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INTERNATIONAL
PLANT NUTRITION
INSTITUTE

The InfoAg Conference

St. Louis, MO
30-31 July 2014

Precision Phosphorus Application for the Lake Erie Watershed

Tom Bruulsema, Director, Northeast Region, IPNI

Agrium Inc.

Arab Potash Company

Belarusian Potash Company

BHP Billiton

CF Industries Holdings, Inc.

Compass Minerals Specialty Fertilizers

International Raw Materials LTD.

Intrepid Potash, Inc.

K+S KALI GmbH

The Mosaic Company

OCP S.A.

PotashCorp

Qatar Fertiliser Company (QAFCO)

Simplot

Sinofert Holdings Limited

SQM

Toros Tarım

Uralchem

Uralkali

Formed in 2007 from the Potash & Phosphate Institute, the **International Plant Nutrition Institute** is supported by leading fertilizer manufacturers.

Its mission is to promote scientific information on responsible management of plant nutrition.

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Ancaster, Ontario – 26 June 2009 – tilled corn
SOIL EROSION IS A REAL RISK

Ponsonby, Ontario – 6 April 2014 – no-till
SURFACE RUNOFF HAPPENS

Essex County, Ontario, 30 July 2009
BMPs that limit soil erosion don’t limit dissolved P runoff.

Outline

1. **Lake Erie P loading trends**
2. **Soil P balance in the watershed**
3. **Precision P application options**
4. **4R certification**
5. **4R research**

- *Slides: available at* ***http://nane.ipni.net***

nutrient stewardship

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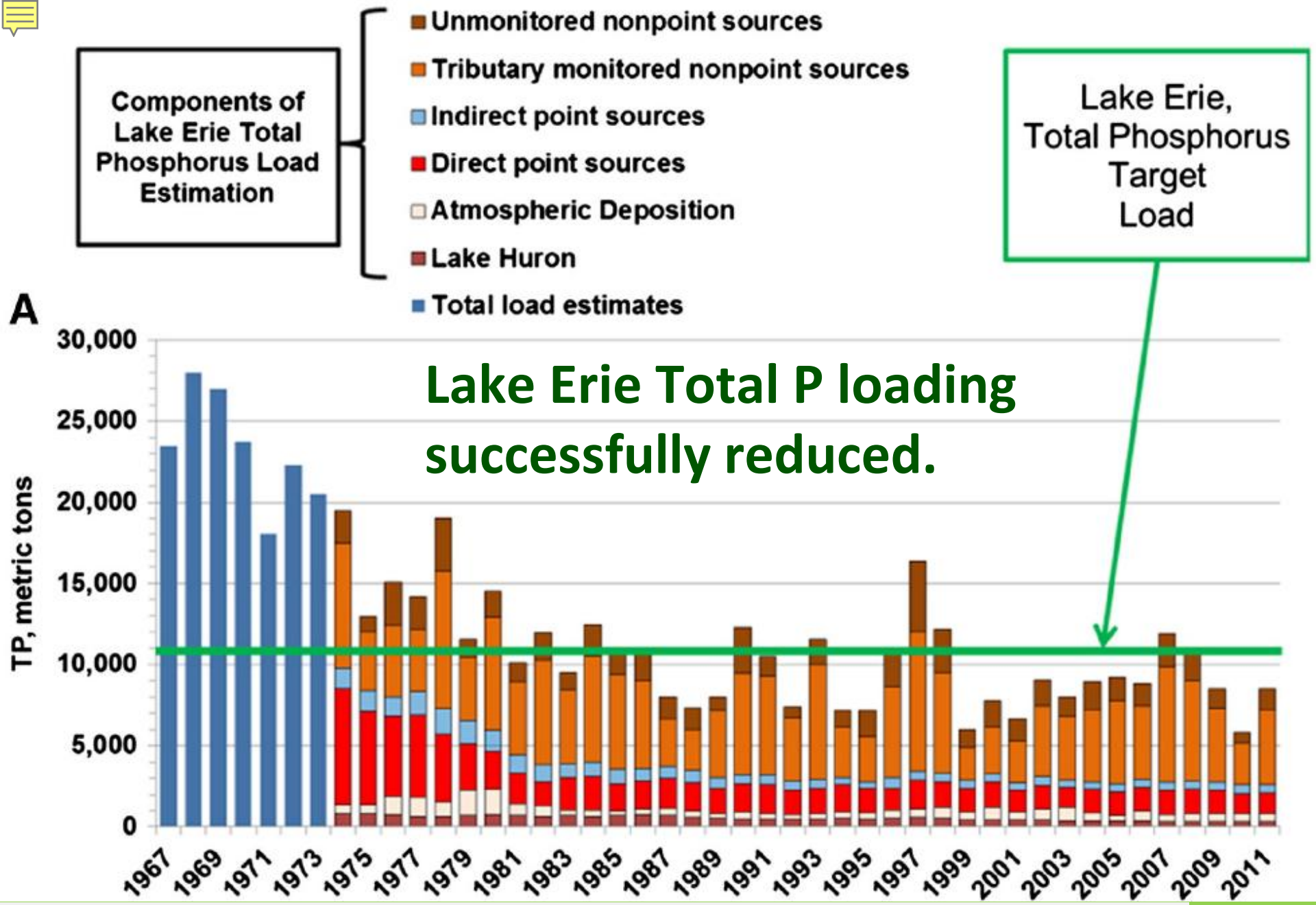
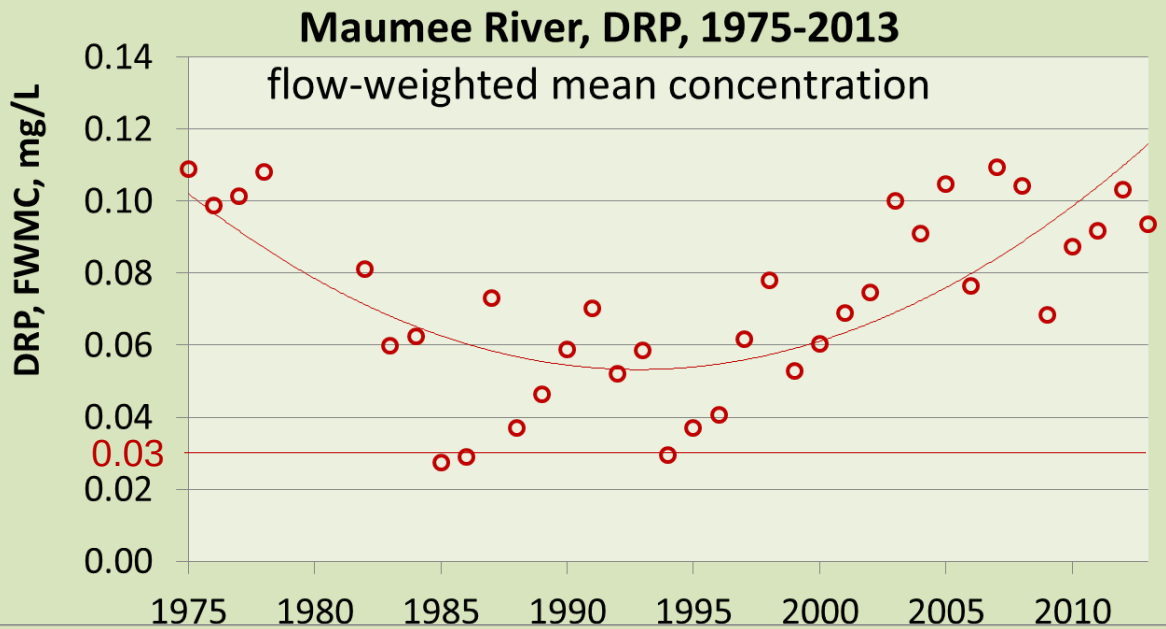
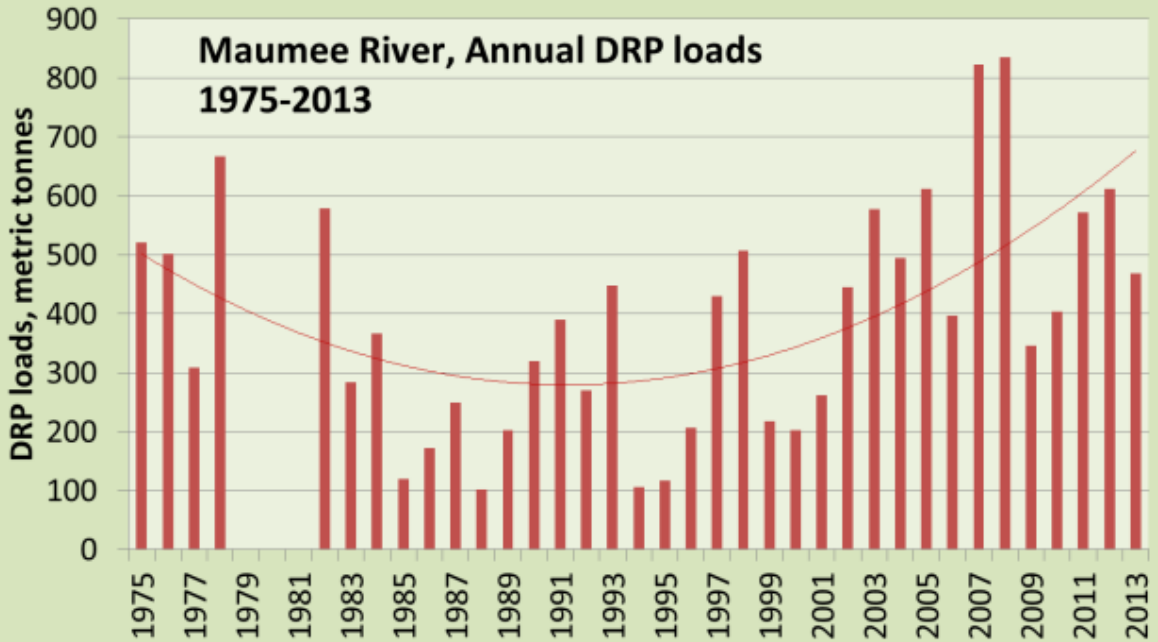


Lake Erie Total P loading successfully reduced.

David Baker et al., National Center for Water Quality Research, Heidelberg U, Tiffin, OH

Western Lake Erie: DRP trends worsening since 1992





David Baker et al., National Center for Water Quality Research, Heidelberg U, Tiffin, OH

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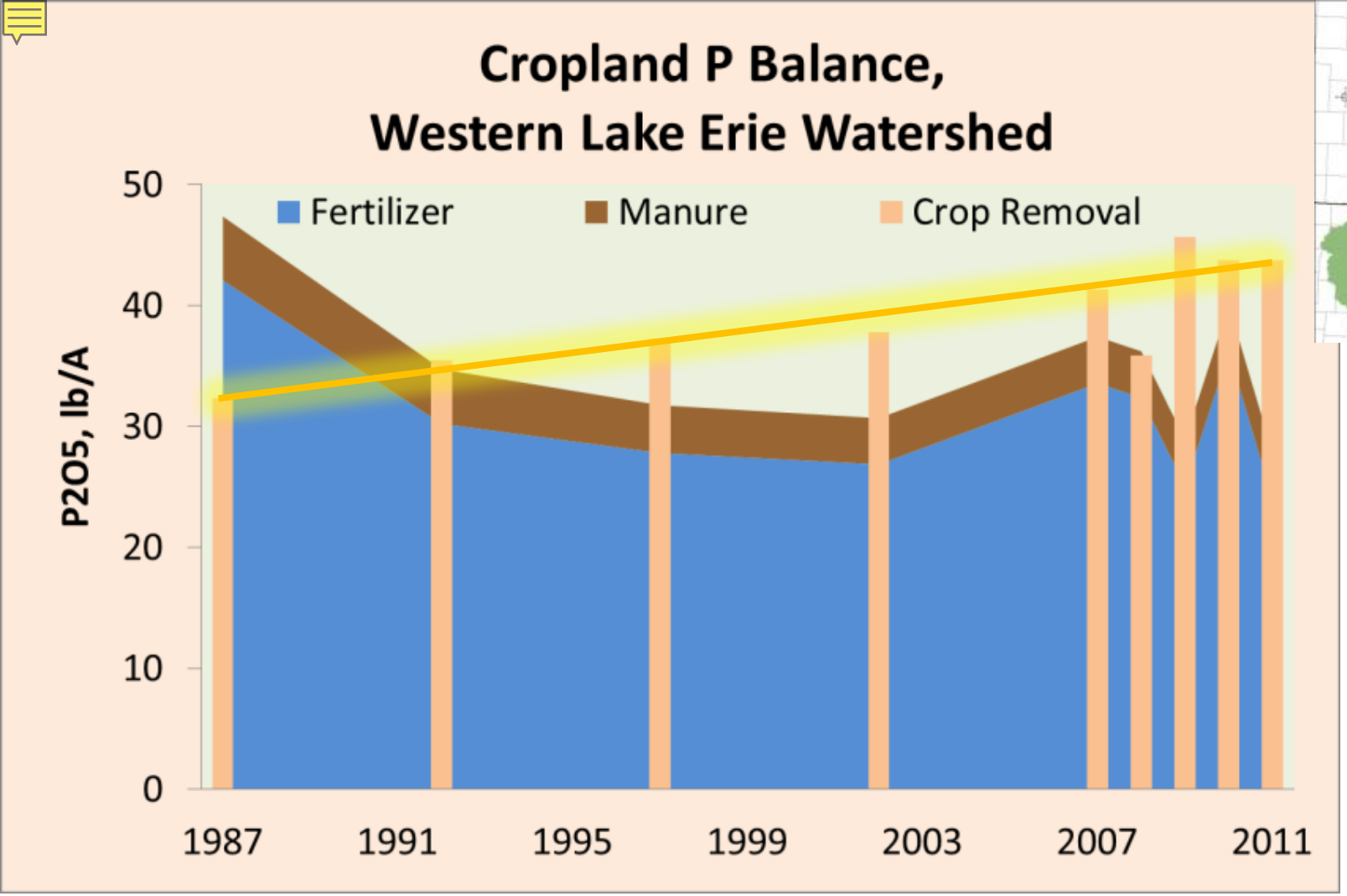
So what could be causing the trend of increased losses of dissolved P?

- Weather patterns
- Tillage trends
- P application
  - Source?
  - Rate?
  - Time?
  - Place?

USGS monitoring gauge, Waterville, Ohio, 31 July 2012



1. Application rates short of crop removal since 1991.
2. Crop removal is increasing with yield.

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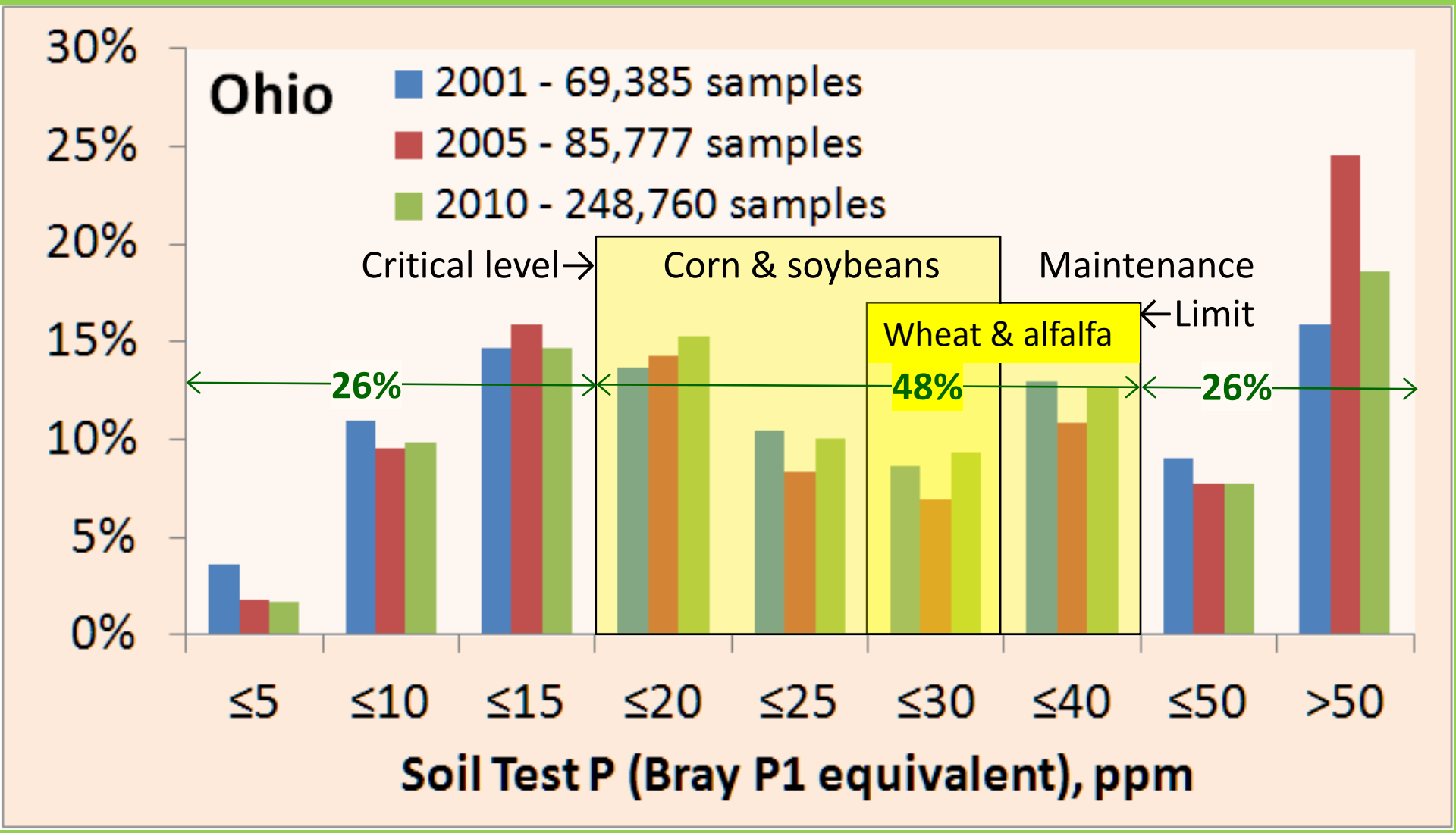
NuGIS
Nutrient Use Geographic Information System

48% of Ohio soils test optimum for P



Soil test P distribution, 2001-2010

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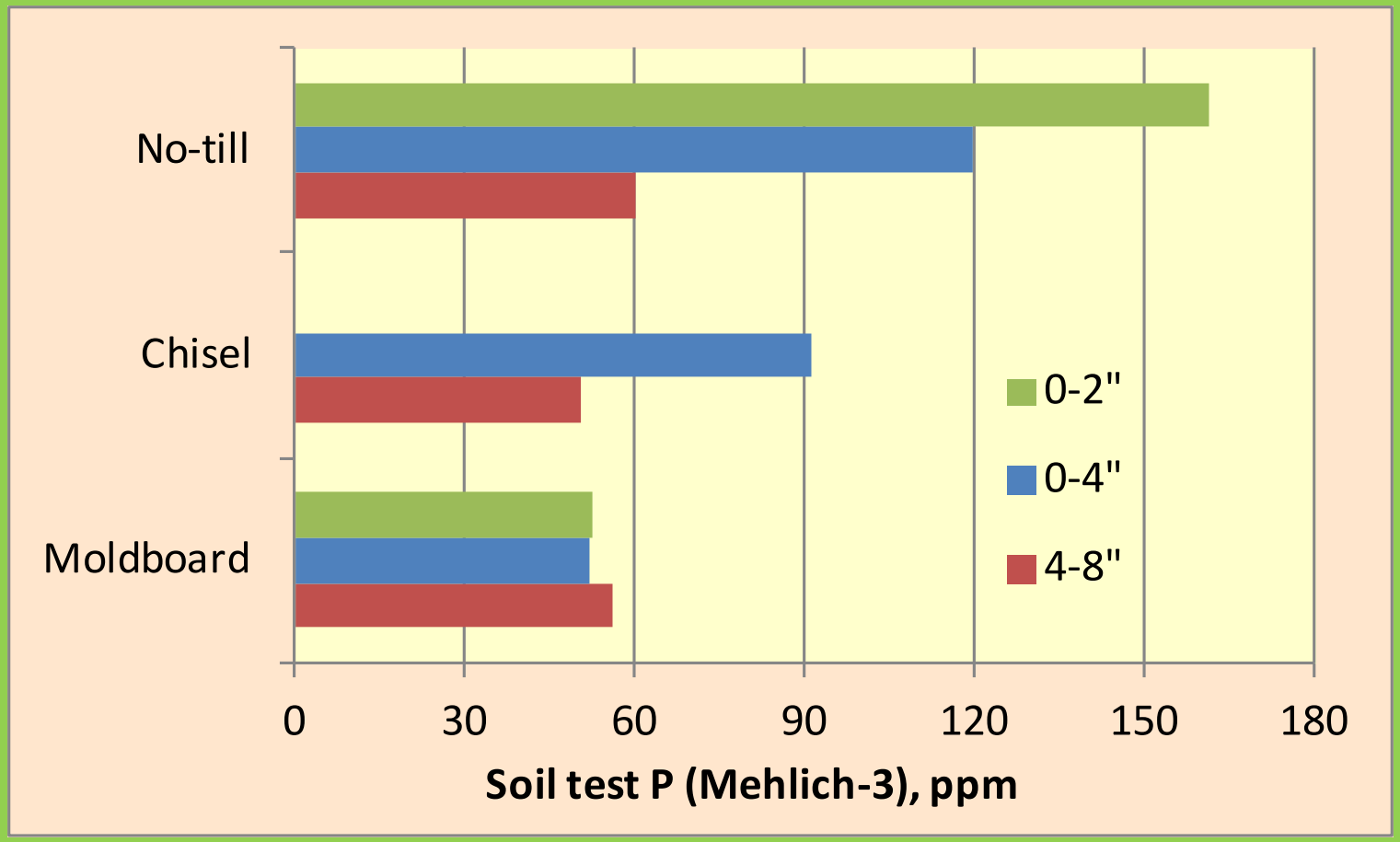
Soil test P stratifies without moldboard plowing



Soil test P distribution with depth in a long-term tillage experiment on a poorly drained Chalmers silty clay loam soil near West Lafayette, Indiana. Moldboard and chisel plots were plowed annually to a depth of 8”. Data from Gál (2005) and Vyn (2000). Fertilizer P applied broadcast.

Ohio Ag Retailer survey – Lake Erie basin March 2013

Soil testing:

Grid (2.5 A)	25%
Soil type	11%
Management zone	6%

Variable Rate Application **33%**

Placement:

Planter band	30%
Strip-till band	4%
Incorporation <7 days	16%

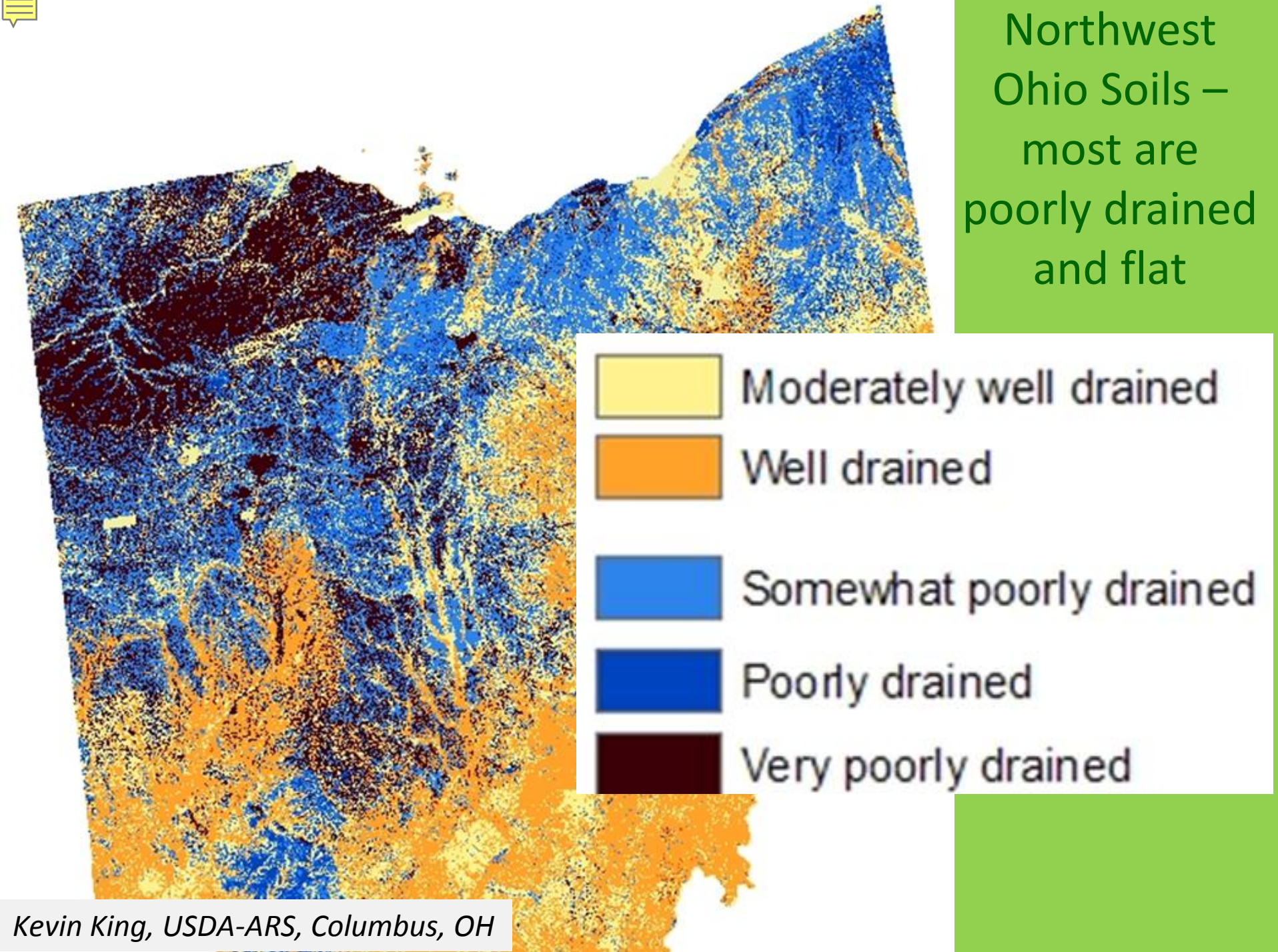
Timing:

Fall 41%

Spring 41%

Greg LaBarge, Ohio State University Extension

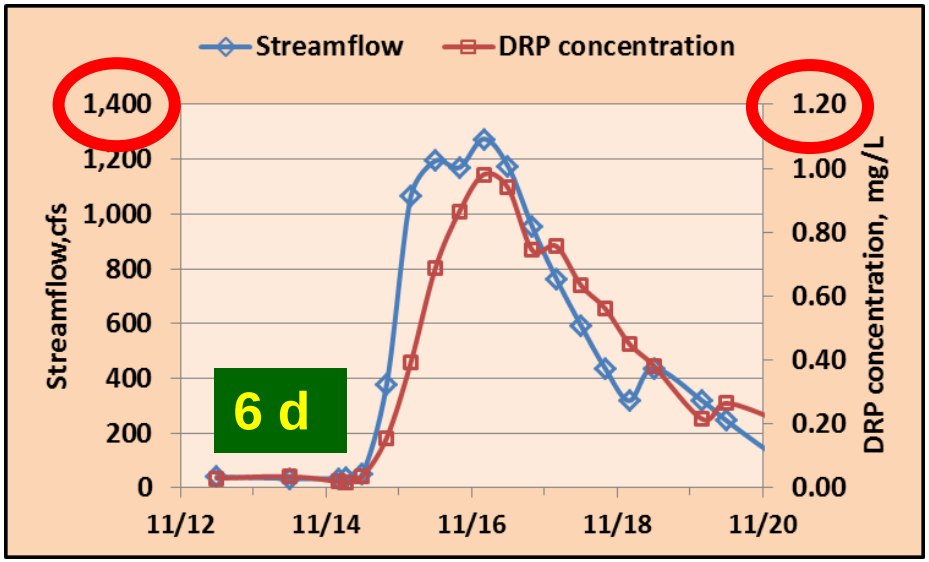
Northwest Ohio Soils – most are poorly drained and flat



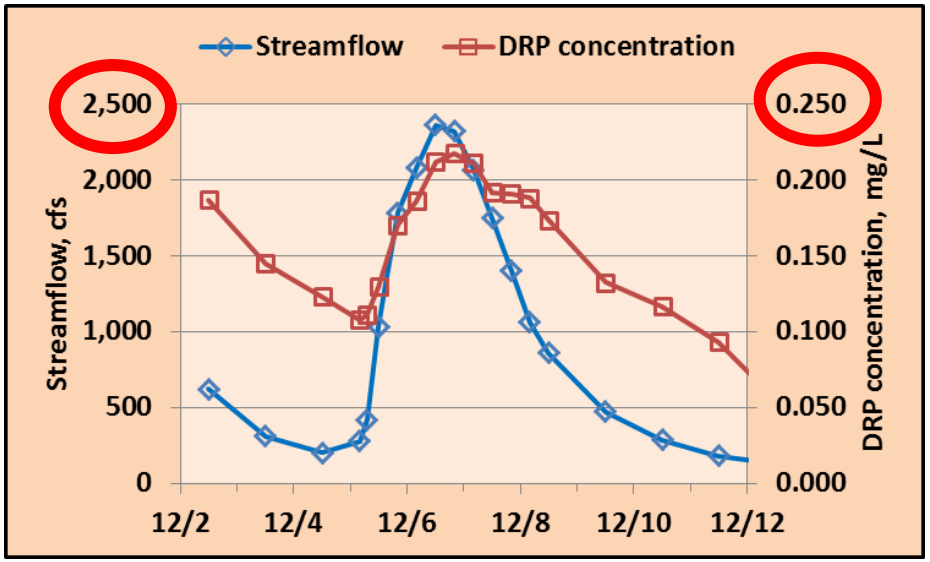
Kevin King, USDA-ARS, Columbus, OH

Honey Creek: comparing two runoff events in fall 2011

14 Nov., after 6d field activity



5 Dec., after 2 further rainstorms



0.64 mg/L | **Mean DRP concentration** | **0.18 mg/L**

0.31 lb P_2O_5/A | **DRP load/A of watershed** | **0.16 lb P_2O_5/A**

1. Intense rainstorms following broadcast of P can generate high P concentrations in runoff but the direct agronomic or economic importance can be minimal.
2. As the time intervals increase between surface broadcast P applications and runoff-producing rainfall events, DRP concentrations spike less.

David Baker, Heidelberg University

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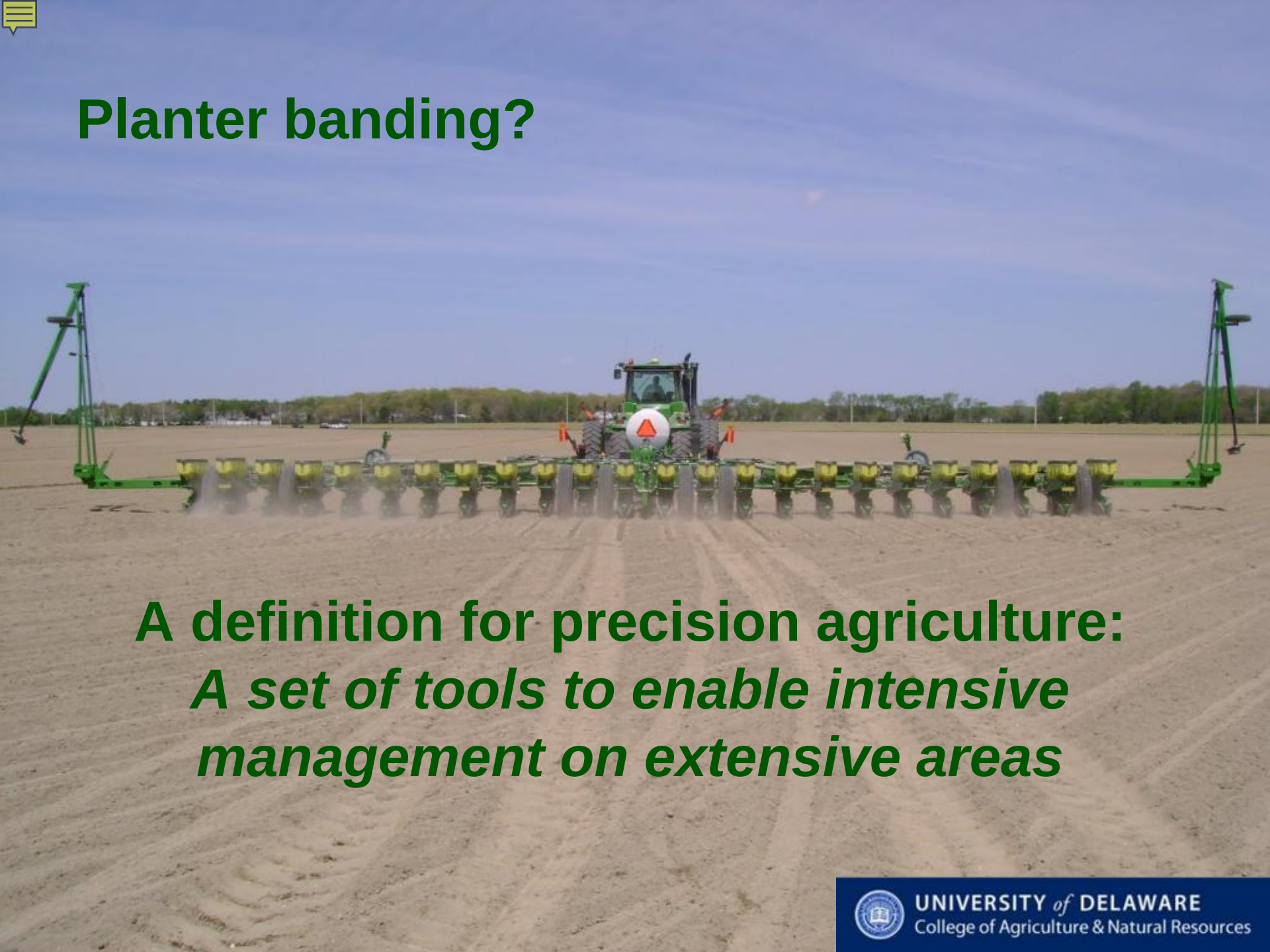
Precision P Application Options

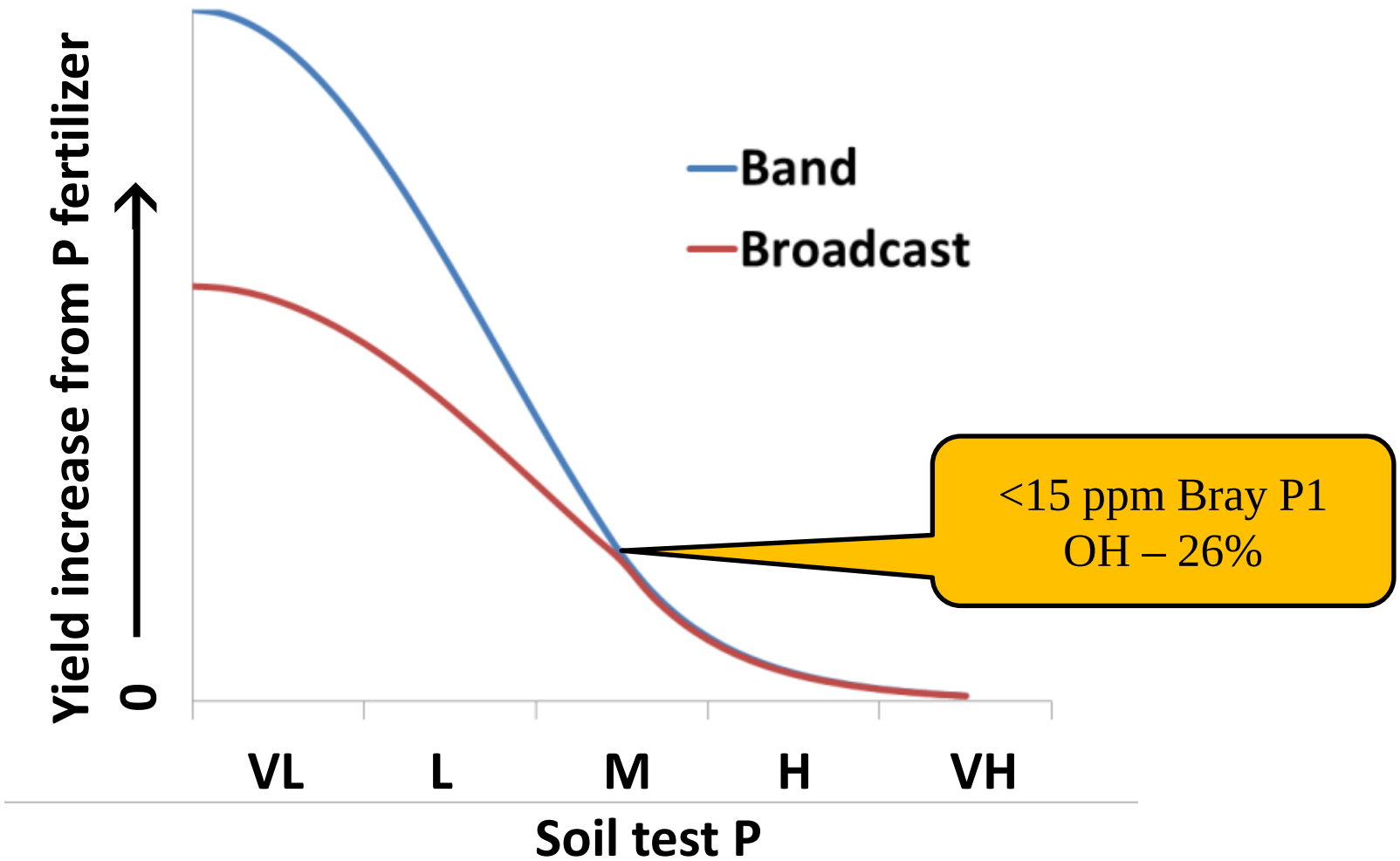
- Right Place
  - Planter band
  - Fall strip-till band
  - Variable rate application
- Right Time
  - Avoid periods just before runoff

Planter banding?



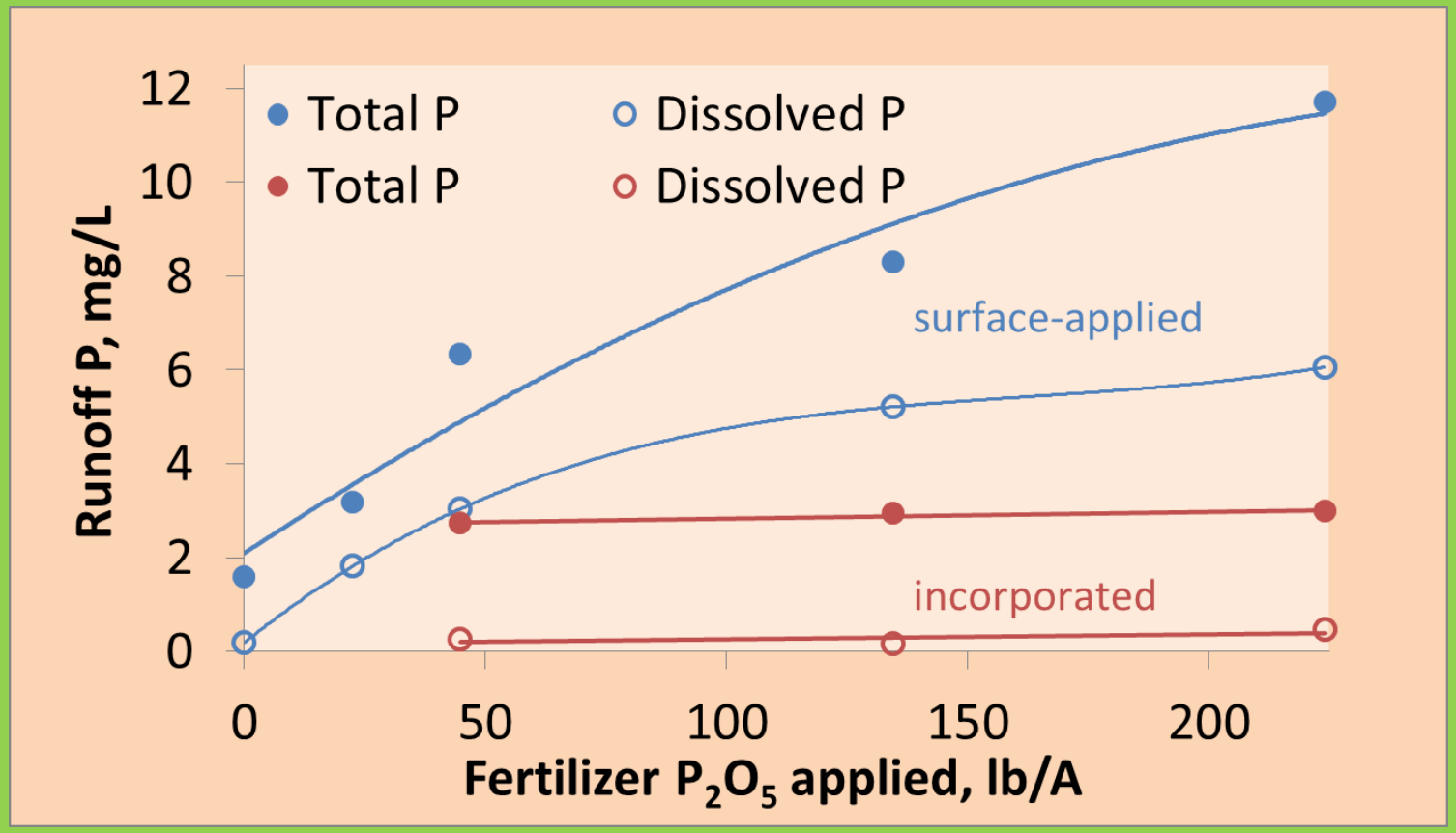
A definition for precision agriculture:
A set of tools to enable intensive management on extensive areas

Idealized effect of placement on crop response



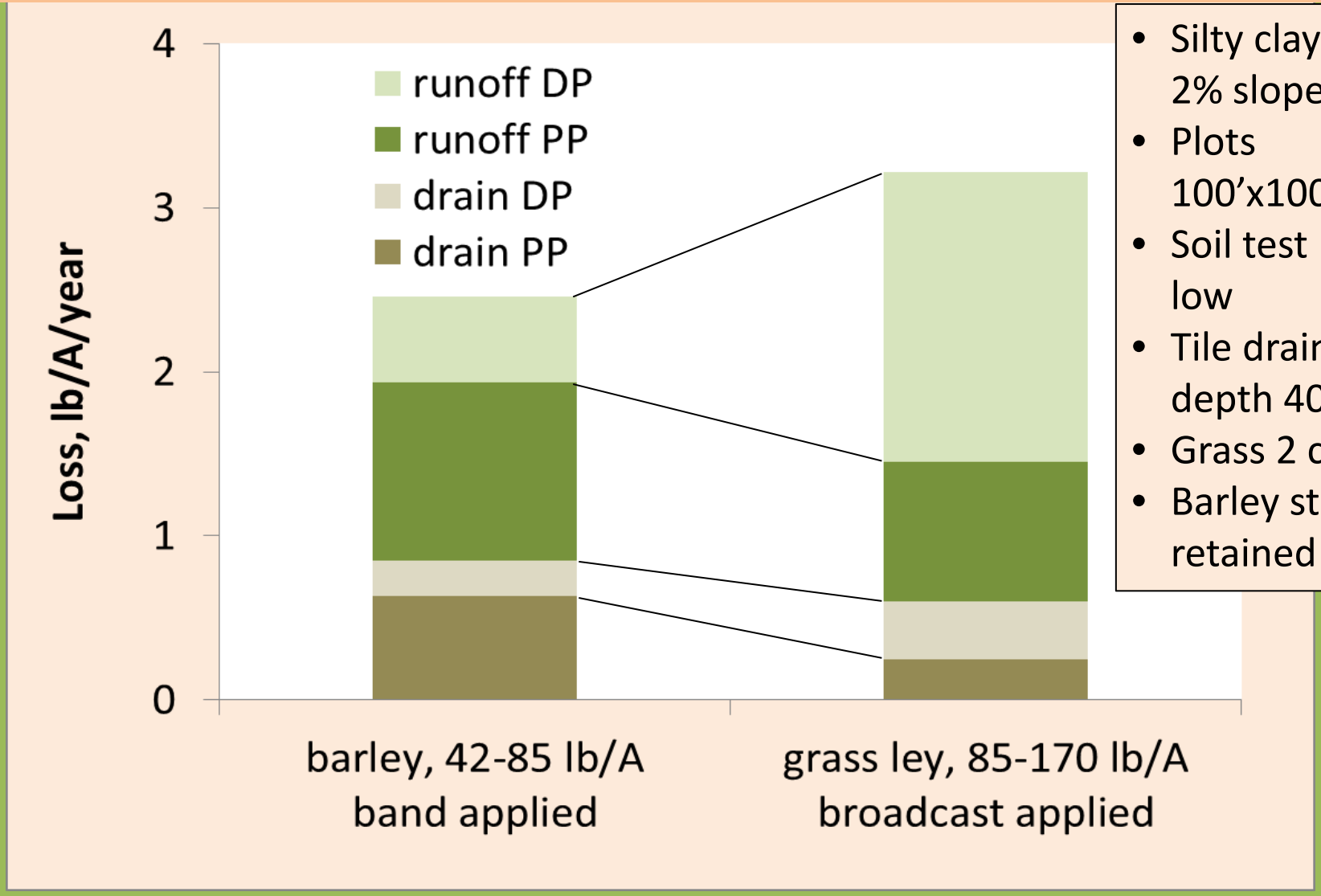
Randall and Hoeft, 1988

Placing P in the soil reduces P loss from a single immediate runoff event



Concentration of dissolved and total P in runoff from a clay loam soil in North Carolina, from artificial rainfall immediately following application of superphosphate fertilizer. Incorporation was to a depth of 5 inches by rotary tillage following application. Data from Tarkalson and Mikkelson (2004).

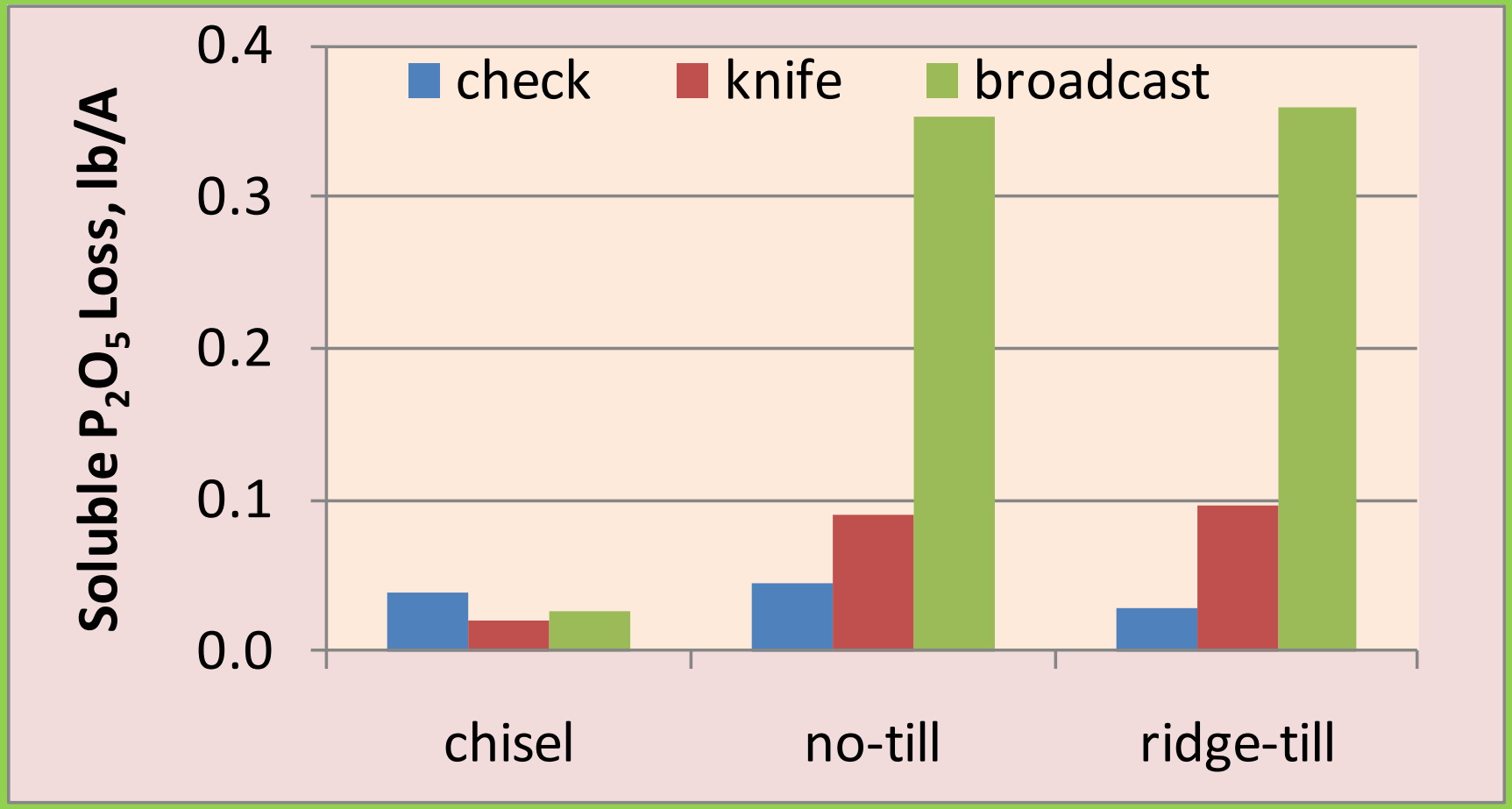
Loss of P (as P_2O_5) in surface runoff and tile drains



- Silty clay soil, 2% slope
- Plots 100'x100'
- Soil test P low
- Tile drain depth 40"
- Grass 2 cuts
- Barley straw retained

Eila Turtola & Antti Jaakkola (1995) Loss of Phosphorus by Surface Runoff and Leaching from a Heavy Clay Soil under Barley and Grass Ley in Finland, Acta Agriculturae Scandinavica, Section B — Soil & Plant Science, 45:3, 159-165

Fluid P – knifed-in versus broadcast



Annual runoff P losses as affected by tillage x placement in sorghum-soybean rotation. East-central Kansas. Mean of 2 growing seasons.
Fluid fertilizer applied @ 50 lb P_2O_5/A.

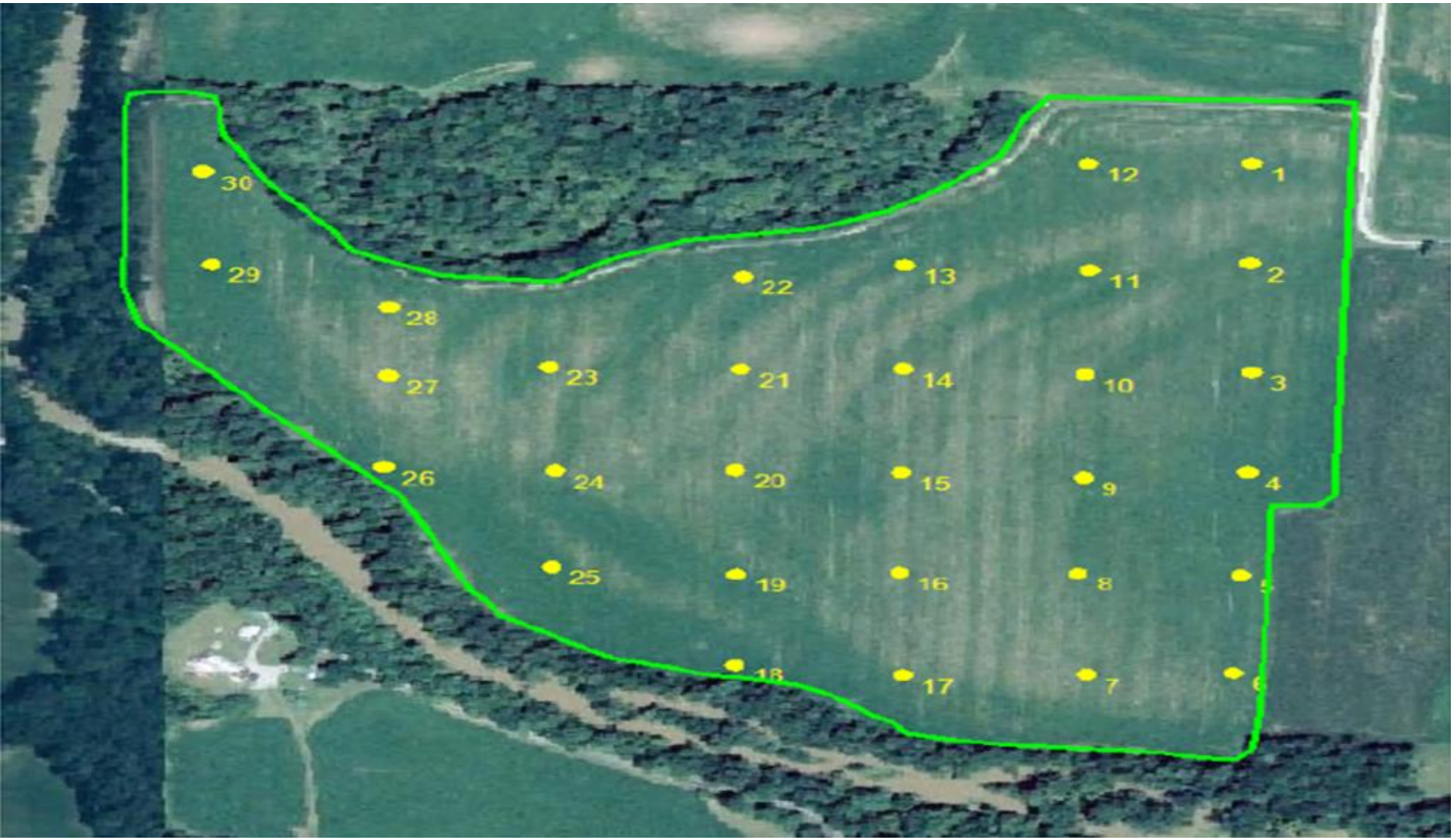
Kimmel et al. 2001. J. Environ. Qual. 30:1324-1330

Fall Strip-till Banding

- Puts the P in the soil
- Keeps residue on the soil
- RTK GPS for precision planting

Greg LaBarge, Ohio State University Extension

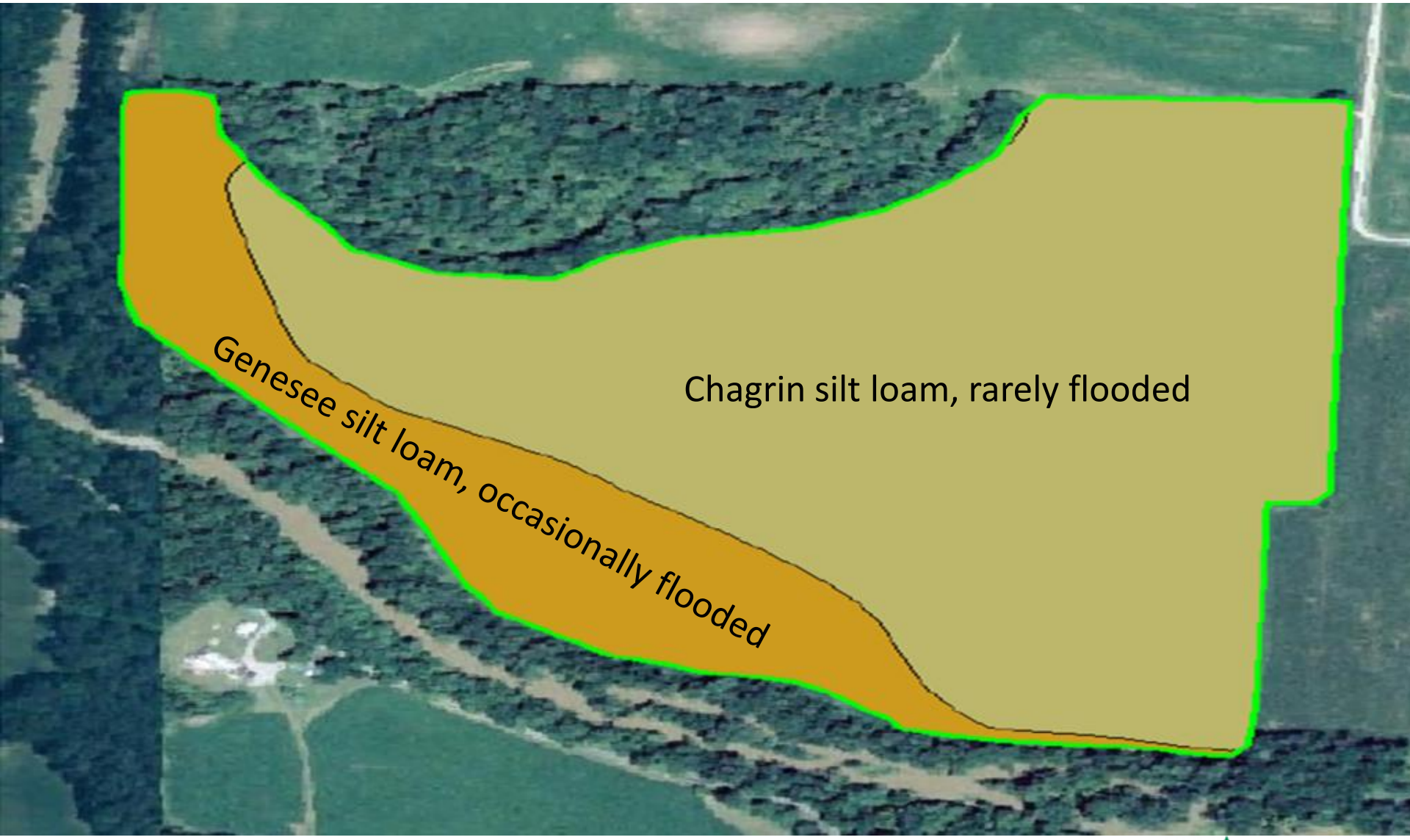
Grid sampling for variable rate application



74 acres, 2.5-acre grid, November 2011

MORRAL COMPANIES

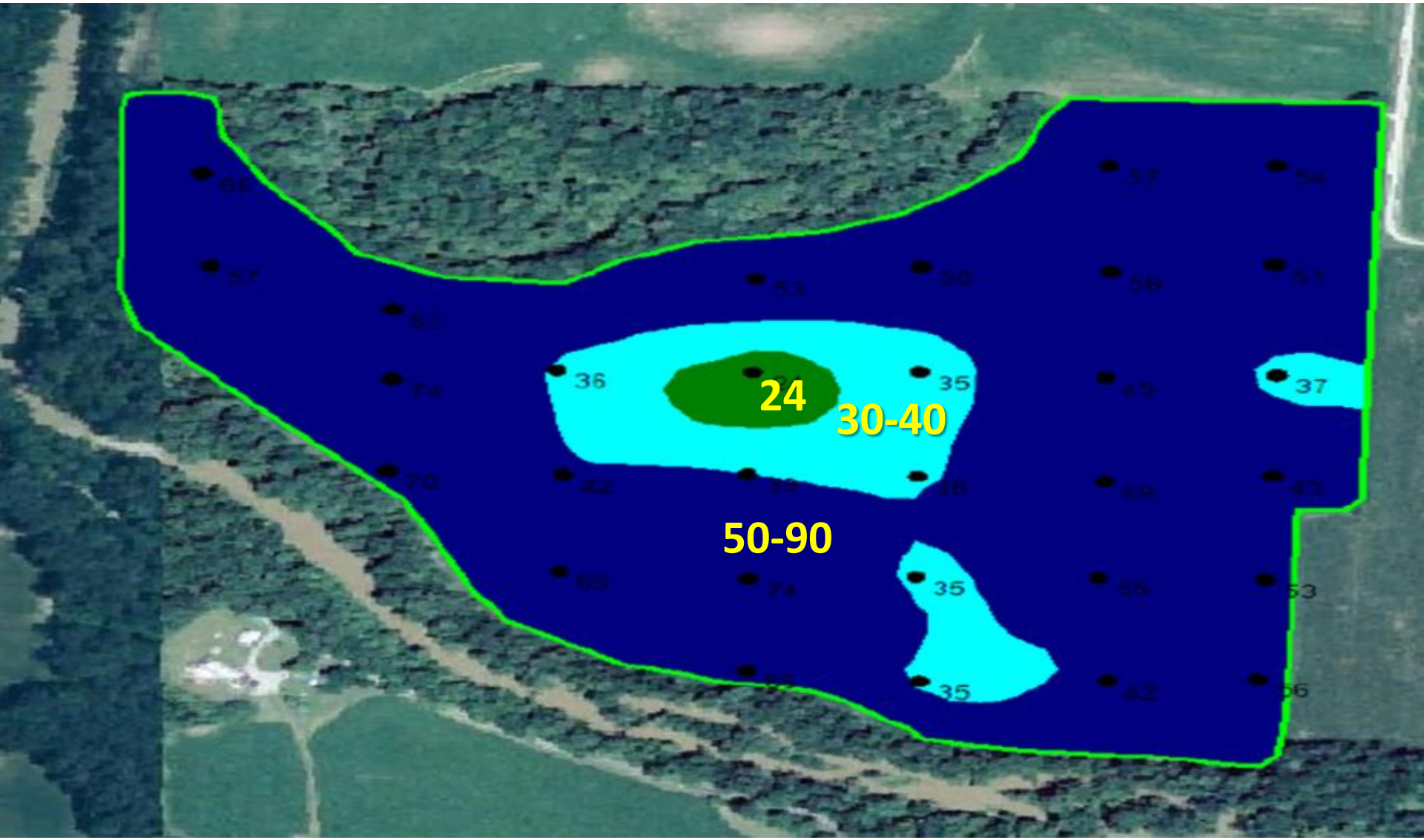
Soil map for variable rate application



Occasionally flooded ~ higher risk of runoff?

MORRAL COMPANIES

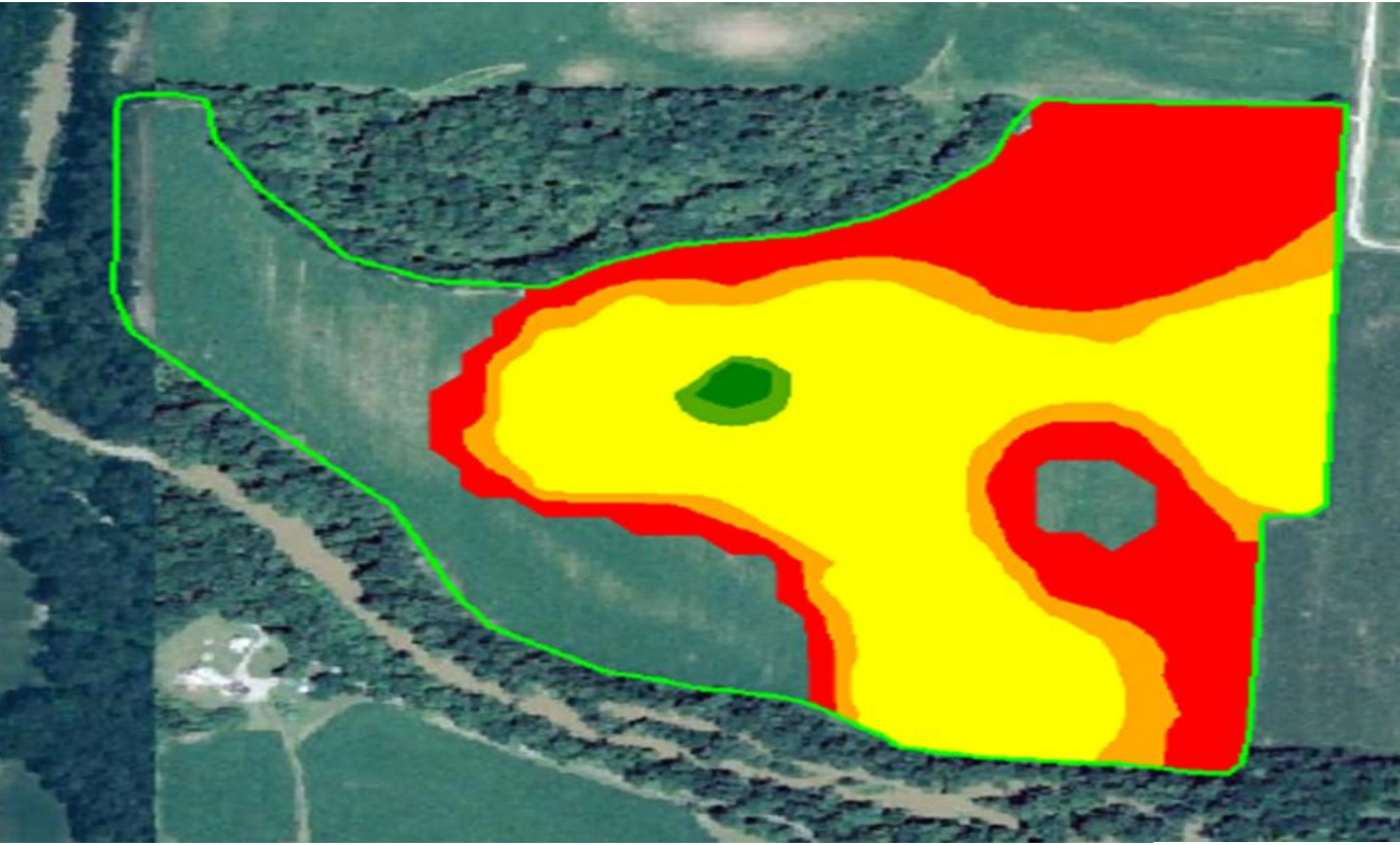
Soil test P from grid, ppm (Mehlich-3)



Soil test P is high in zone of occasional flooding…

MORRAL COMPANIES

Variable rate P application map



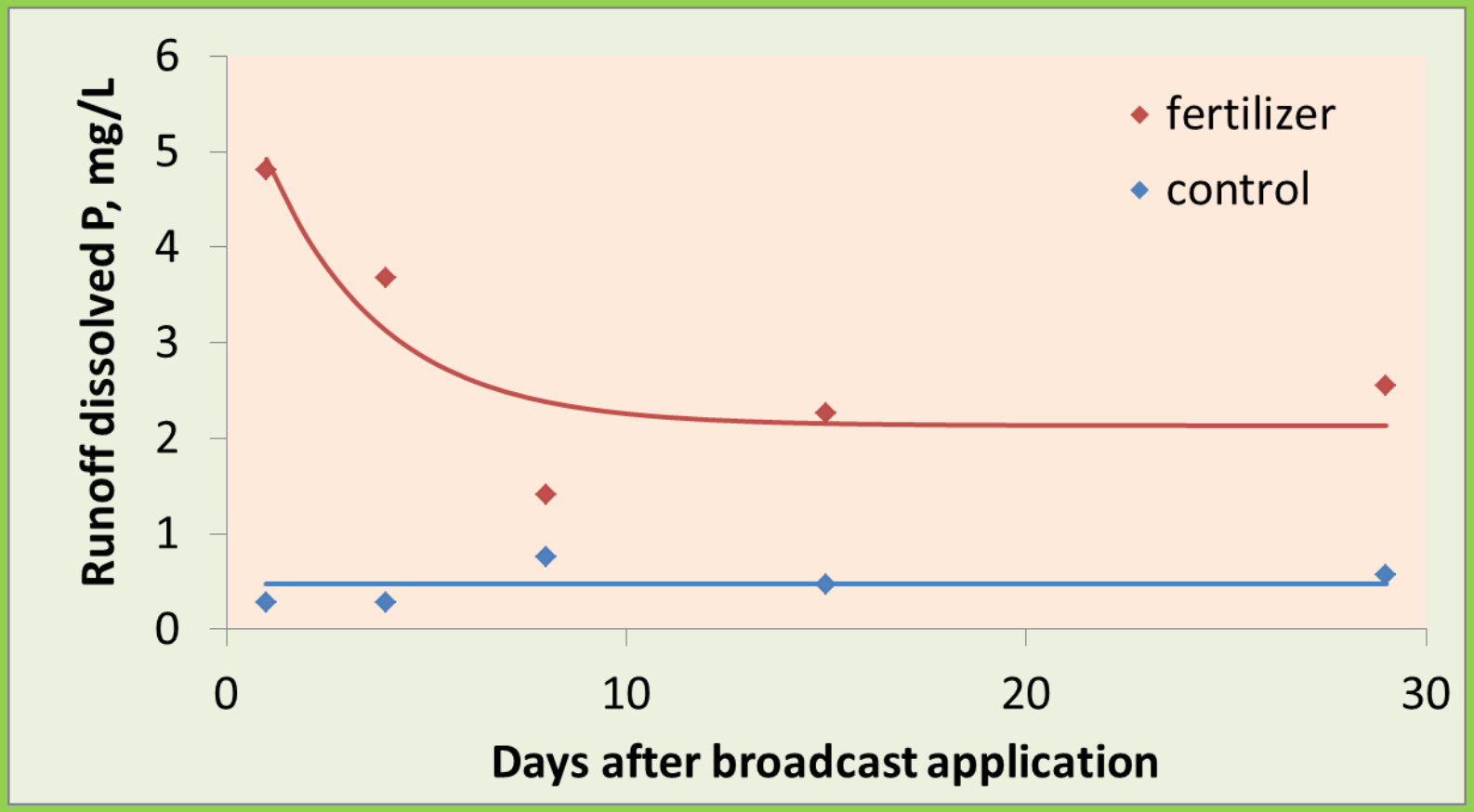
Zero rate where P is high, in zone of flooding…

MORRAL COMPANIES

Published reductions in P loss using VRA

- **Iowa:** "On average, [variable compared with fixed rate] applied 12% less P and reduced STP variability in five fields… and *showed potential* for reducing excess P loss…" (Bermudez and Mallarino, 2007) [sampling grid: 4 samples/A, 10-12 cores each]
- **Minnesota:** based on a calibrated ADAPT model, "Phosphorus losses for the variable strategy were significantly lower than losses for a uniform strategy." (Gowda and Mulla, 2005) [sampling grid: 1.5 samples/A]
- **Nova Scotia:** wild blueberry field mapped with RTK-GPS management zones based on slope and bare spots. Natural runoff monitored June-October 2011. "The VRA significantly ($p \leq 0.05$) decreased TP, DRP, and inorganic nitrogen losses in surface runoff as compared to UA in low lying area of the field." (Saleem et al., 2014)

Less P is lost with more time between application and runoff



Concentration of dissolved P in surface runoff from plots cropped to tall fescue during rainfall simulations that occurred 1 to 29 days after broadcast application of triple superphosphate fertilizer (Smith et al., 2007).

Developing 4R Nutrient Stewardship Certification

4R NUTRIENT STEWARDSHIP CERTIFIED

The Andersons

MABA

AGRibusiness Council of INDIANA

MORRAL COMPANIES

Corn Marketing Program of Michigan
Michigan Corn Growers Association

CAP CONSERVATION action PROJECT

The Fertilizer Institute
Nourish, Replenish, Grow

The Nature Conservancy
Protecting nature. Preserving life.™

SOY OHIO
Ohio Soybean Council
www.soyohio.org

SOIL AND WATER RESOURCES
Ohio Department of Natural Resources

INDIANA CONSERVATION PARTNERSHIP

IPNI INTERNATIONAL PLANT NUTRITION INSTITUTE

Ohio AgriBusiness Association

Ohio Federation of Soil and Water Conservation Districts

NRCS

Legacy Farmers Cooperative

F3 OHIO FARM BUREAU

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EDF ENVIRONMENTAL DEFENSE FUND™
Finding the ways that work

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SANDUSKY RIVER WATERSHED COALITION

MAEAP

MICHIGAN STATE UNIVERSITY

THE OHIO STATE UNIVERSITY

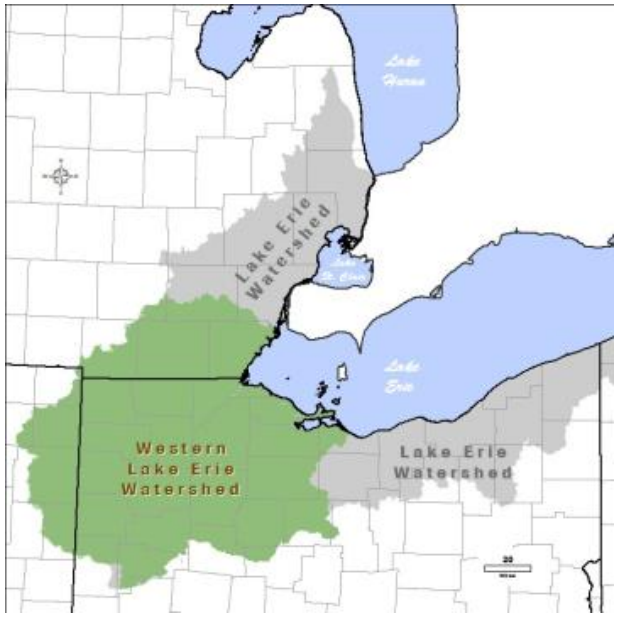
Ohio Corn & Wheat Growers Association

AMERICAN SOCIETY OF AGRONOMY
CERTIFIED CROP ADVISER

NUTRIENT STEWARDSHIP CERTIFICATION

Private Third Party Auditor

Nutrient Service Providers



Voluntary

4R Certification for Agri-retailers in the Lake Erie Watershed

Key criteria:

- Recommendations are consistent with the land-grant university, allowing for adaptive management.
- A certified professional reviews the nutrient recommendations made for the grower customers.
- **Source**: All sources of fertilizer are accounted for in the nutrient recommendation.
- **Rate**: Soil tests are less than four years old; application equipment is calibrated annually.
- **Time**: Avoids spreading on frozen or snow-covered fields; no broadcast prior to a predicted heavy rainfall.
- **Place**: Phosphorus is applied below the soil surface whenever possible; nutrient application setbacks are followed in sensitive areas.

http://4Rcertified.org/

4R Research Fund
environmental, social, economic impacts

- Established by the fertilizer industry to support research on 4R sustainability impact across North America – aiming for $7M over 5 years.
- **Meta-analysis:** 5 projects, 2014-2015.
- **Measurement:** 4 projects, 2014-2019.
- For additional information: www.nutrientstewardship.com/funding

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4R Research Fund – Lake Erie Watershed Project

- Evaluating the 4R Nutrient Stewardship Concept and Certification Program in the Western Lake Erie Basin
- GOAL: to evaluate the specific impacts of the adoption of practices associated with 4R Nutrient Stewardship, and the impact of the 4R Certification Program, on crop productivity and profitability, water quality, and perceptions of growers, nutrient service providers, and residents in the western Lake Erie watershed.
- 10 collaborators… land-river-lake continuum.

4R Research Fund – Lake Erie Watershed Project

Monitoring impacts on Lake Erie from 4R practices and the 4R program

1. Kevin King
USDA-ARS, Columbus, OH
- Project lead
- Edge-of-field research on rate, time and place of P application

2. Mark Williams
USDA-ARS, Columbus, OH
- Edge-of-field research on rate, time and place of P application

3. Laura Johnson
Heidelberg University, Tiffin, OH
- Watershed scale

4R Research Fund – Lake Erie Watershed Project

Modeling impacts on Lake Erie from 4R practices and the 4R program

4. Carrie Vollmer-Sanders
The Nature Conservancy
Angola, IN

- Integration
- Outreach
- Triple bottom line

5. Rem Confesor
Heidelberg University,
Tiffin, OH

- Soil and Water Assessment Tool (SWAT)

6. Joe DePinto
LimnoTech,
Ann Arbor, MI

- Western Lake Erie Ecosystem Model (WLEEM) & SWAT

nutrient stewardship

NUTRIENT STEWARDSHIP CERTIFIED

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4R Research Fund – Lake Erie Watershed Project

- To determine the behavioral impact of 4R educational efforts and the 4R Certification Program on the knowledge, beliefs, and management practices of crop growers and nutrient service providers

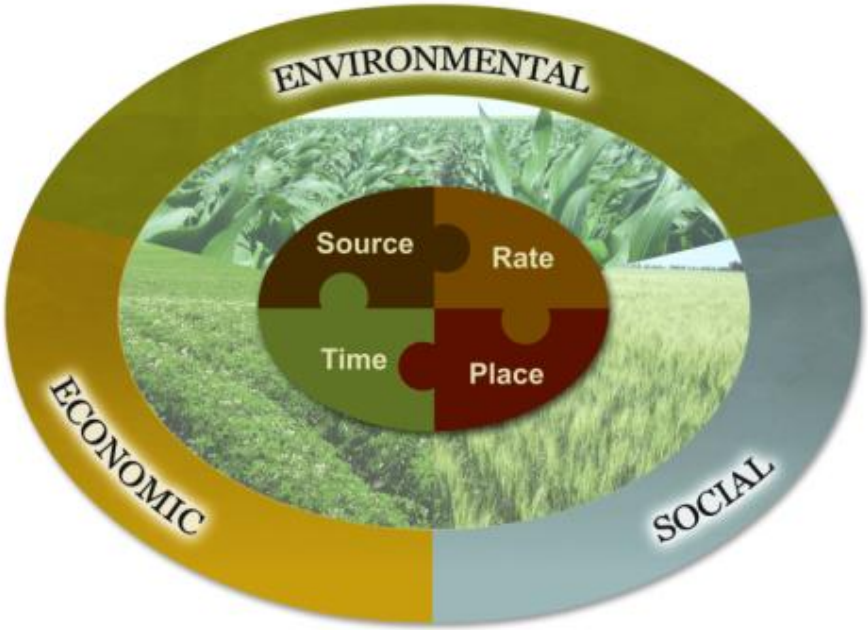
7. Greg LaBarge
Ohio State University Extension,
Marion, OH

8. Robyn Wilson
Ohio State University,
Columbus, OH

9. Brian Roe
Ohio State University,
Columbus, OH

4R: “right” means sustainable

Field to Market
The Keystone Alliance for Sustainable Agriculture



Walmart
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How to Make a Difference - Fertilizer optimization

CCA - THAT'S SOUND ADVICE™

FARM & FOOD Care ONTARIO

“Building public trust in food and farming”

4R PLANT NUTRITION

r4 nutrient stewardship

Summary – Precision P for Lake Erie

- Lake Erie P – we all play a role, and we need to sustainably intensify crop production while countering the trend to increasing DRP in runoff
- Crop P balances for every grower, matching surpluses to low soil tests and deficits to high soil tests
- Precision technology, research, and adaptive management needs to focus on placement, timing, and tillage, preventing loss of BOTH particulate and dissolved forms of P
- 4R certification – recognizing lake-friendly practitioners and building public trust
- 4R Research – quantifying the 4R effect on dissolved P runoff as well as social and eocnomic productivity

4R nutrient stewardship

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Thank you!

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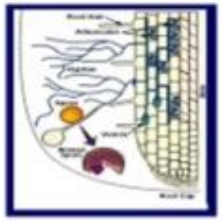
Topics /

Lake Erie P Issues

Algae blooms have been increasing in the past ten years, especially in 2011. Algal growth is often limited by phosphorus (P). Runoff from cropland is one of the sources of P in tributaries draining into Lake Erie. Learn how agri-service providers and producers are minimizing runoff losses by implementing 4R Nutrient Stewardship.

Sort by Date

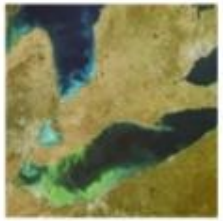


11 Nov 2013
Mycorrhizae
A collection of articles on plant root associations with beneficial fungi and their role in improving phosphorus uptake.

22 Jul 2013
Managing losses of dissolved phosphorus by time and place of application
Presented at the Joint meeting of the

03 Jun 2013
Place phosphorus in the soil to protect water quality in Lake Erie.
The link on the left leads to module 6.3-2 of the 4R Plant

03 Jun 2013
Timing broadcast phosphorus fertilizer applications can help protect Lake Erie
The link on the left



22 May 2013
Reducing Loss of Fertilizer Phosphorus to Lake Erie with the 4Rs
by Tom Bruulsema, Robert Mullen, Ivan

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