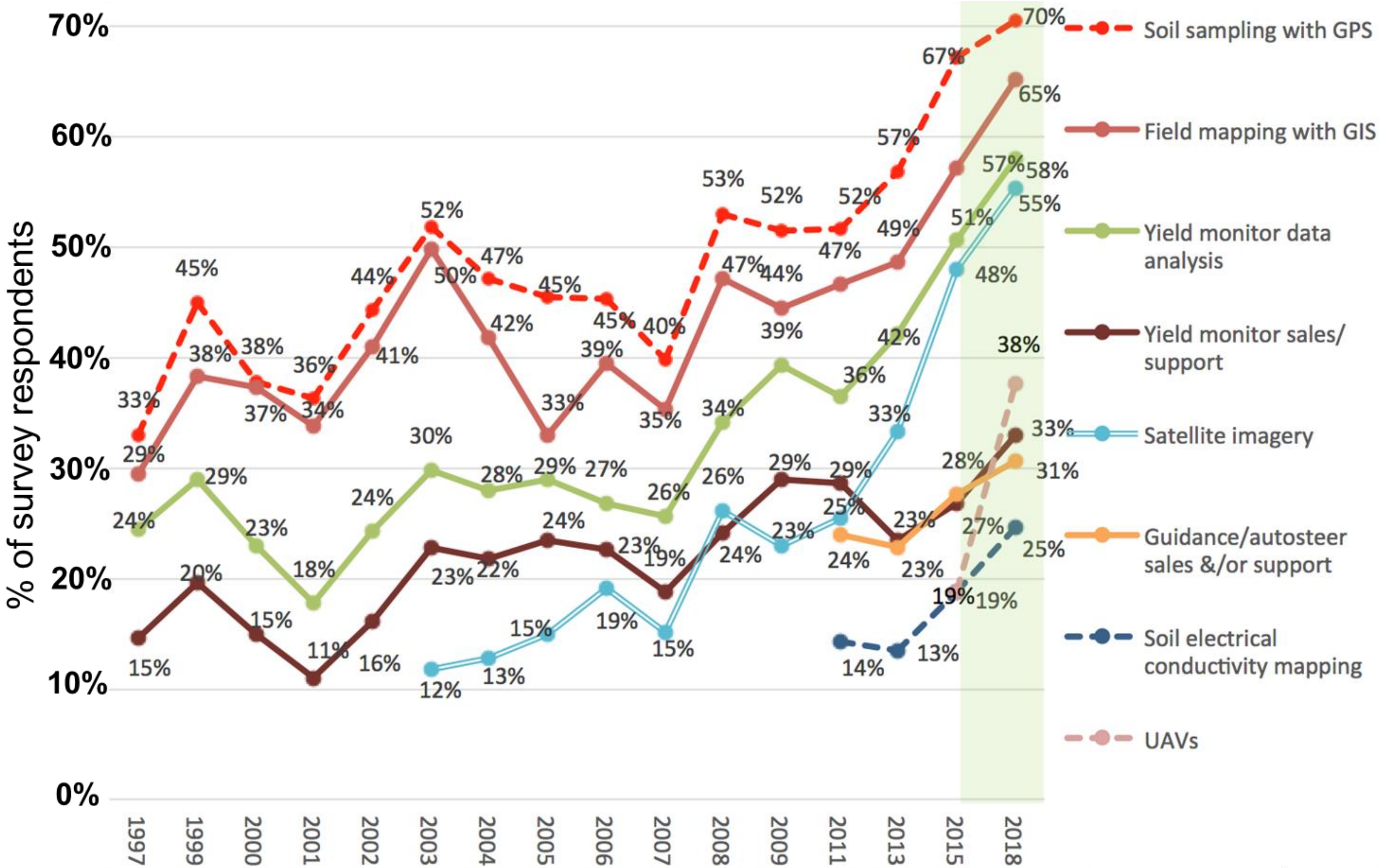






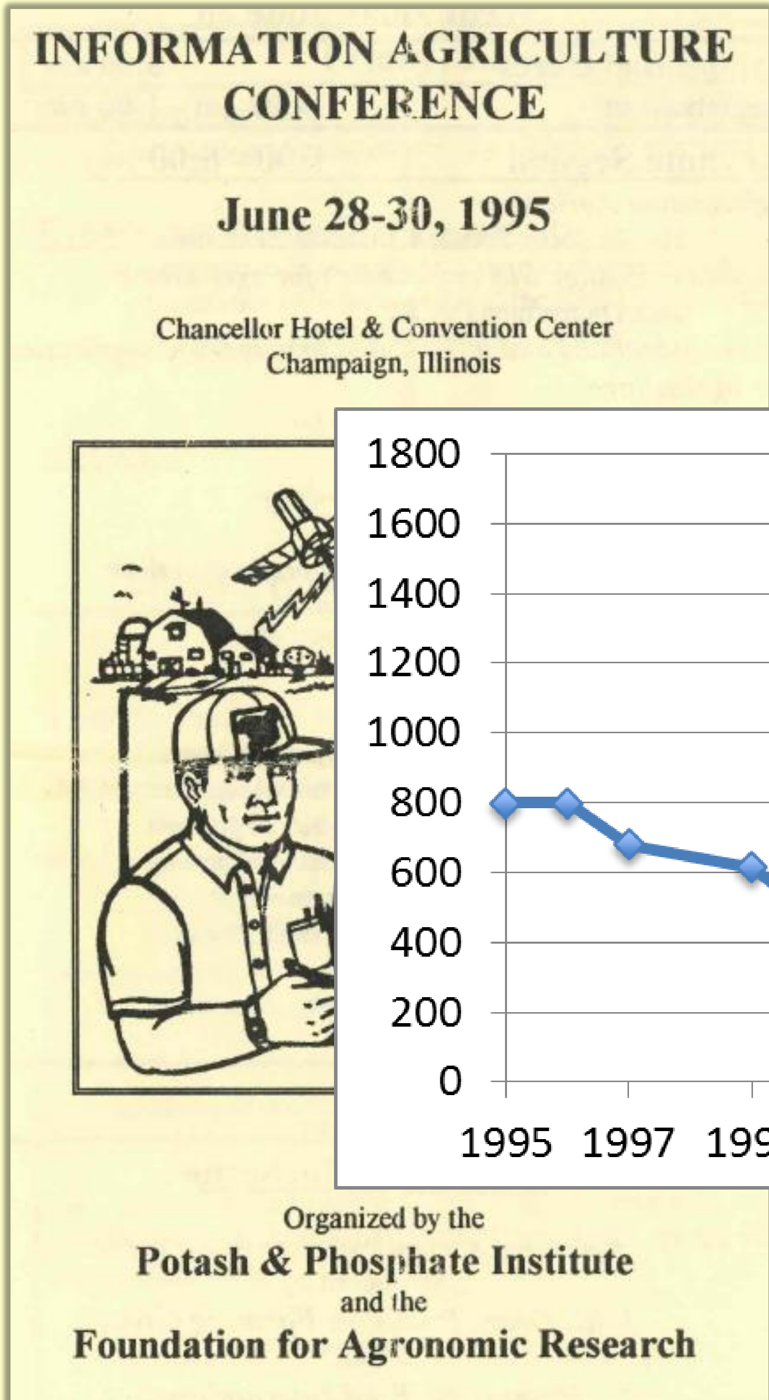


Precision services in US – rapidly increasing



Erickson, 2015

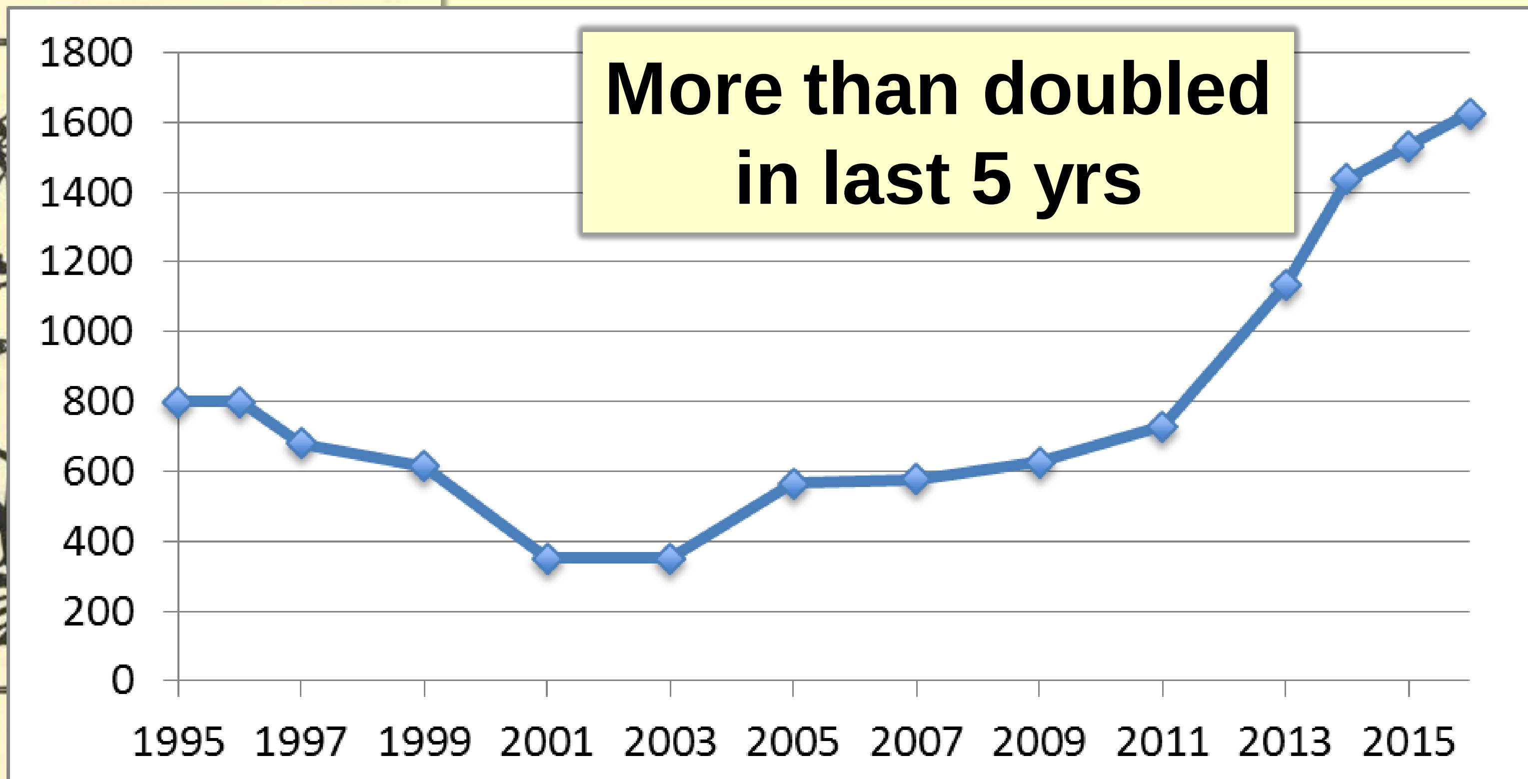
InfoAg Attendance


INFORMATION AGRICULTURE CONFERENCE

June 28-30, 1995

Chancellor Hotel & Convention Center
Champaign, Illinois

Organized by the
Potash & Phosphate Institute
and the
Foundation for Agronomic Research



Data: major component of precision - in 1995 & even more so today

1995 InfoAg Topics

- **Data analysis** in site-specific systems – Don Bullock
- **Handling data** for site-specific management – Craig Elliot
- Requirements for integrating maps & **databases** – Ted Macy

2015 InfoAg Topics

- Agronomic lessons from **data analysis** – Dan Frieberg
- **Weather data** sources – Jim Angel & Tim Marquis
- **Yield data** mining– Raj Khosla
- **Big Data** in context – Lisa Prassack & Douglas Hackney
- **Data issues** – Mary Kay Thatcher & Matthew Darr
- **Data warehouses**/exchanges – Jason Tatge & John Fulton
- Using **satellite/NASA data** – Phyl Speser & Munch Moulton

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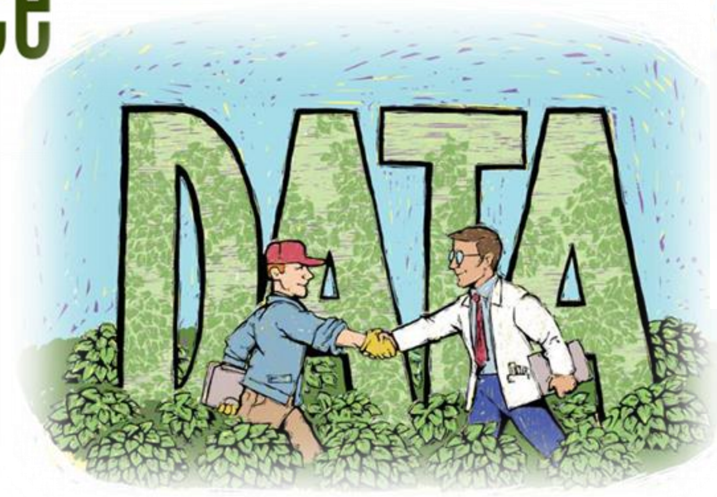

Data has become a huge part of **agronomic practice**
… and is becoming a more visible component of **agronomic science**

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Examples of progress in knowledge and its application …

It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.

Mark Twain

We ‘Know’ That Potassium Has To Be Placed Where We Want It In The Root Zone Since It Does Not Move In Soil ?

We ‘Know’ That Phosphorus Has To Be Placed Where We Want It, In The Root Zone Since It Does Not Move In Soil ?

We ‘Know’ That Starter Fertilizer Has To Be Placed Where We Want It In The Root Zone - With Or Below The Seed?

We ‘Know’ That Manure Should be Credited for its Nutrient Content which can be Estimated from Tabular Values?

A classical fertilizer recommendation paradigm

<u>Concealed in the box:</u>

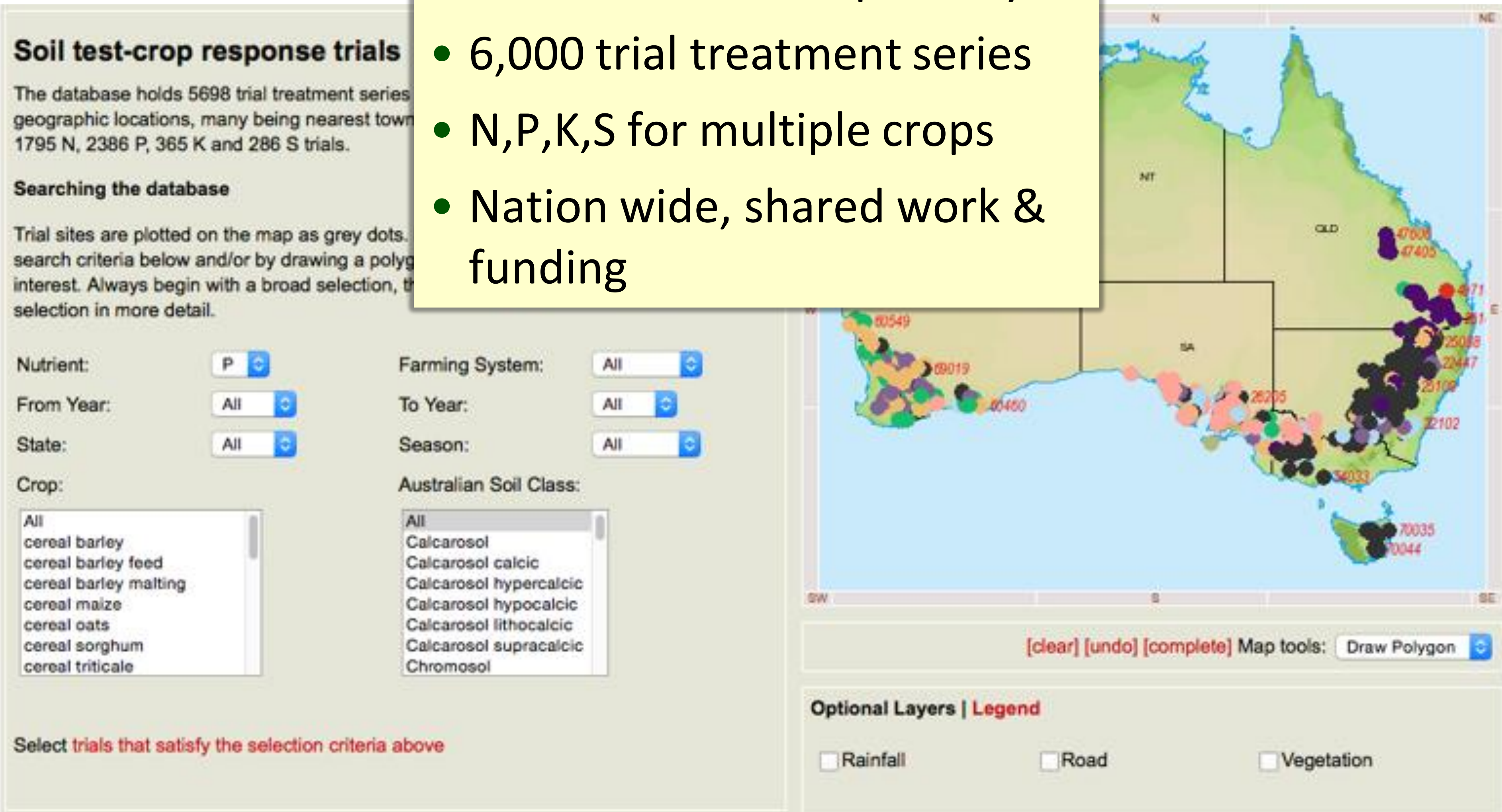
Calibration data
Other data
Data manipulation
Tradition & philosophy
Assumptions

Fixen, 1992

Evidence-based Soil Test Calibration in Australia

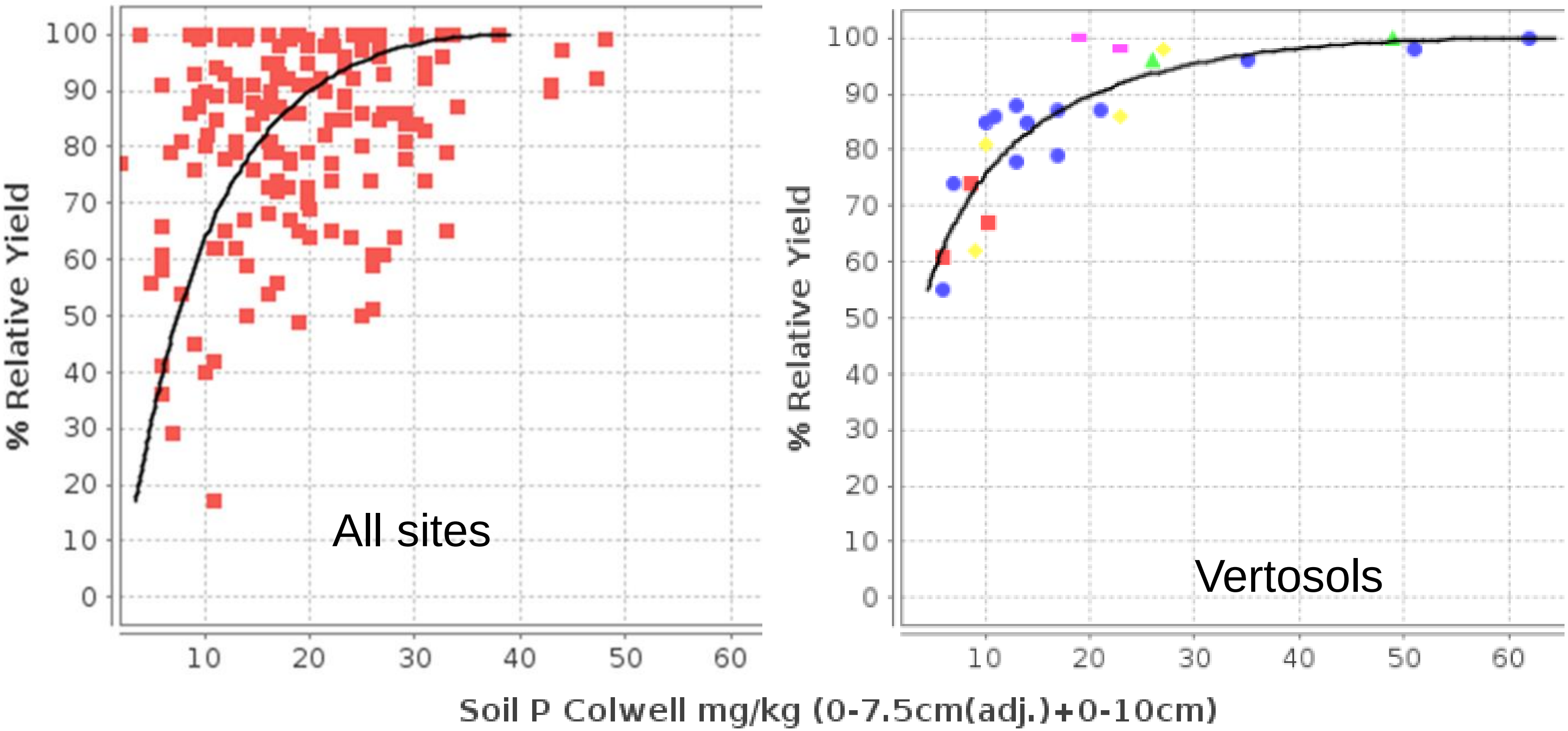
“Better Fertilizer Decisions for Cropping Systems (BFDC)”

- Searchable data repository
- 6,000 trial treatment series
- N,P,K,S for multiple crops
- Nation wide, shared work & funding



Wheat response to P fertilizer in Australia

"Better Fertilizer Decisions for Cropping Systems (BFDC)"



Effort underway for a similar system for the U.S.

www.bfdc.com.au

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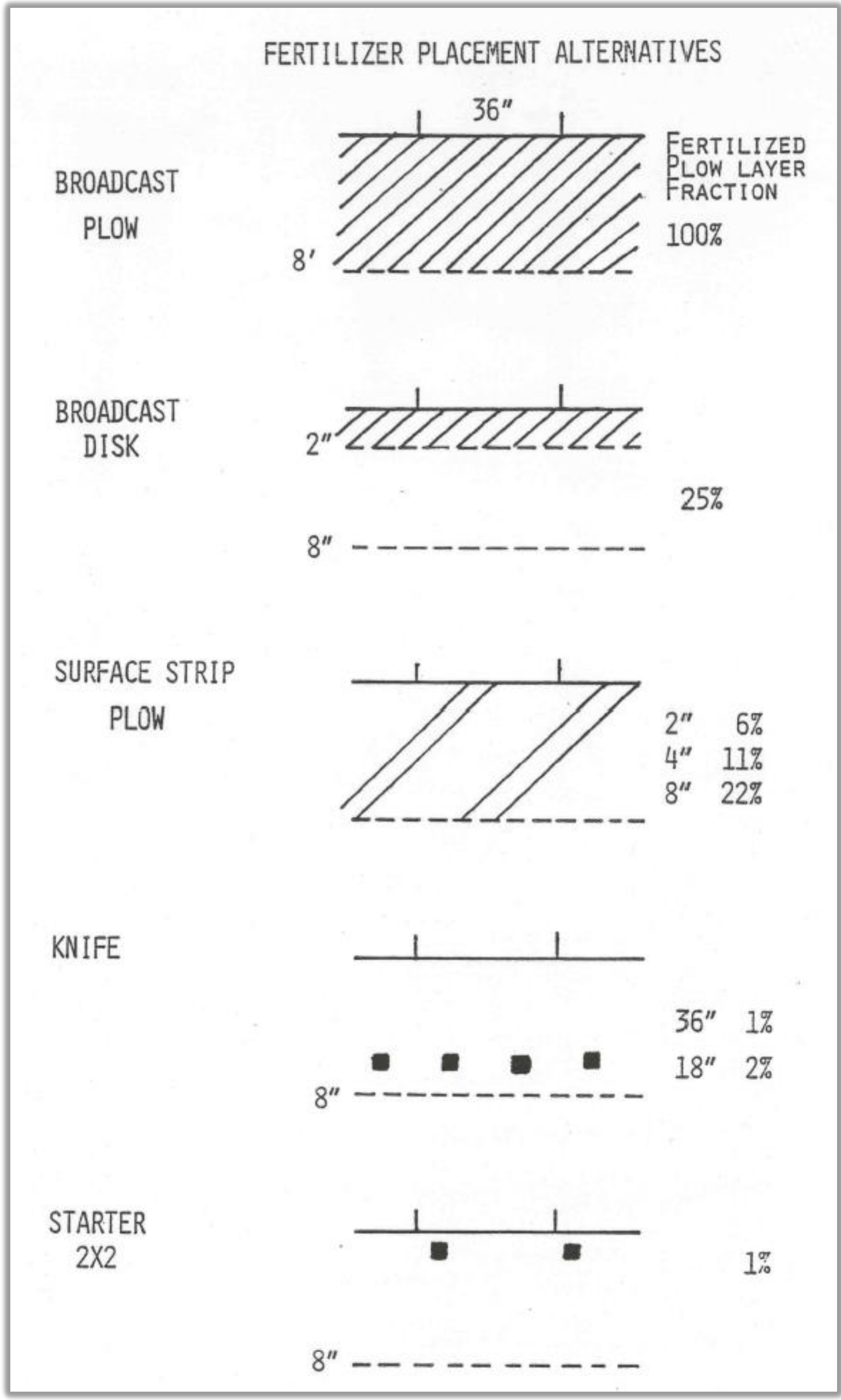
Roots, soils and fertilizer nutrients

Dr. Stan Barber
Winter 1994

- Corn or soybean roots occupy 1% of soil volume
- P movement depends on soil: faster & further in high P soils; that hold more water

- Fertilizing 5-20% of soil volume would be better than all or with conventional banding



by Dr. Stanley A. Barber

Timing And Placement One Key to High Yields

Purdue scientist shows how strip placement of fluids is superior to broadcasting.

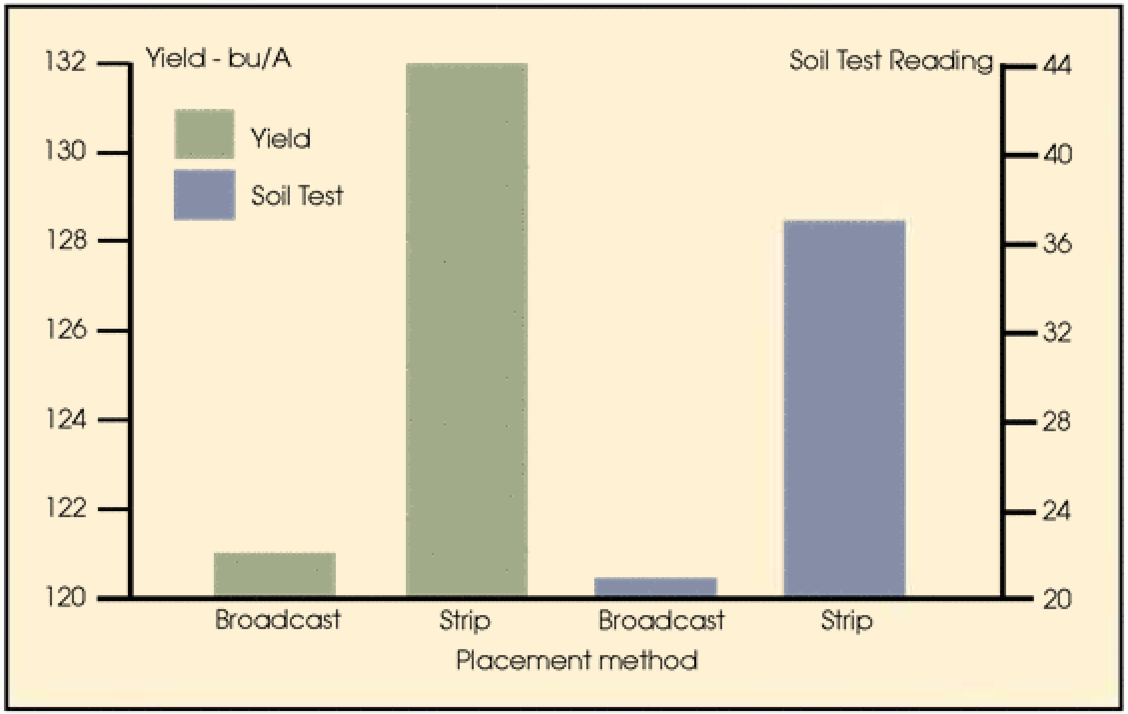


Figure 3. Average corn yields in a five-year comparison study of strip versus broadcast, Barber, Purdue University.

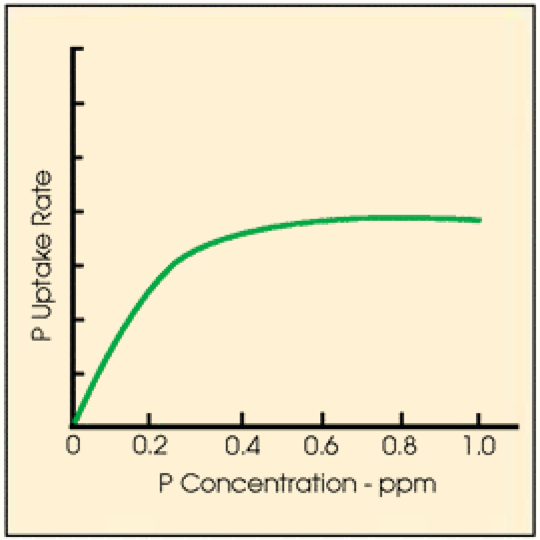


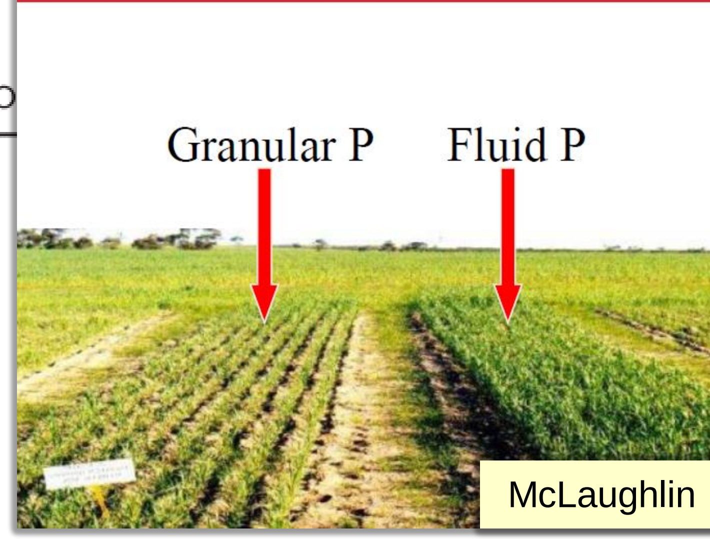
Figure 1. Relationship between phosphate in solution at the root surface and the rate phosphate is taken up by corn roots, Barber, Purdue University.

Drs. M. McLaughlin, E. Lombi, B. Holloway, R. Armstrong, Ms. C. Johnston, Ms. D. Brace

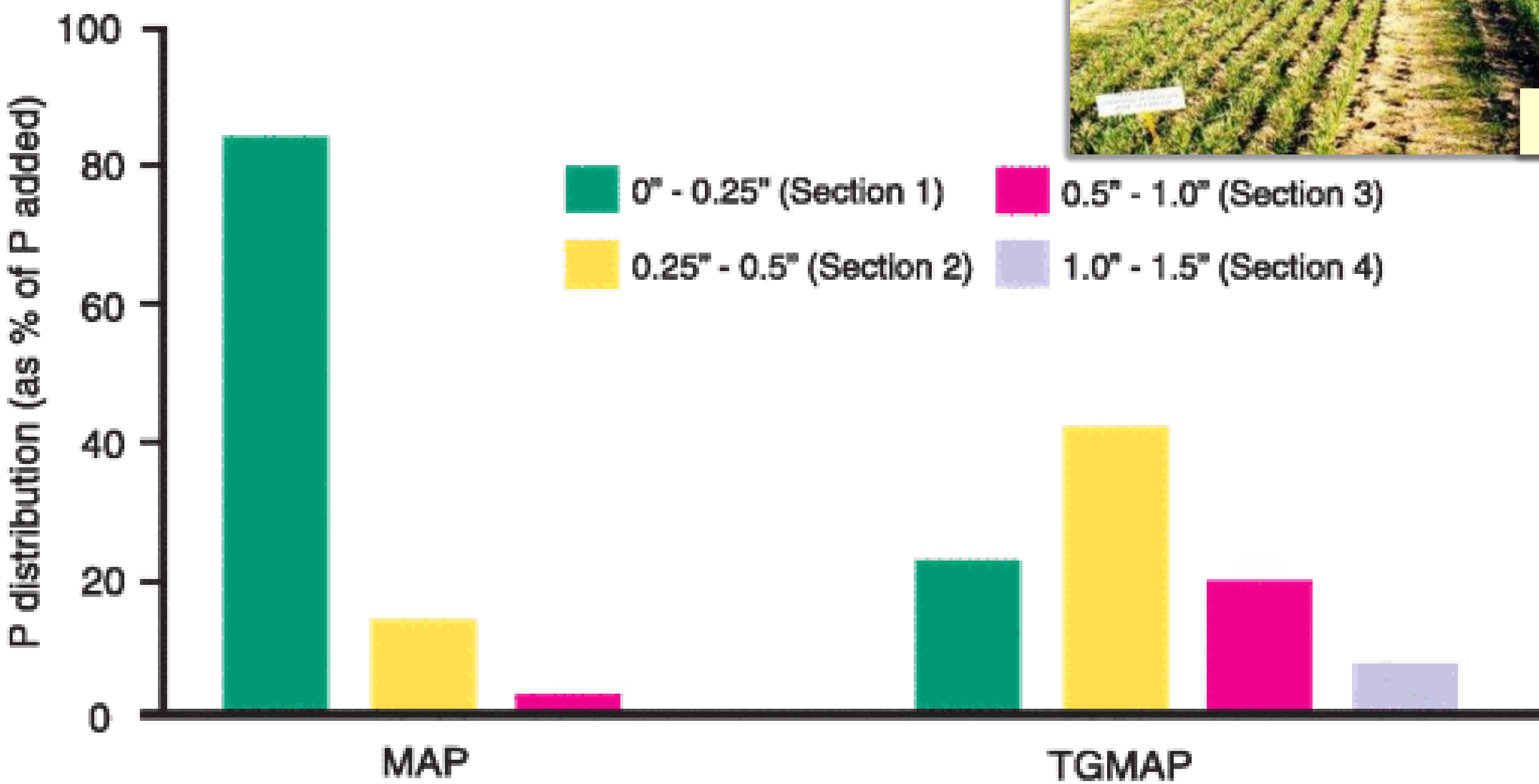
Fluids Beat Granular in Soil

Granular fertilizers found to be inferior to fluids in calcareous so

Fluid P effective in calcareous soils



Increasing movement … a placement effect



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Larry Oldham and Dr. George Rehm

Does Pattern of Root Development Explain Variances in Crop Response?

Minnesota ridge-till studies suggest corn hybrids with shallower root system patterns may respond better to potash applications in early growth stages.

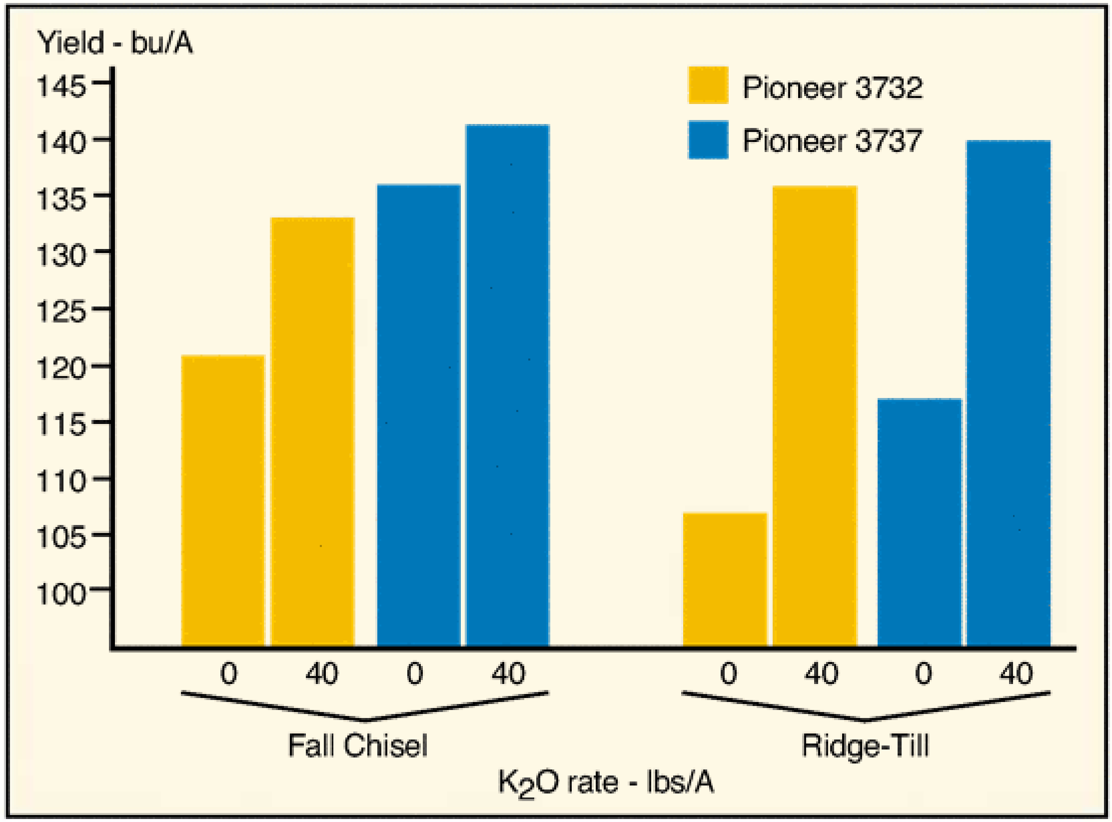

Figure 2. Corn yields in two tillage systems as affected by hybrid and banded potash, yields avg. of two years, Oldham and Rehm, University of Minnesta, 1991-92.

Figure 3. Root system patterns of two hybrids used in field research, Oldham and Rehm, University of Minnesota.

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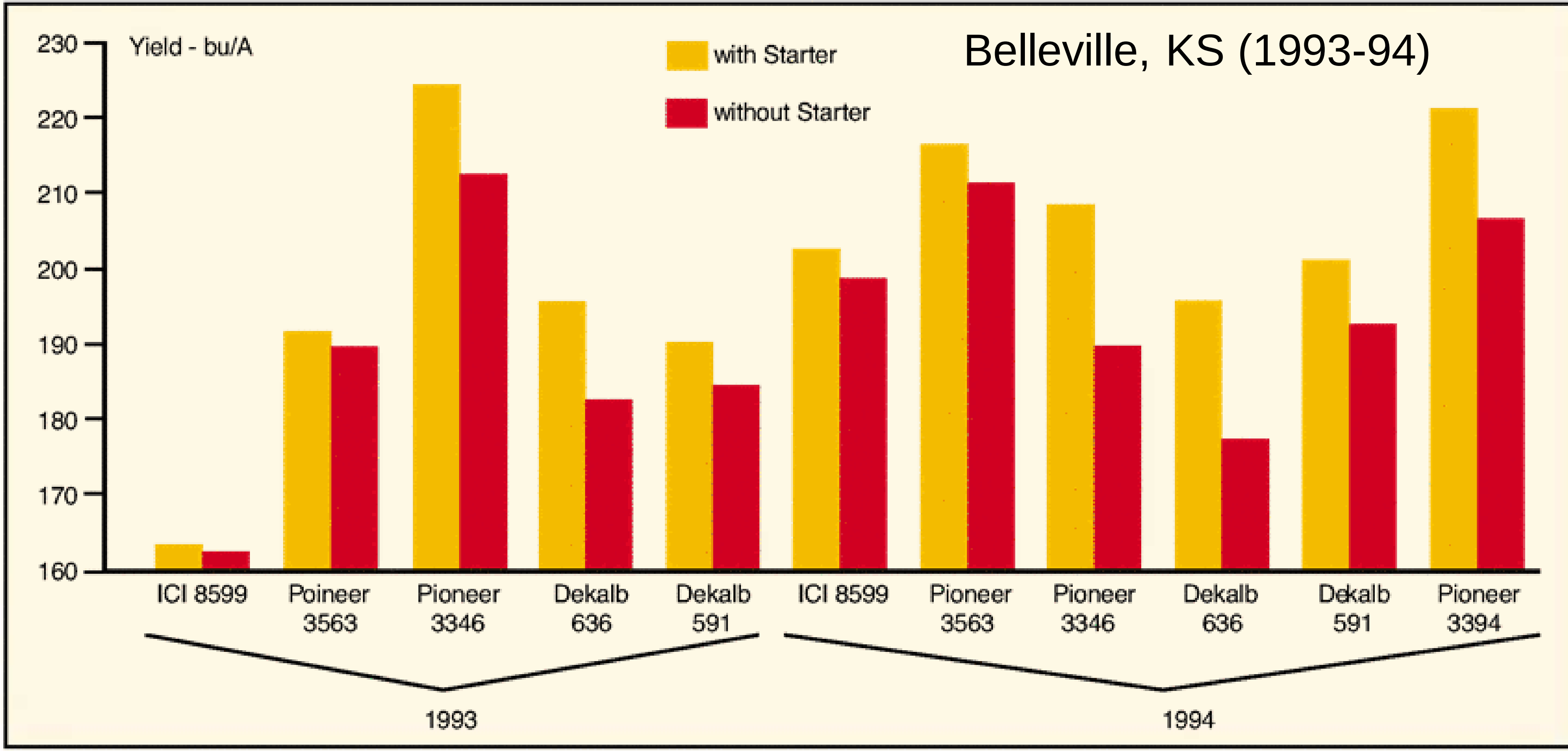
Drs. W. B. Gordon, D. L. Fjell, and D. A. Whitney

Corn Hybrids Vary In Response To Starter Fertilizers

Possibility of different rooting characteristics in hybrids prompts this two-year study of selected corn varieties grown under no-till, dryland conditions.



Achieving 300 Bu/A Corn Sustainability

Involves agricultural intensification that pursues higher yields, biofuel production potential, and preservation of our soil and water resources.

Drs. Laura F. Gentry and Fred E. Below

The Fluid Journal • Official Journal of the Fluid Fertilizer Foundation • Spring 2011 • Vol. 19, No. 3, Issue #73

Table 3. Traditional vs. high-tech, two years.

	Traditional		High-tech	
Factor	Yield	*	Yield	**
	Bu/A[-1]			
None or all	193		245	
Fertility	197	+4	236	-9
Nitrogen	198	+5	232	-13
Genetics	202	+9	225	-20
Population	187	-6	238	-7
Fungicide	198	+5	218	-27

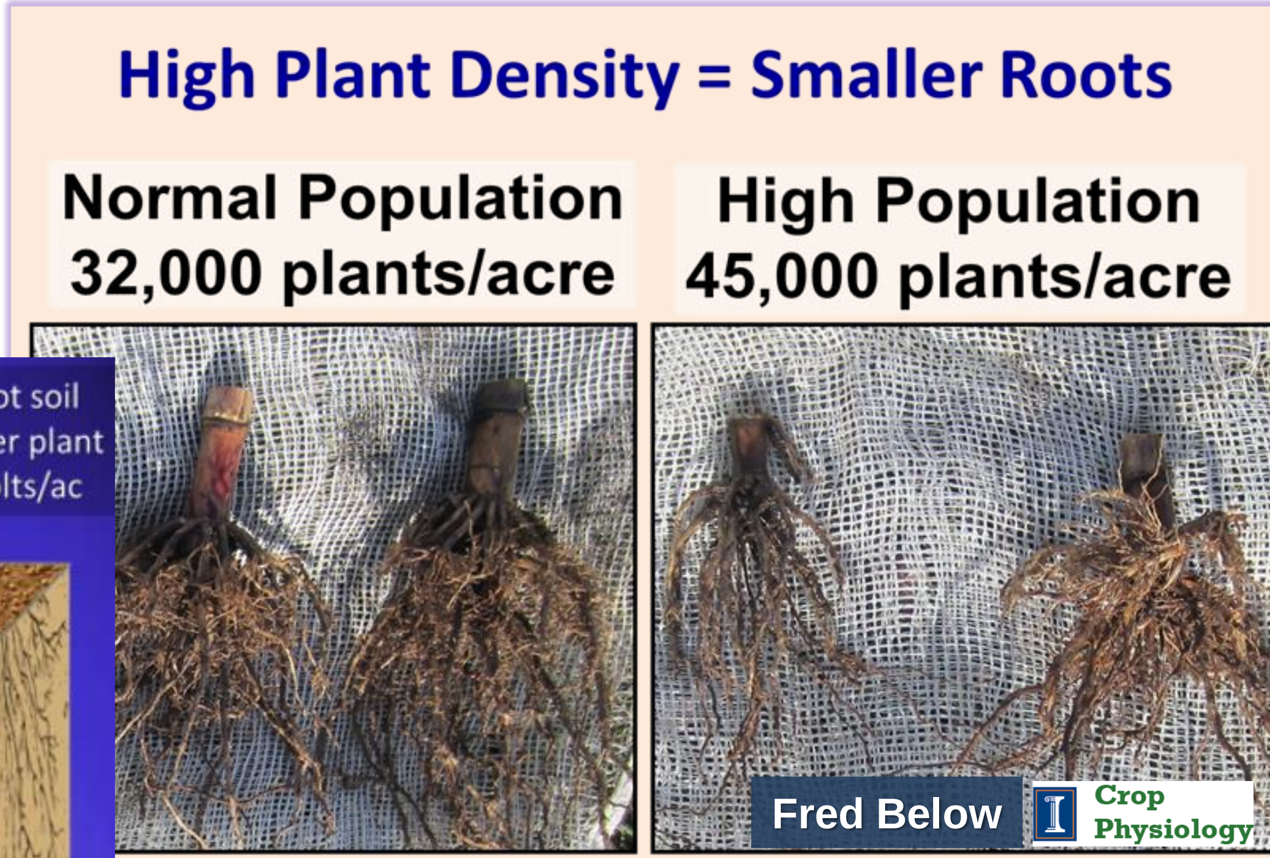
Data from Champaign and Dixon Springs

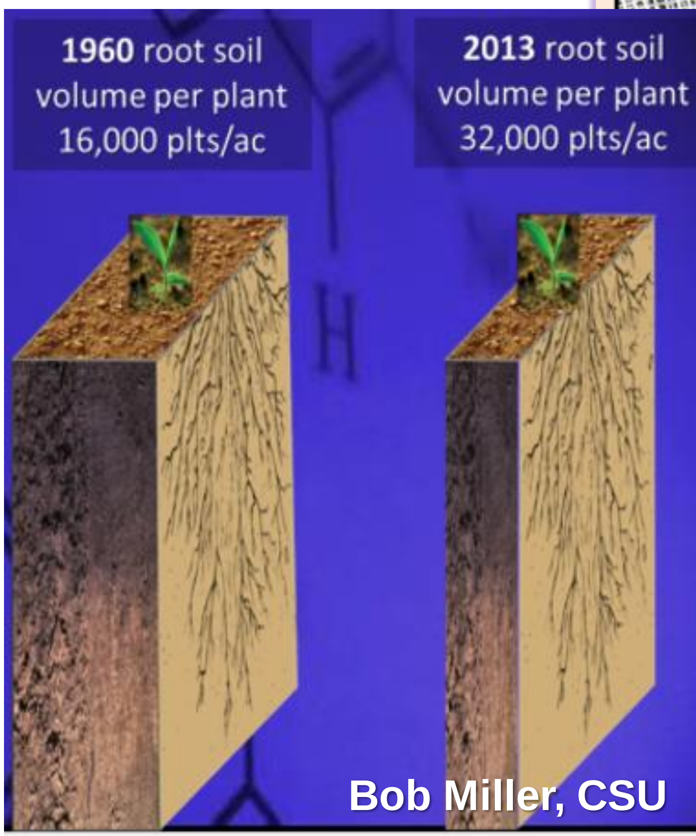
* *Difference when changed to high-tech level*

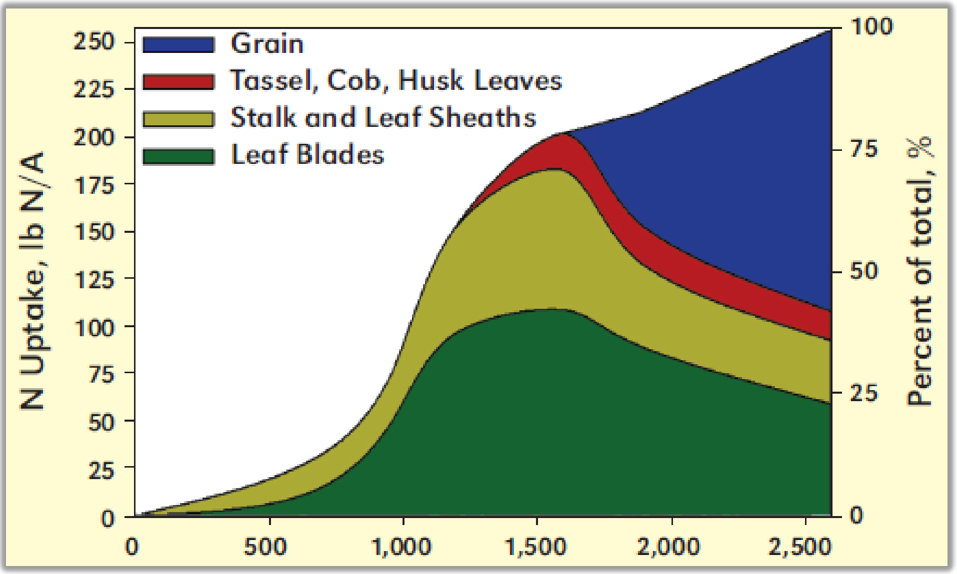
** *Difference when changed to traditional level*

*** *Adapted from Ruffo, Henninger, and Below. A new experimental design to analyze the value of management factors contributing to high corn yield. Am. Soc. Ag. Mtg. Oct 31-Nov 4, 2010.*

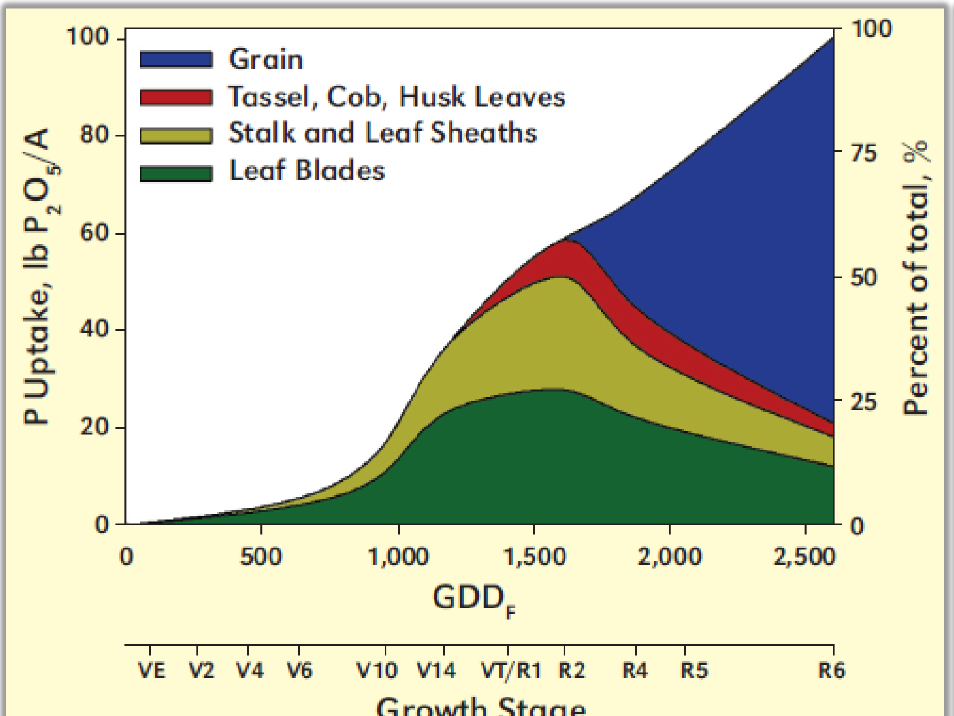
Higher Yields & High Population: Impact on Root Mass & Nutrient Uptake?

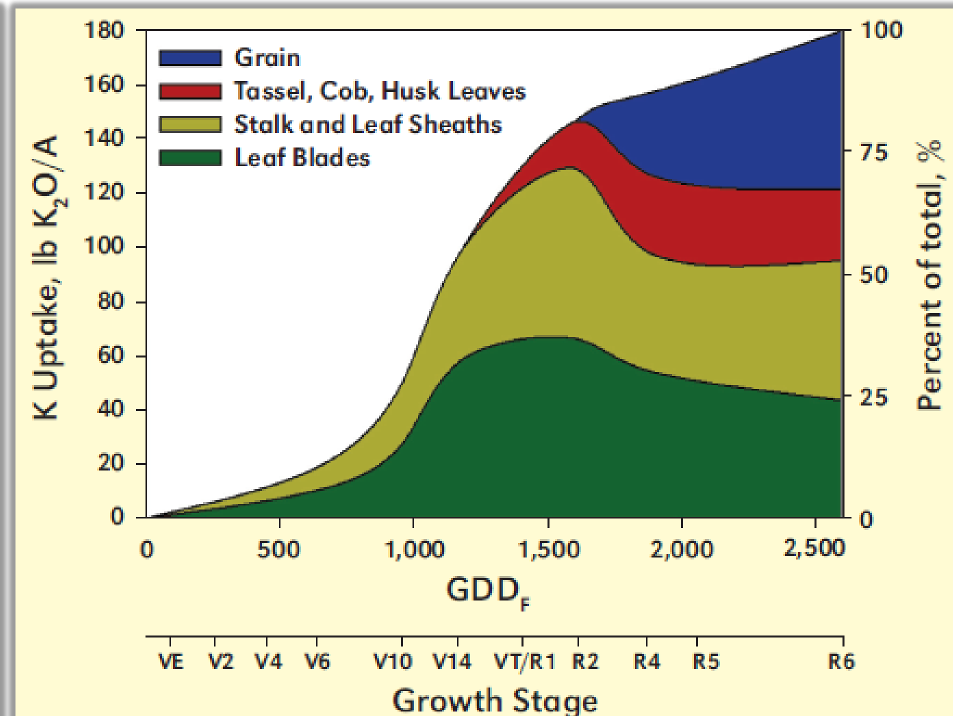






Meeting nutrient demand through entire increasingly variable growing seasons





Bender et al., 2013.

Photo by Alyssa Abbott, DuPont/Pioneer Account Manager; NE IL

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Fluid JOURNAL
Official Journal of the Fluid Fertilizer Foundation
Early Spring 2008
Vol. 16 No. 2, Issue #60

Dr. Newell R. Kitchen

What's Right Amount of N? Using Sensors May Provide Better Answer

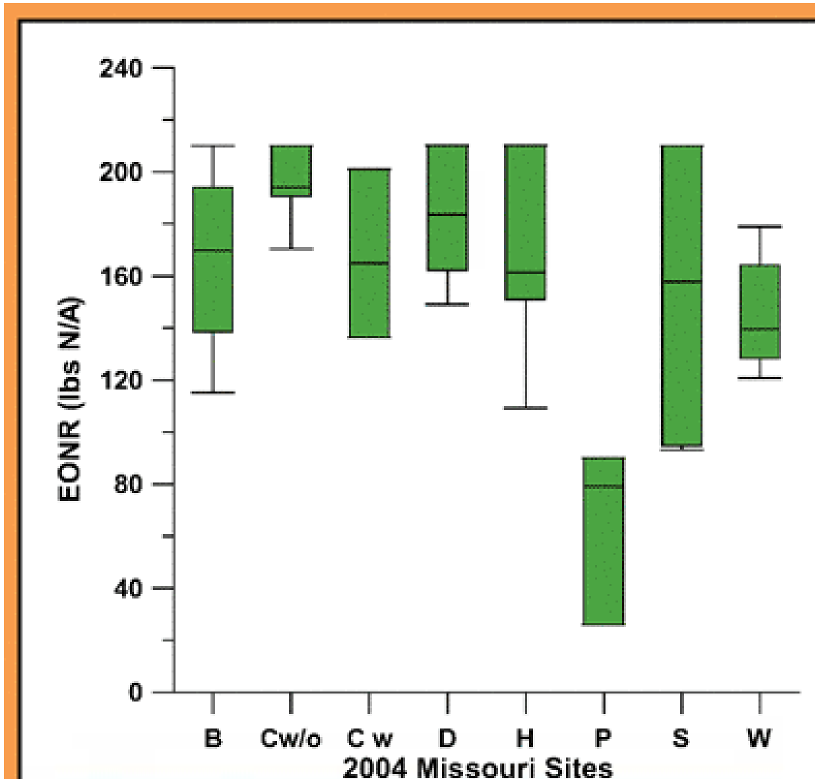

Figure 1. Economic optimal N rate (EONR) varies tremendously between farmers' fields and within fields (box represents the 25th to 75th percentile).

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Nitrogen Source Effects on Soil Nitrous Oxide Emissions

an be a mitigation practice for reducing N_2O emissions in irrigated corn.

Drs. Ardell Halvorson, Stephen Del Grosso, and Claudia Jantalia

al of the Fluid Fertilizer Foundation • Late Spring 2013 • Vol. 21, No. 3, Issue # 81

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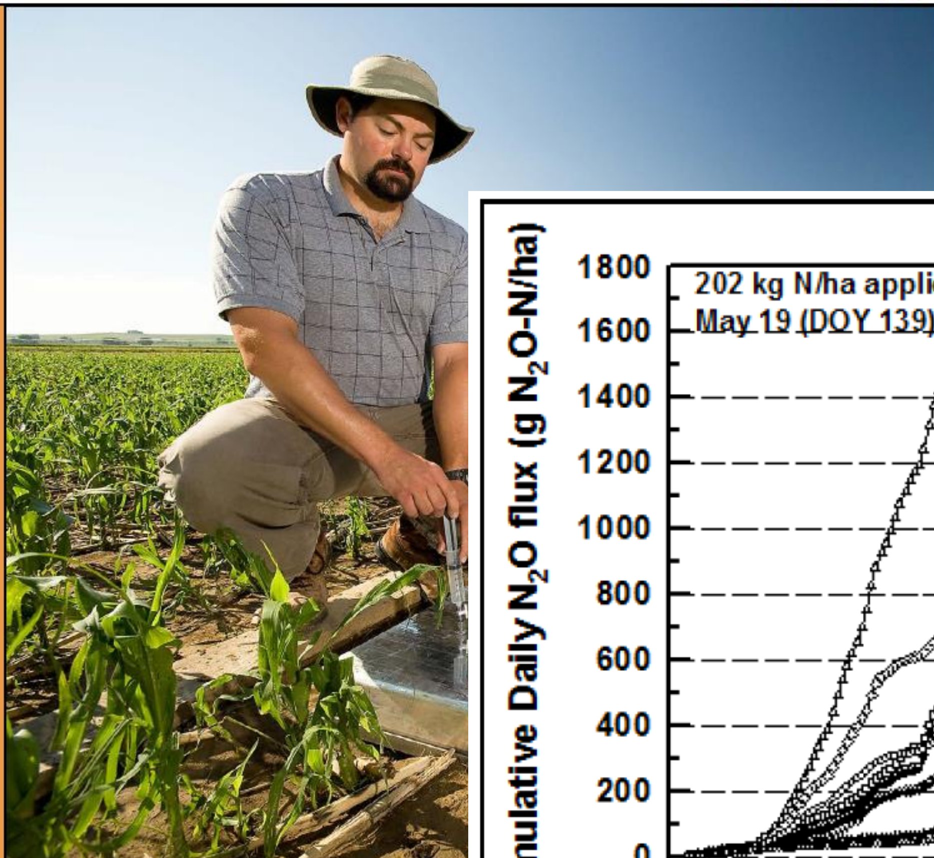

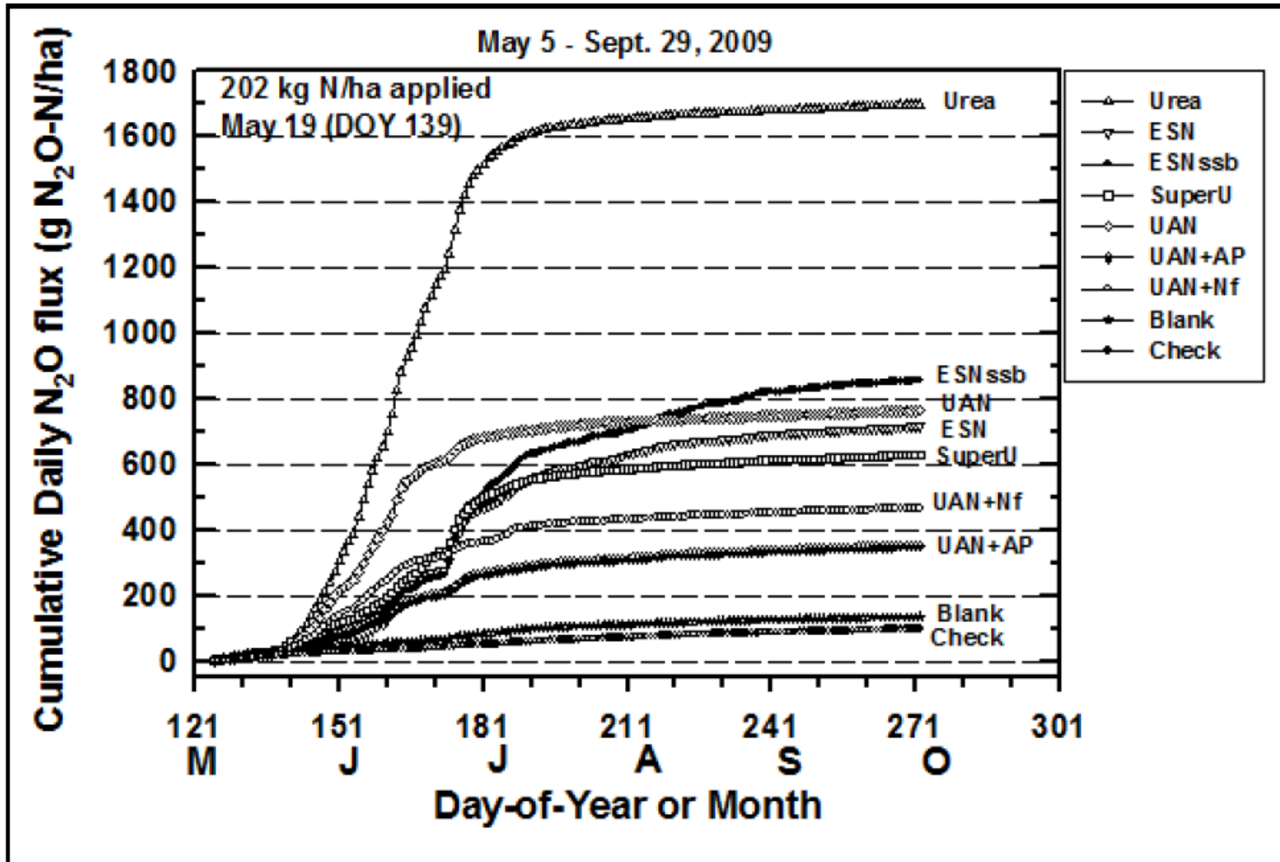

Figure 6. Cumulative daily N2O-N emissions during the 2009 growing seasons for each N treatment: urea, urea-ammonium nitrate (UAN), ESN, ESN subsurface band (ESNssb), SuperU, UAN+Nfusion (Nf), UAN+AgrotainPlus (AP), blank, and check.


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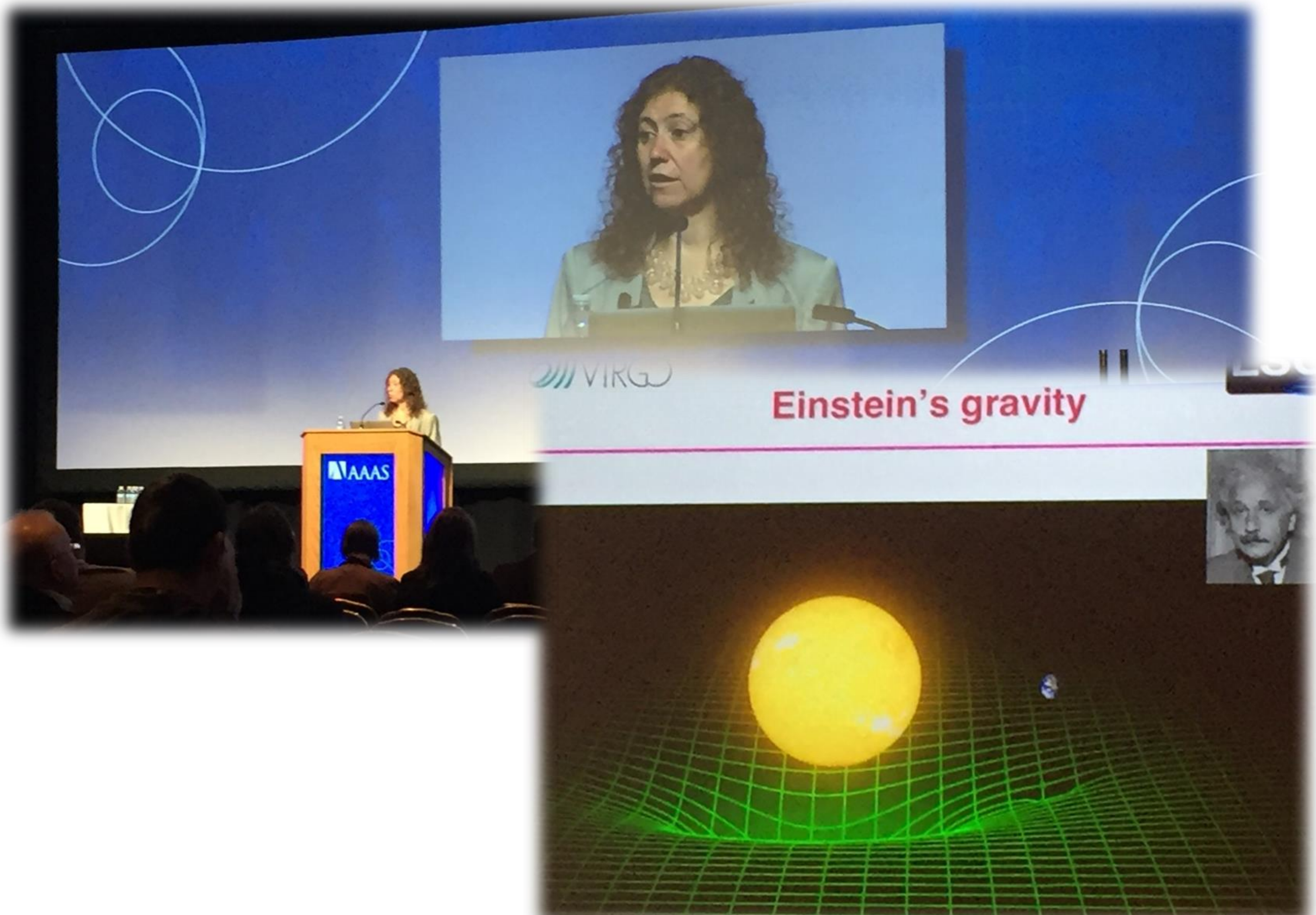
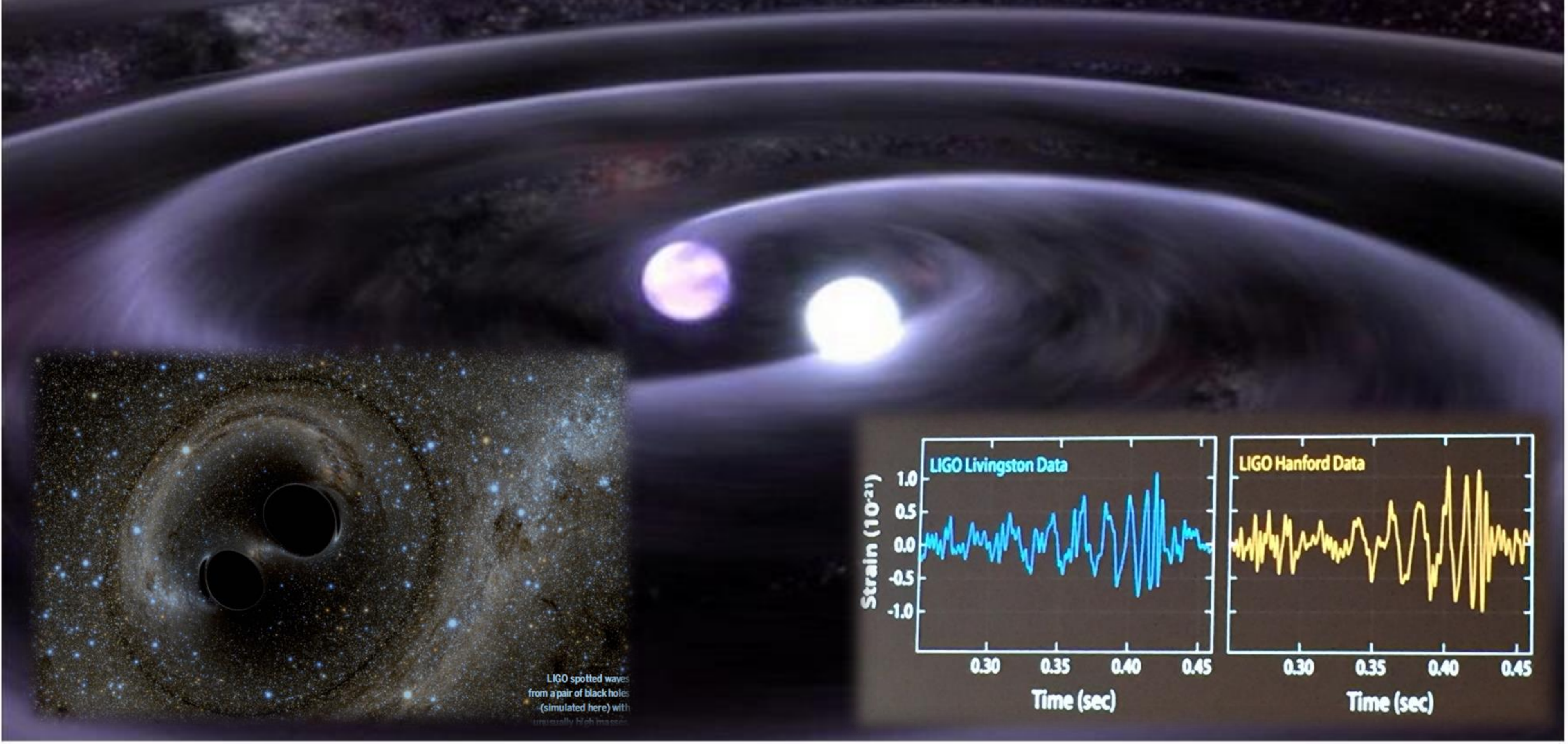
Special section: Breakthrough of the Year
Science's editors and writers choose their scientific breakthrough of 2016
© Rich Frishman
2016
BREAKTHROUGH
of the YEAR


The cosmos aquiver
Detections of gravitational waves foreshadow a new way to eavesdrop on the most violent events in the universe
By Adrian Cho

AAAS Annual Meeting, February 2016



Gravitational Waves



NASA/CXC/GSFC/T. Strohmayer

- 1.3 billion light years away – two black holes merged
- On 9/14/2015 the impact on space-time was **<u>MEASURED</u>** on Earth … Einstein in 1916 was right!

Selected for a Viewpoint in *Physics*
PRL **116,** 061102 (2016) PHYSICAL REVIEW LETTERS week ending 12 FEBRUARY 2016

Observation of Gravitational Waves from a Binary Black Hole Merger

B. P. Abbott *et al.**

1,000 authors collaborating … sharing ideas, resources & data

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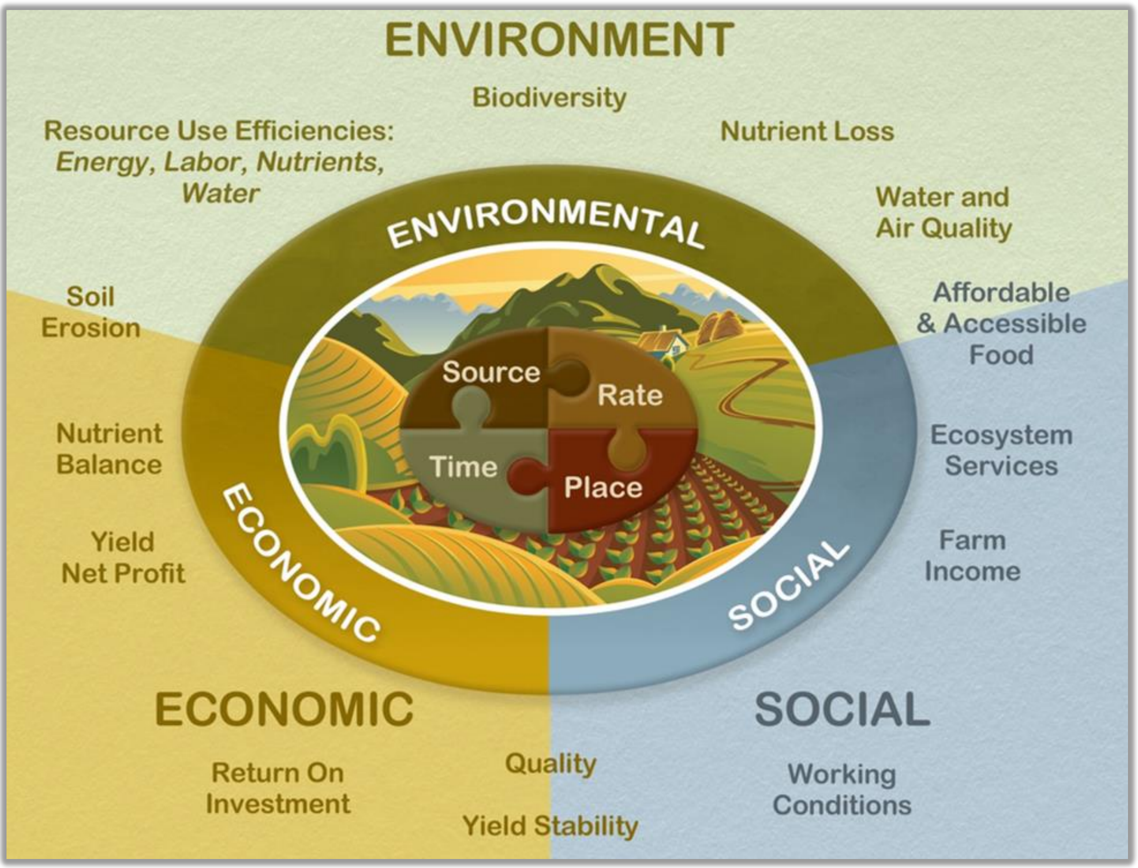
Collaboration in Agronomy

- Meeting pre-competitive needs
- To focus resources on common science-based needs – short & long term
  - 1977 Potash & Phosphate Institute (PPI)
  - 1980 Foundation for Agronomic Research (FAR)
  - 1982 Fluid Fertilizer Foundation (FFF)
  - 1992 Certified Crop Adviser program (CCA)
  - 2007 International Plant Nutrition Institute (IPNI)
  - 2013 4R Research Fund

- Launched in 1992 … 1st exam in 2/93 (Passing rate <50%)
- Requested by and led by the industry
- 13,000+ certified professionals providing science based guidance to producers
  - Instrumental in the progress made in nutrient stewardship & agronomic practice
  - Even more so in the future



nutrient stewardship

The greatest sign of stewardship progress in 35 yrs?

- **2007:** Presented in raw form as a global framework for adapting fertilizer BMPs to local conditions
- **In 10 yrs:** a remarkable impact on the mind set of producers, advisers, NGOs, and researchers

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What's next?

We do not know!

- Fluids and 4Rs
- Genetic improvement
- Nutrient sources
- Soil fertility
- Evidence
- Communication

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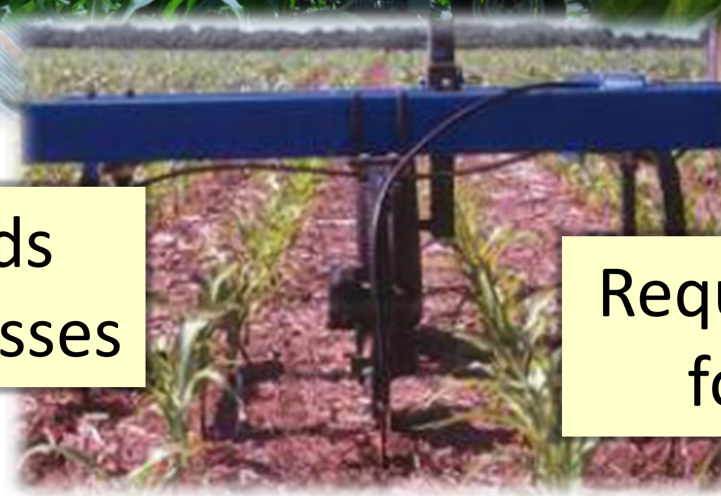
Fluids and 4Rs – great opportunity (right source, place, time … and rate)



Meeting crop needs
Reducing nutrient losses

Requires **evidence** for adoption

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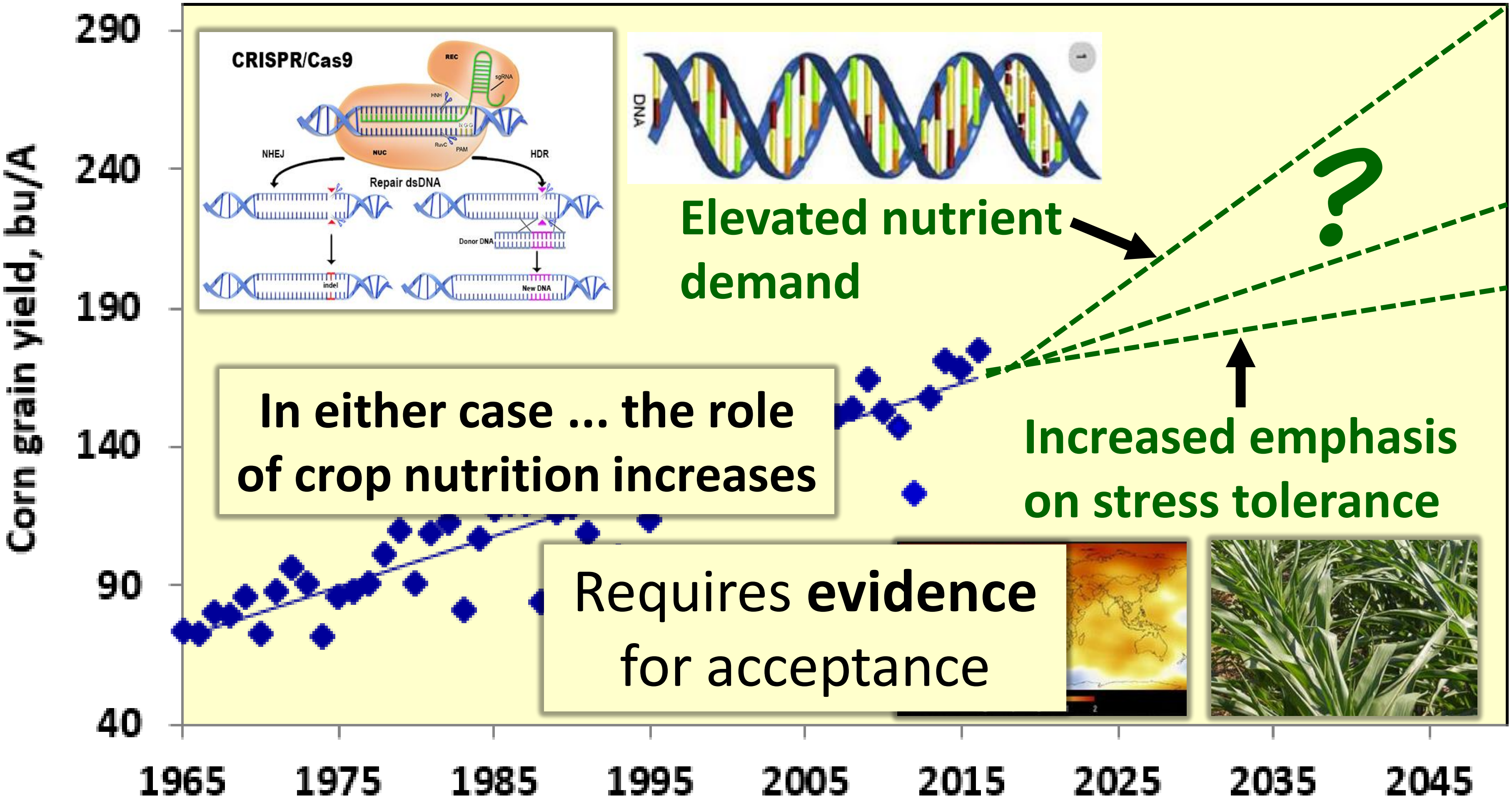
Accelerated genetic improvement?
Negative impacts of climate change?



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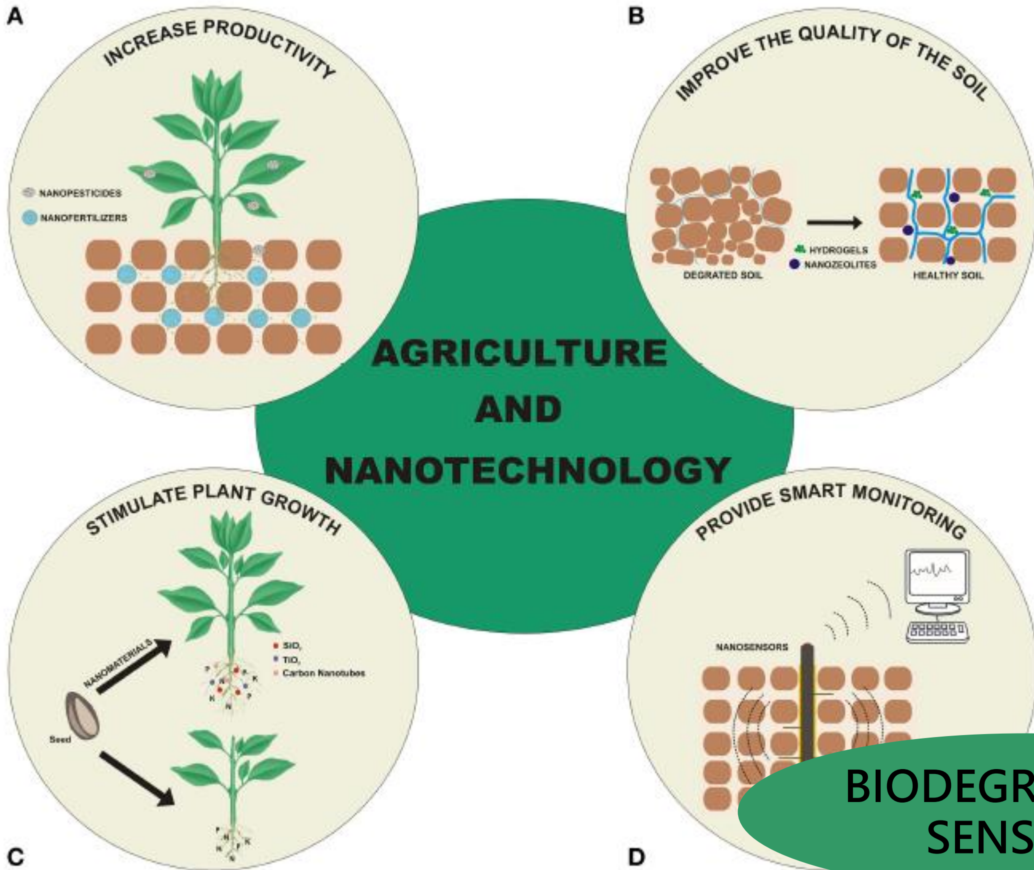
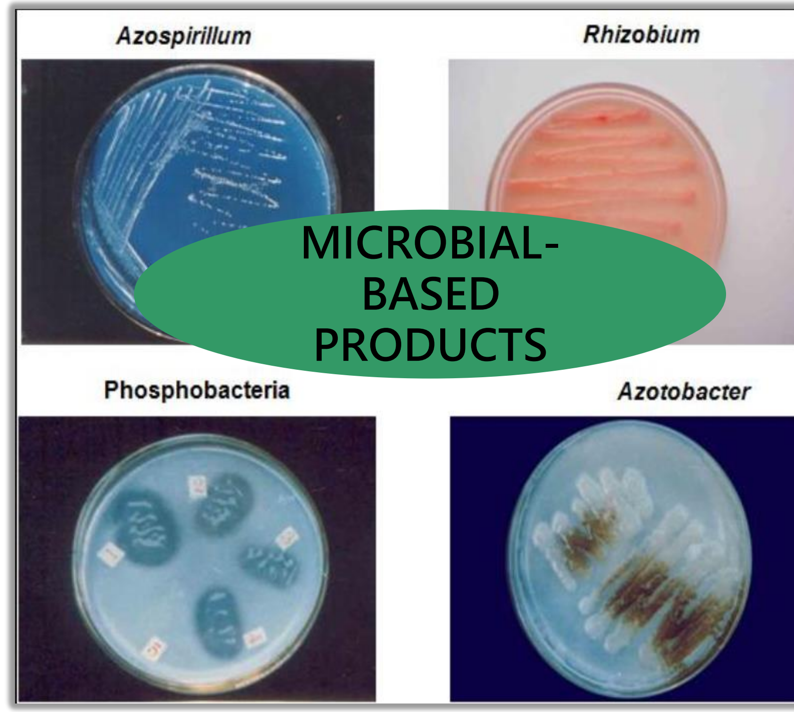
Advances in nutrient sources?





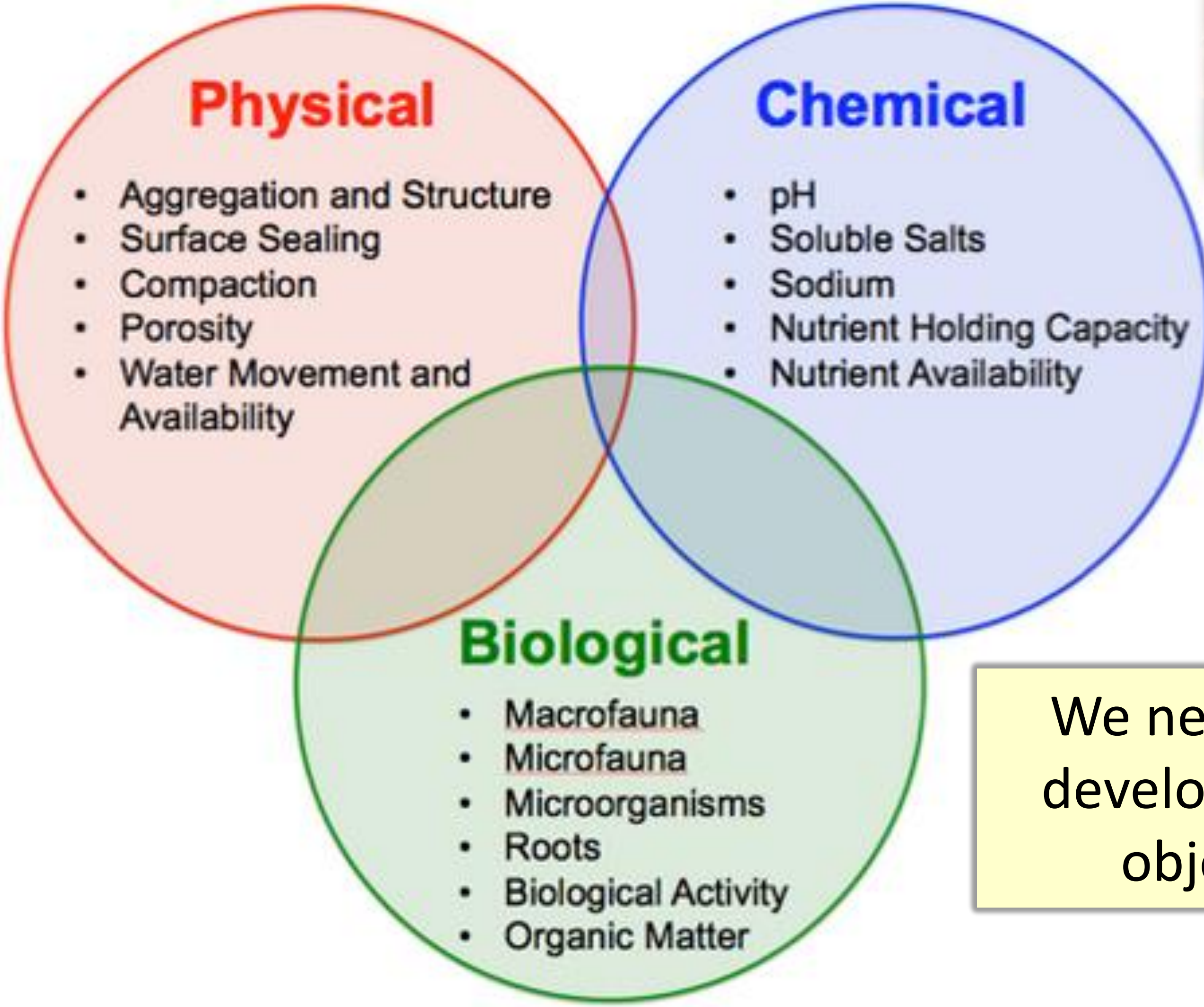
MICROBIAL-BASED PRODUCTS

BIODEGRADABLE SENSORS

Whether investing, purchasing or advising:
Insist on reliable data … look for **evidence** … evaluate cost/benefit
… beware of miracles ... consider long-term impacts

See next topic …

SOIL HEALTH

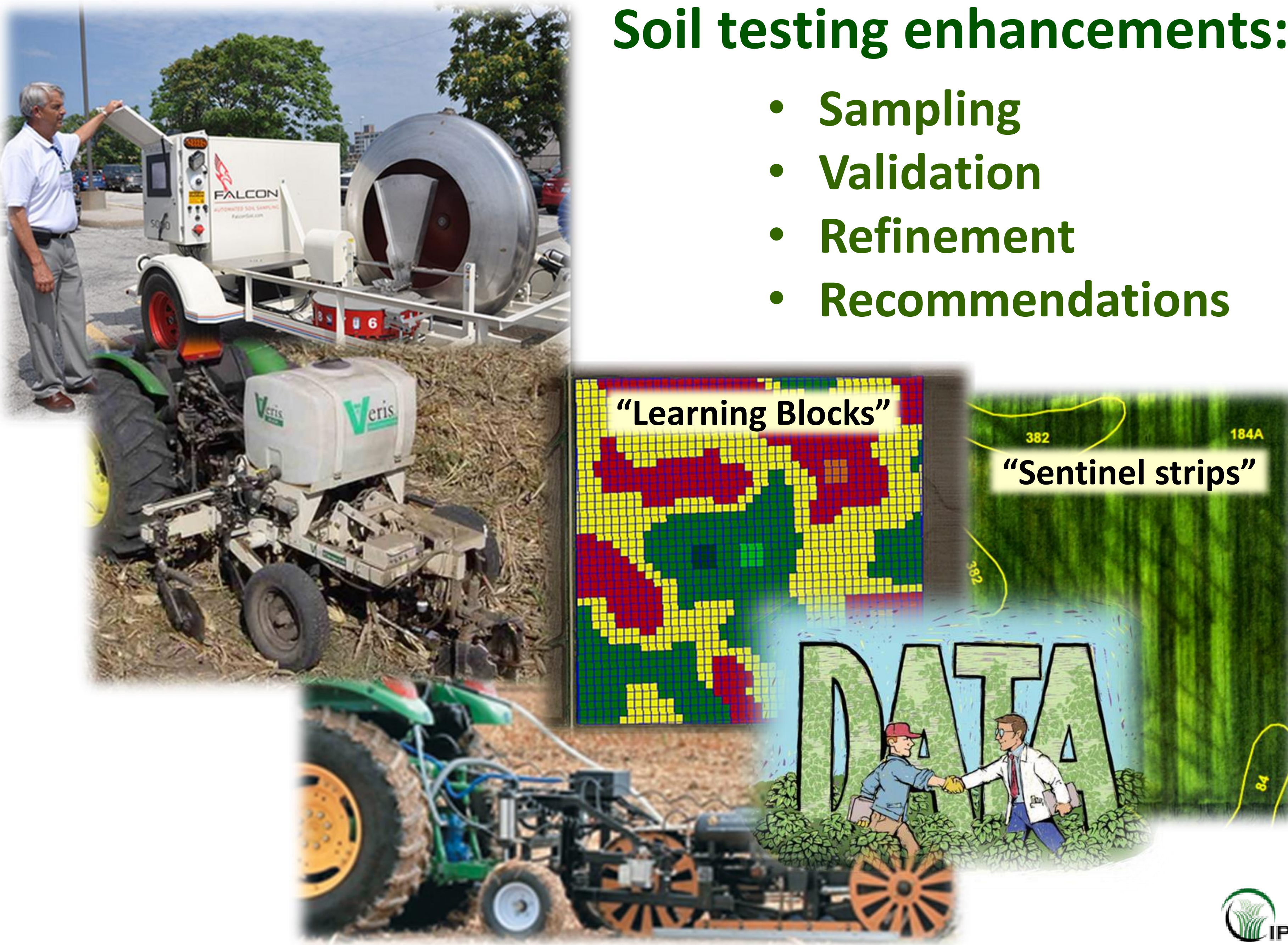


Re-energized management for optimal soil fertility

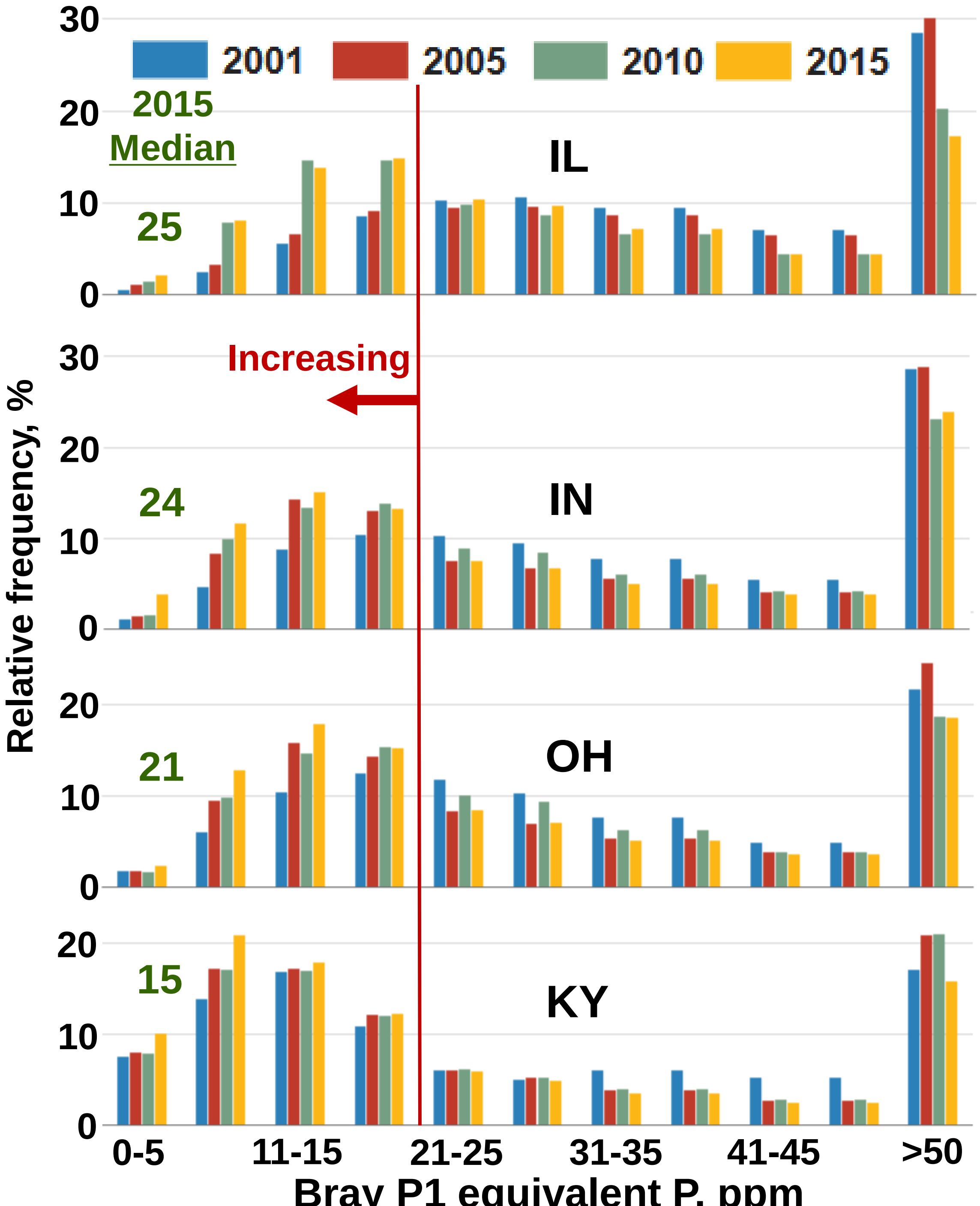
We need to be engaged in development of soil health objectives & metrics

Soil testing enhancements:

- Sampling
- Validation
- Refinement
- Recommendations



Changes in soil test P levels in four states



- Samples testing in high & very high categories are declining
- Samples testing in responsive categories are increasing

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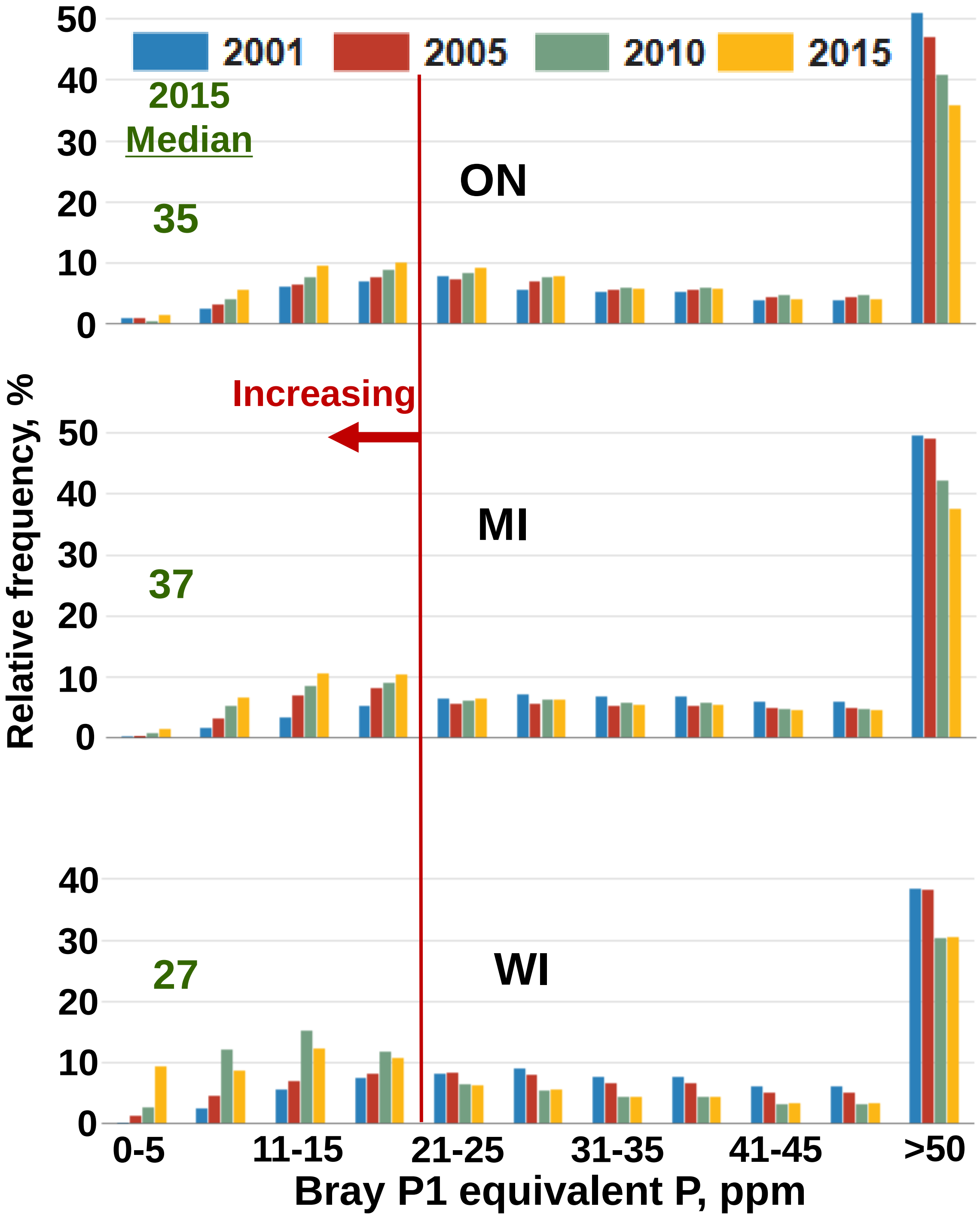
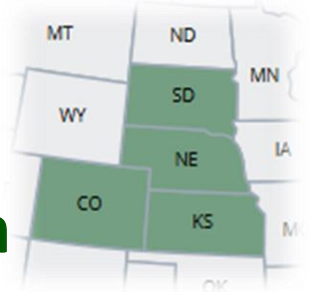
Changes in soil test P levels further north

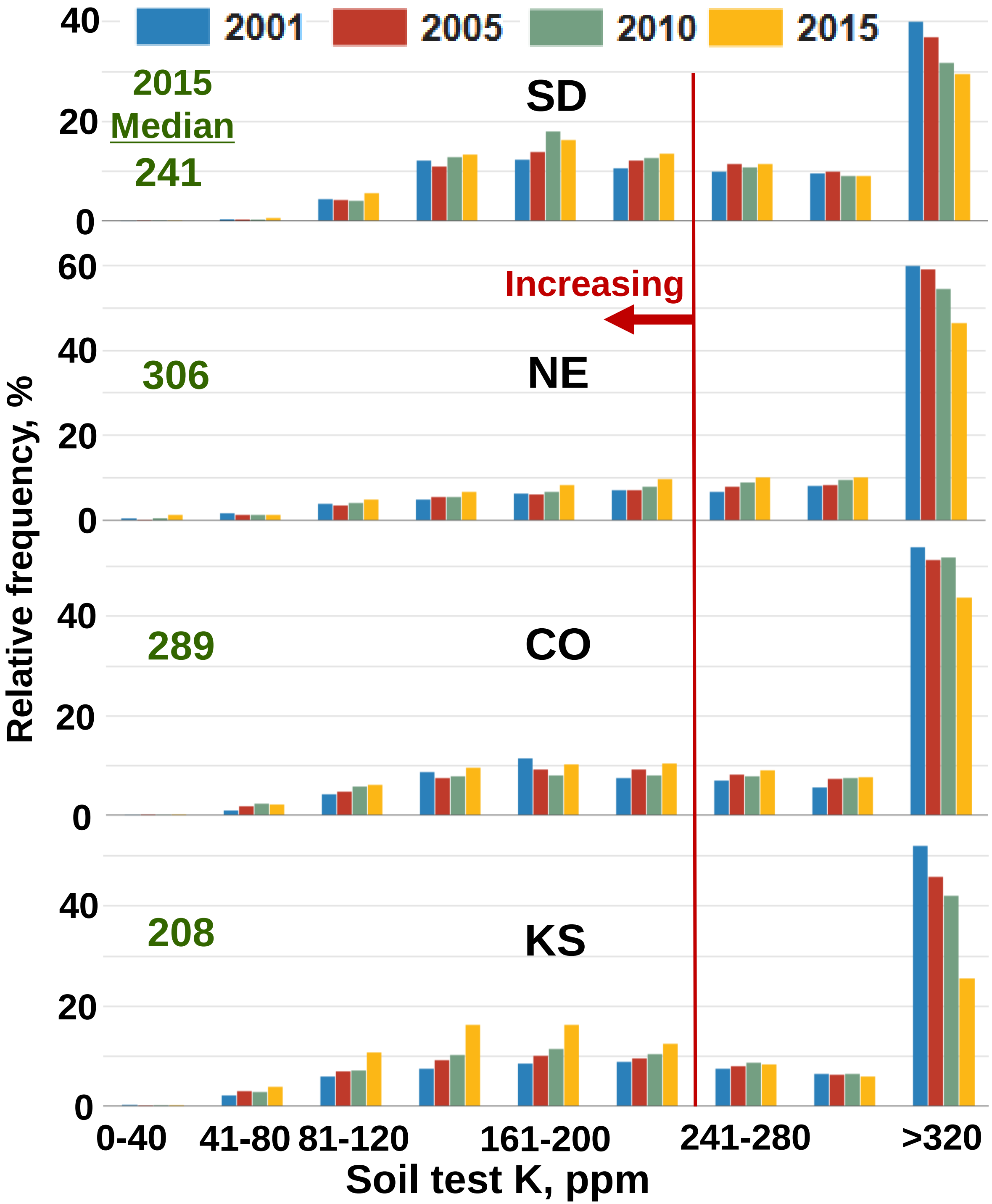


- Samples testing in high & very high categories are declining
- Samples testing in responsive categories are increasing

Needed change in P use will require **evidence** of a benefit

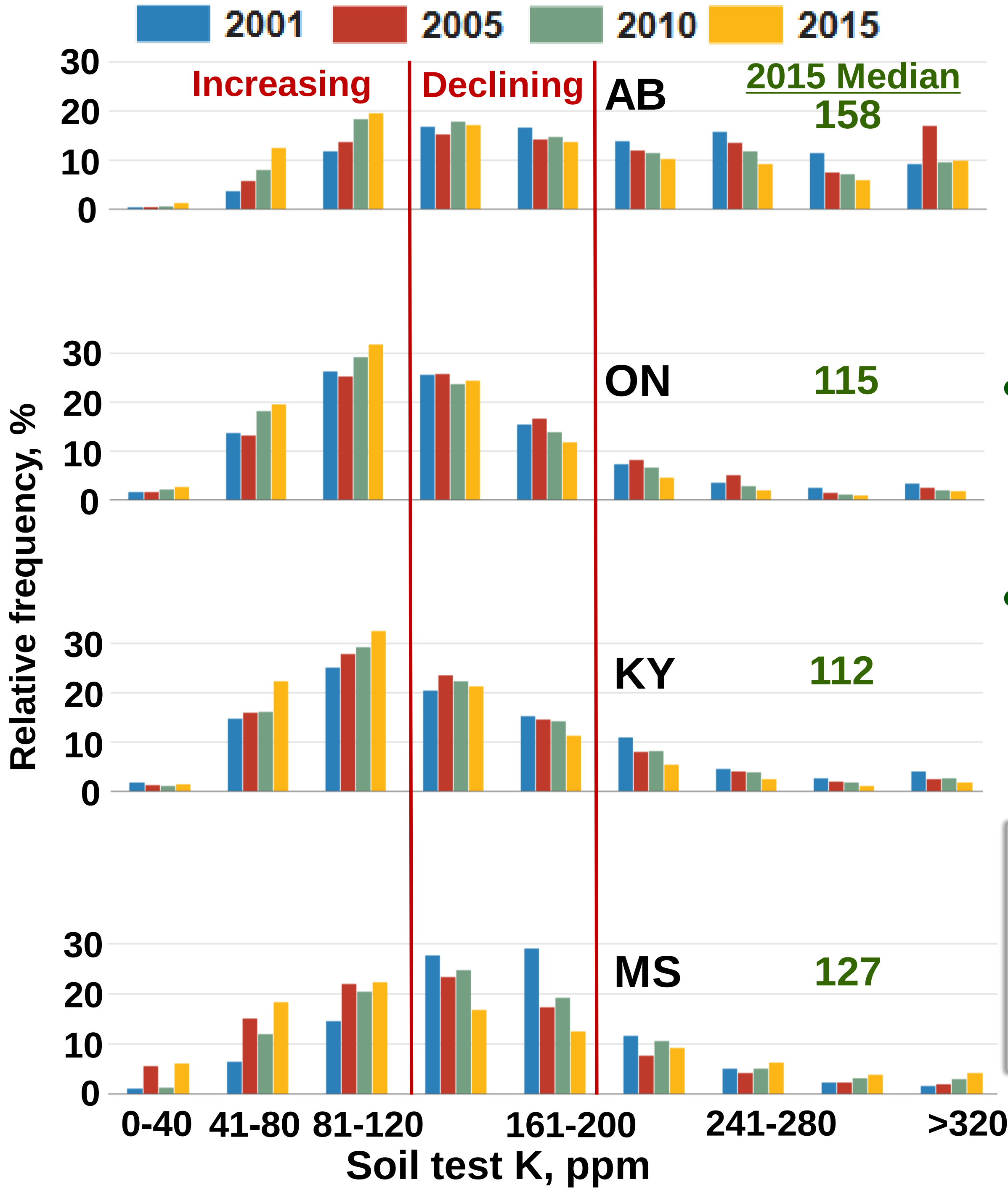
Changes in soil K levels in 4 western states





- Samples testing in very high category are declining
- Samples testing in responsive categories are increasing

Changes in soil K levels in 4 states & provinces



- Samples testing in intermediate categories are declining
- Samples testing in responsive categories are increasing

Needed change in K use will require **evidence** of a benefit

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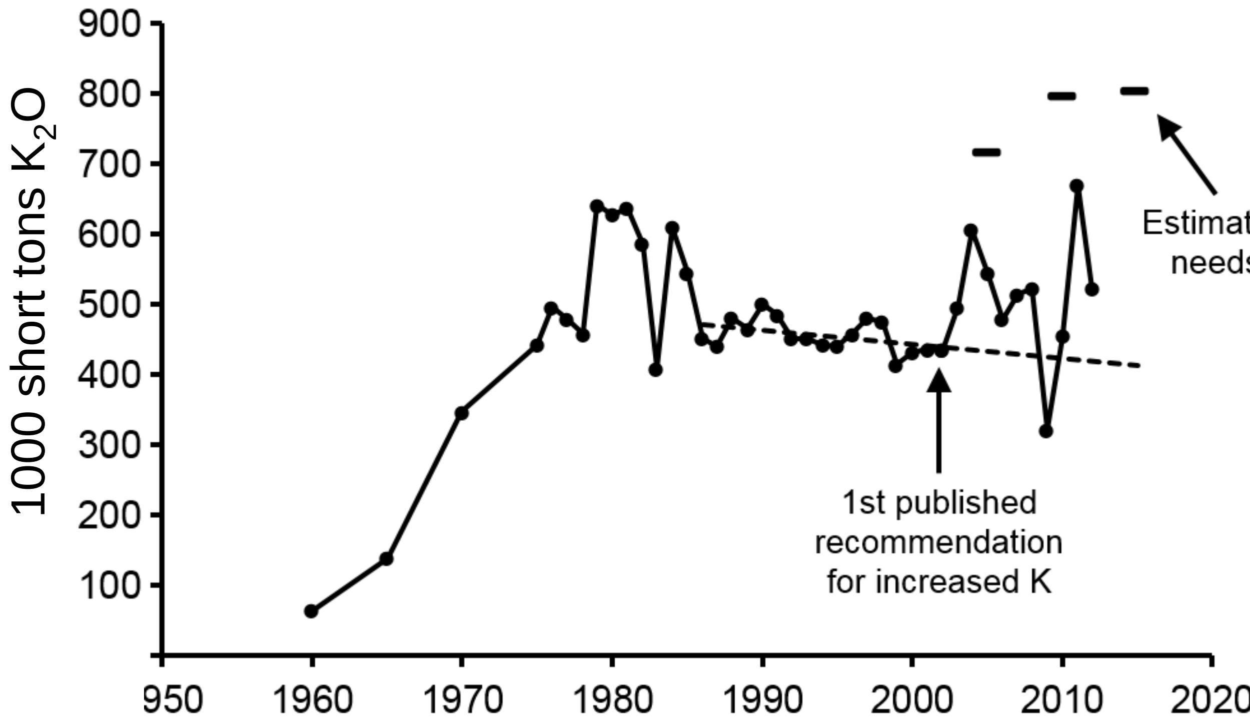
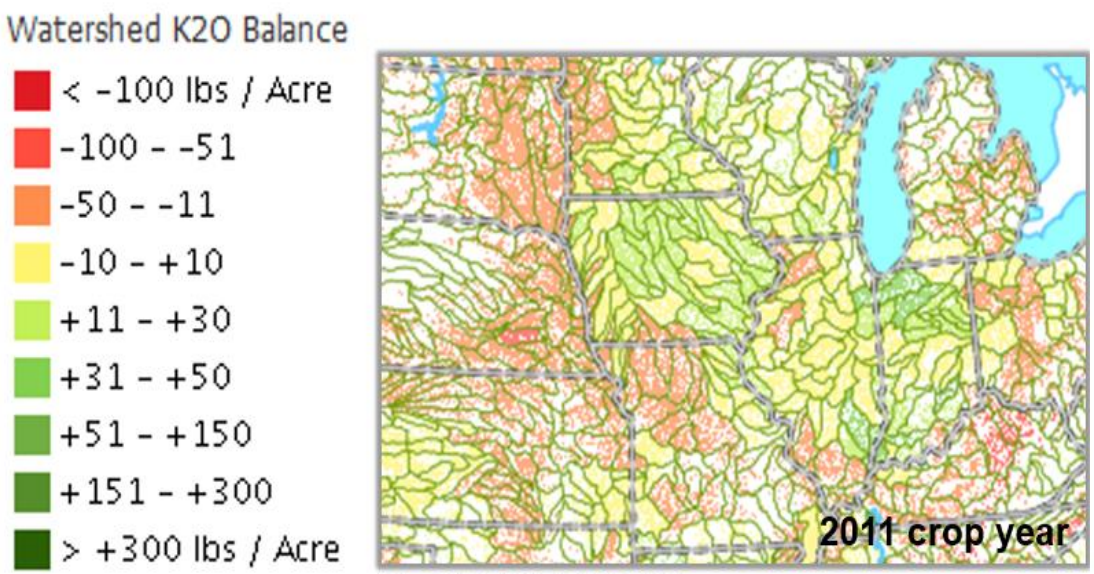
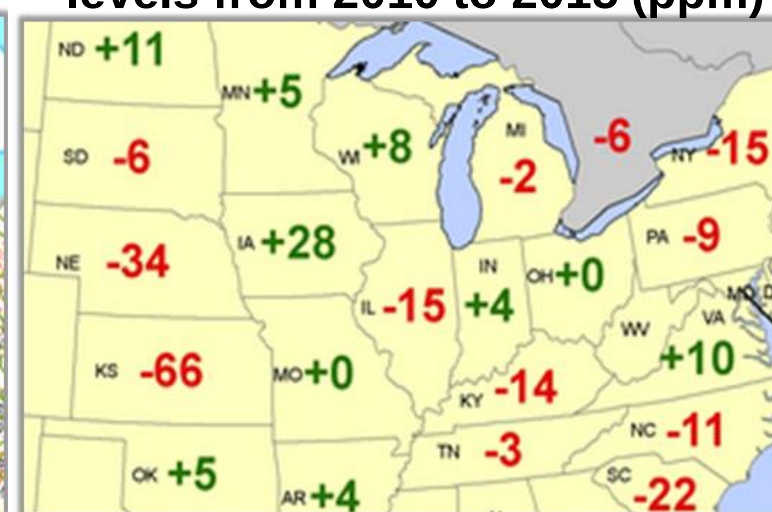


Research provided <u>evidence</u> of a benefit to changing K use in IA



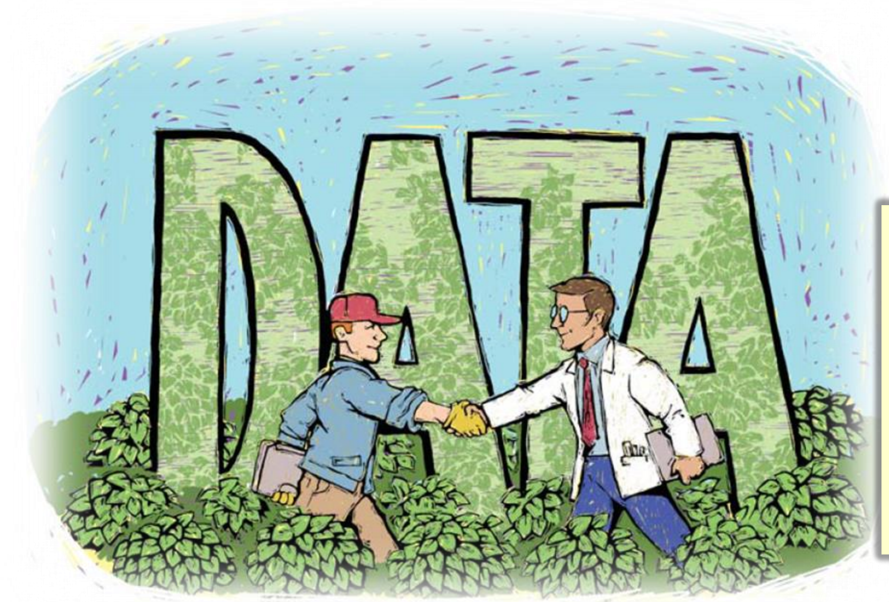
NuGIS (5/16/2016)

Change in median soil test K levels from 2010 to 2015 (ppm)



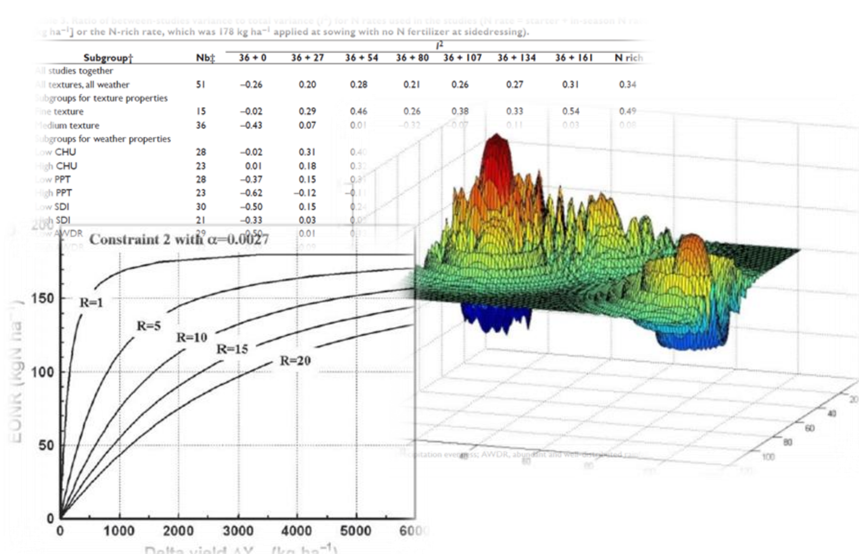
IPNI, 2015

Evidence-based agronomy



On the farm

- Data as a valued product of the farm … part of its legacy
- Using data/metrics for learning, selling, and communicating



In ag research

- Publishing and curating high quality, open-access data sets
- Systematic reviews of literature and meta-analyses

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What's next? A communication challenge …

- Great **progress** in agronomy in the last 35 years
- But **challenges** remain … to continue efforts to:
  - Increase **productivity & profitability** for producers
  - Reduce **nutrient loss** to surface & ground **water**
  - Reduce **loss** of nitrous oxide, ammonia, & other N forms to **air**
  - **Capture more nutrients** in the crop rather than risk loss to **environment**
- **Biggest challenge is to tell our story**
  - Help the public appreciate:
    - The **remarkable progress** of the last 35 years
    - Our **dedication** to accelerating that progress in the future
    - Progress based on **science-based** technologies & hard facts
- **Focus on credible education** rather than questioning motives

An example of our challenge …

Recent letter to the Director General of FAO, Pope Francis criticized modern agriculture for its:

- "production at any cost"
- "improperly modifying various animal and plant species"
- model that "despite all its science, allows around 800 million people to continue to go hungry."

One cannot question the motives of such a man, but we can use these statements to inspire us to better communicate our own motives and dedication to future progress.

We have an evidence-rich story worth telling

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What's next?

The future that we create

Fluid Fertilizer Foundation

The Wave of The Future

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INTERNATIONAL
PLANT NUTRITION
INSTITUTE