



**Joint meeting: Soil interfaces for sustainable development**  
Commission 2.5 of the International Union of Soil Science  
Canadian Society of Soil Science  
Association québécoise des spécialistes en sciences du sol  
6 July 2015

# **Managing soil interfaces with 4R crop nutrition**



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Agrium Inc.



Arab Potash Company



BELARUSIAN  
POTASH COMPANY  
Belarusian Potash  
Company



BHP Billiton



CF Industries Holdings,  
Inc.



Compass Minerals Plant  
Nutrition



International Raw  
Materials LTD.



Intrepid Potash, Inc.



K+S KALI GmbH



LUXI Fertilizer Industry  
Group



The Mosaic Company



OCP S.A.



PhosAgro



PotashCorp



QATAR FERTILISER COMPANY  
(QAFCO)



Shell Sulphur Solutions



Simplot



SinoFert Holdings Limited



SQM



TOROS TARIM



Uralchem



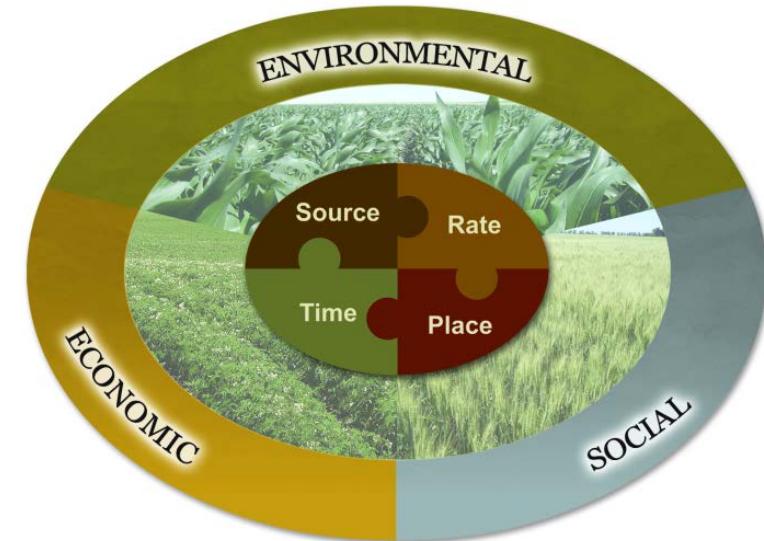
Uralkali

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



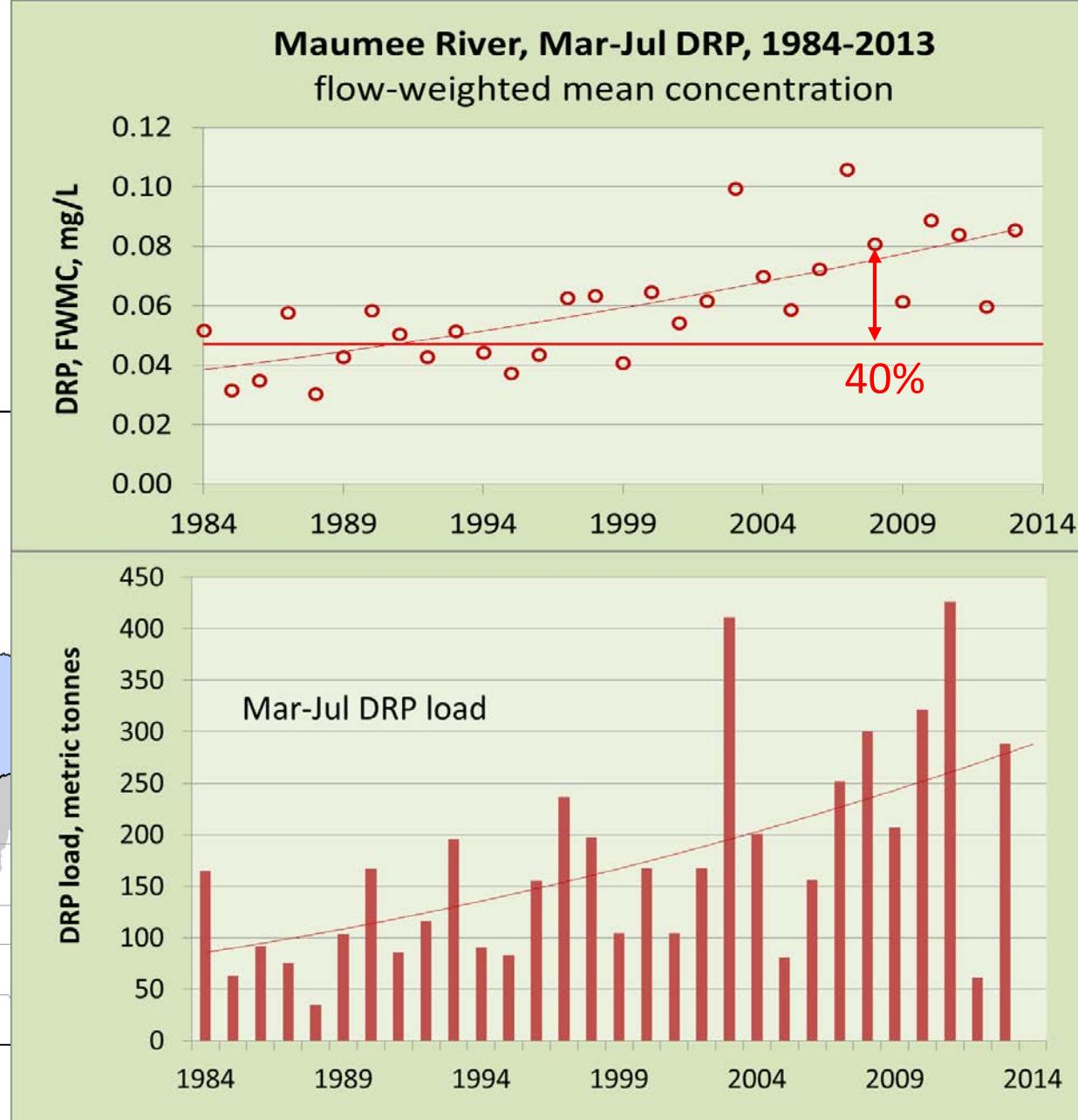
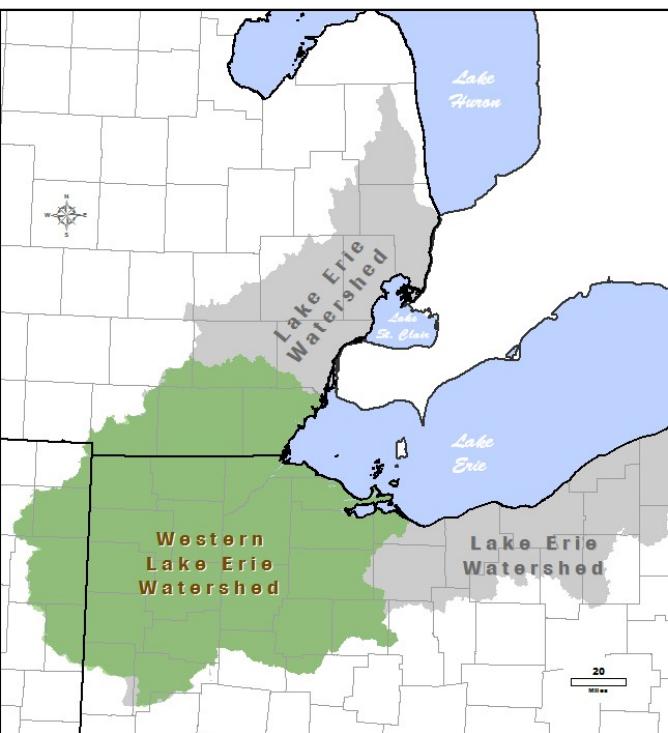
# Soil Interfaces - 4R Phosphorus

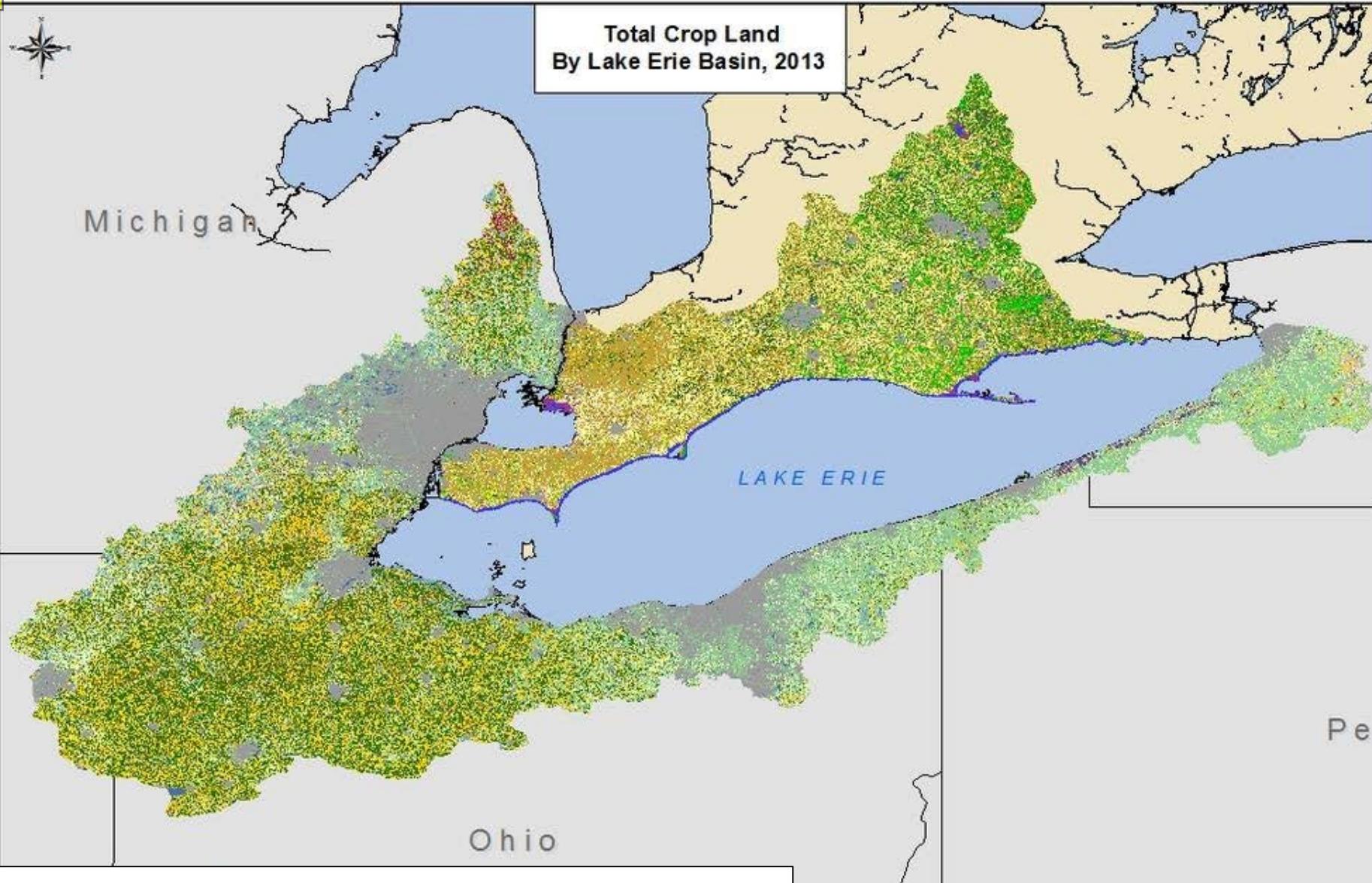
Interface	Right Place	Right Time	Right Rate	Right Source
1. Soil:Root	Close	Growing	0.2 ppm	Soluble
2. Soil Matrix:Macropore		Matrix	Soil P optimum	Slowly soluble
3. Soil:Drainage Water surface & tile	Off surface, out of tile	Avoid big rains	Soil P stratification	Slowly soluble
4. Soil:Society		Brand recognition, Certification, Metrics		





# Western Lake Erie: DRP trends increasing since early 1990s





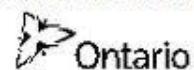
# The Lake Erie watershed includes cropland in Ontario

This map is for illustrative purposes only. Do not rely on it as being a precise indicator of routes, locations of features, or as a guide to navigation. This map may contain cartographic errors or omissions.

Map data compiled from 2013 Agriculture and Agri-Food Canada Crop Layer, Statistics Canada and 2013 National Agricultural Statistics Service, United States Department of Agriculture.

Projection: WGS 84  
Datum: World Geodetic System 1984

Published September 2014  
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# P export – does Ontario differ from Ohio?

	Strawberry Creek, ON	Holiday Beach, ON	Woodslee, ON	Upper Big Walnut Creek, OH
Soil	Loam to silt loam	Perth clay loam	Brookston clay loam	Silt loam to clay loam
Total P, kg/ha/year	0.35	1.14	1.1-2.1	0.98
DRP, kg/ha/year	0.09	0.08	0.6-1.5	0.66
Years	2000-2001	2000-2004	1988-1990	2005-2012
Reference	Macrae et al, 2007	Tan and Zhang, 2011	Gaynor & Findlay, 1995	King et al., 2015

## 2. Soil matrix:macropore interface

- In the matrix, soils can retain P by sorption and precipitation
- Macropores enable fast flow, and P in both soluble and particulate forms can bypass the matrix
- BIG implications for place & time of P application, and for tillage on tile-drained soils



# Fertilizer P granules on soil surface are soluble



# Effect of tillage on preferential flow and phosphorus transport

**Soil type:** Silt loam

**Tile depth:** 90 cm

**Soil test P:** 30 ppm Mehlich-3P

**Tillage:** No-till

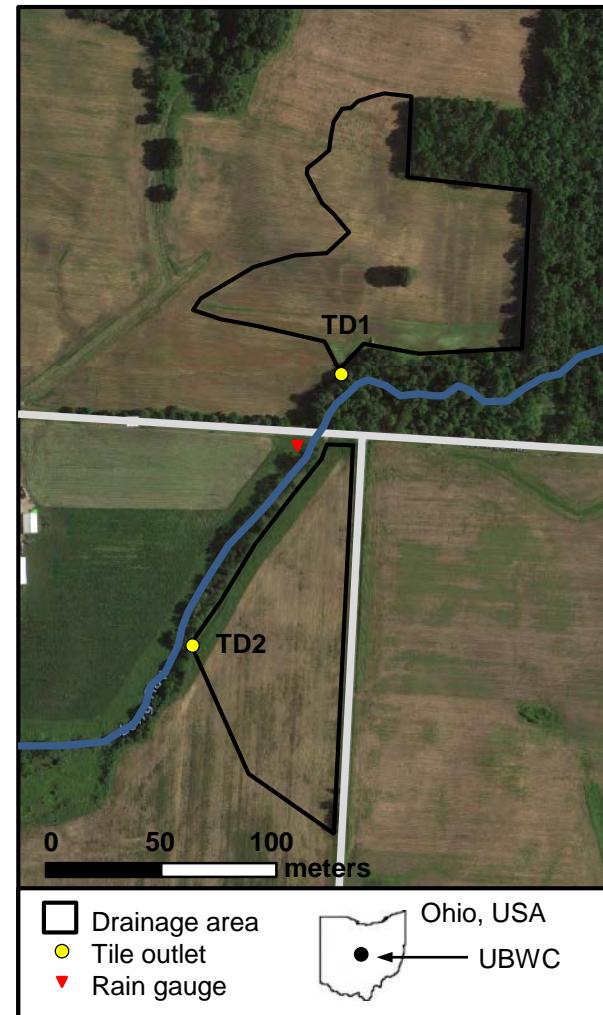
## 2014 management

May 6<sup>th</sup> – Applied MAP @ 45 kg P/ha

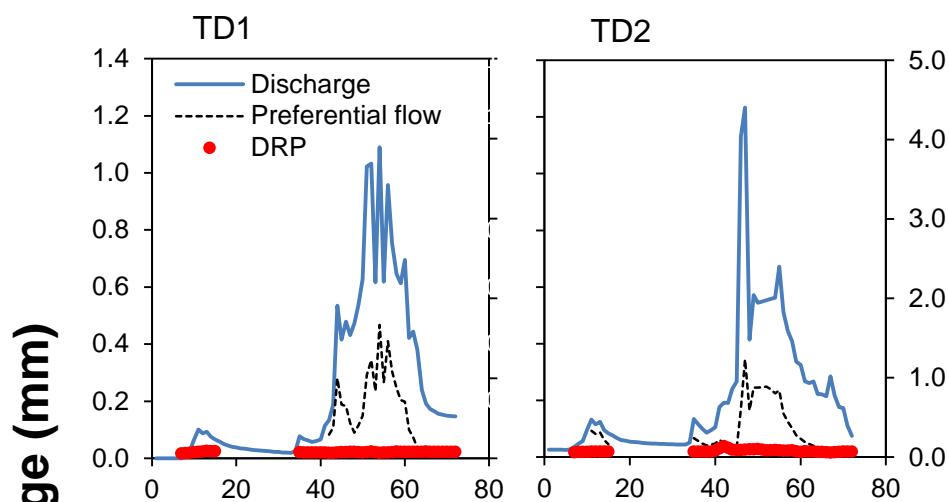
May 8<sup>th</sup> – Tilled field TD1 (disc)  
(TD2 remained no-till)

## Study Objective

Compare P transport before and after tillage and between tilled and no-till fields

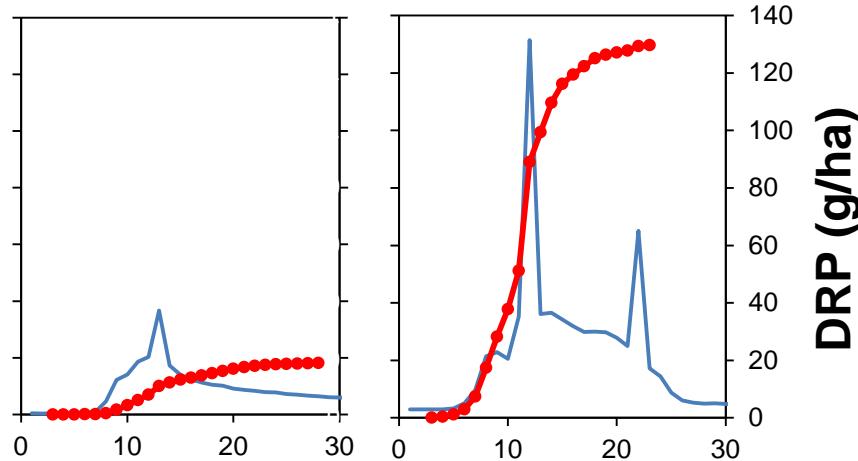
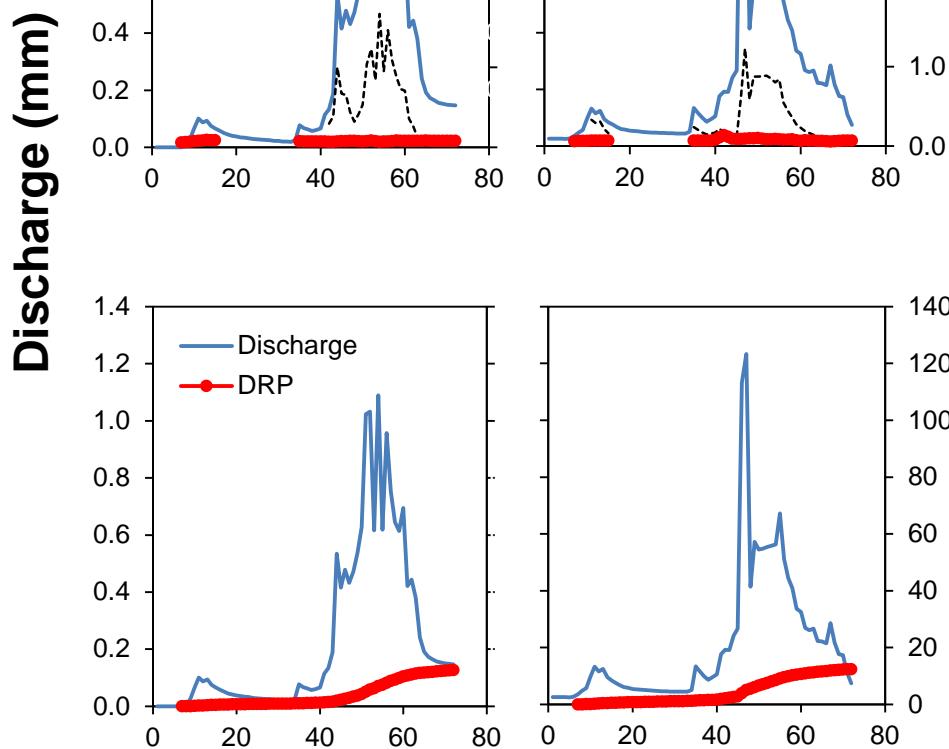
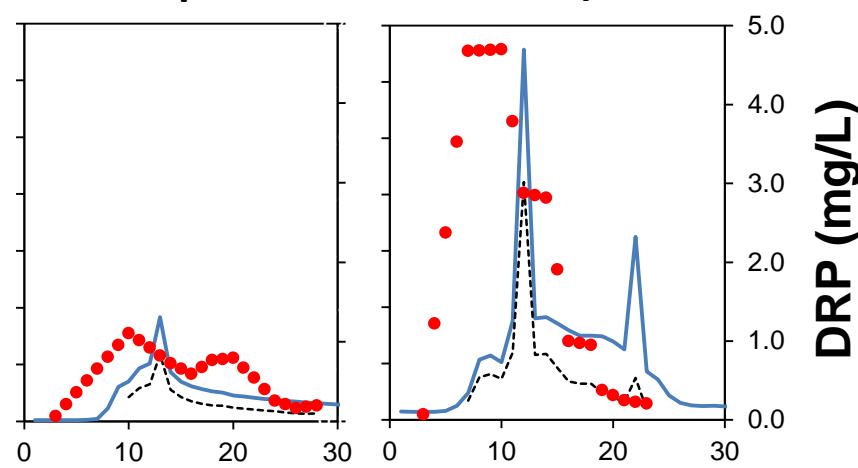


## Before P application & tillage (April 28<sup>th</sup>)



## After P application & tillage (May 12th)

P incorporated    P not incorporated

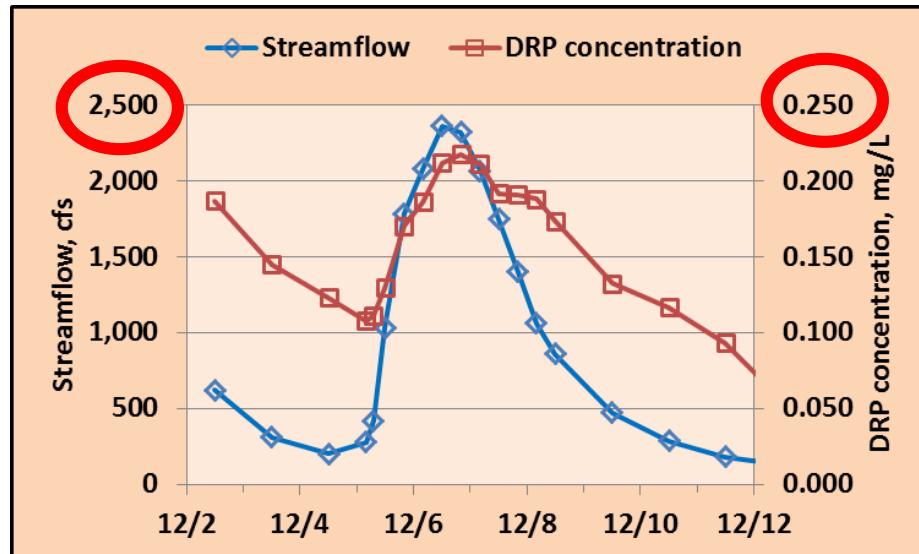
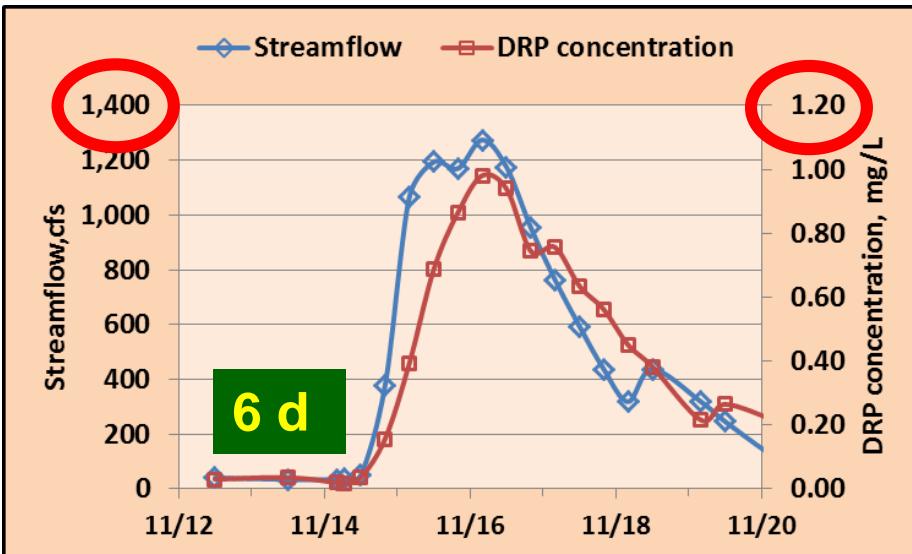


Incorporating P reduced DRP loss from 130 g/ha to 18 g/ha

# 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

150 g/ha

DRP load/ha of watershed

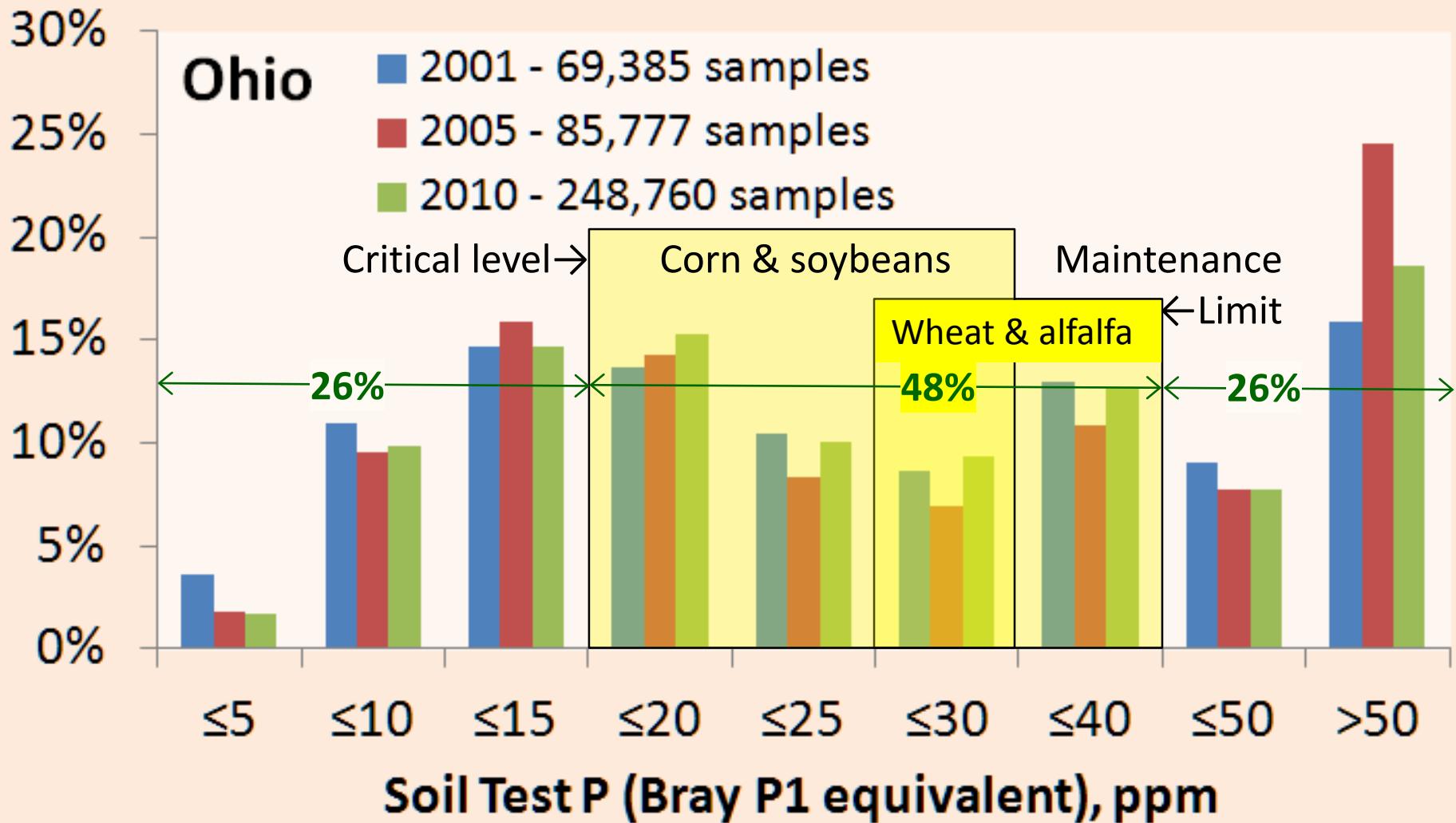
78 g/ha

1. Intense rainstorms following P broadcast 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.

### 3. Soil:drainage water interface – surface & tile drains

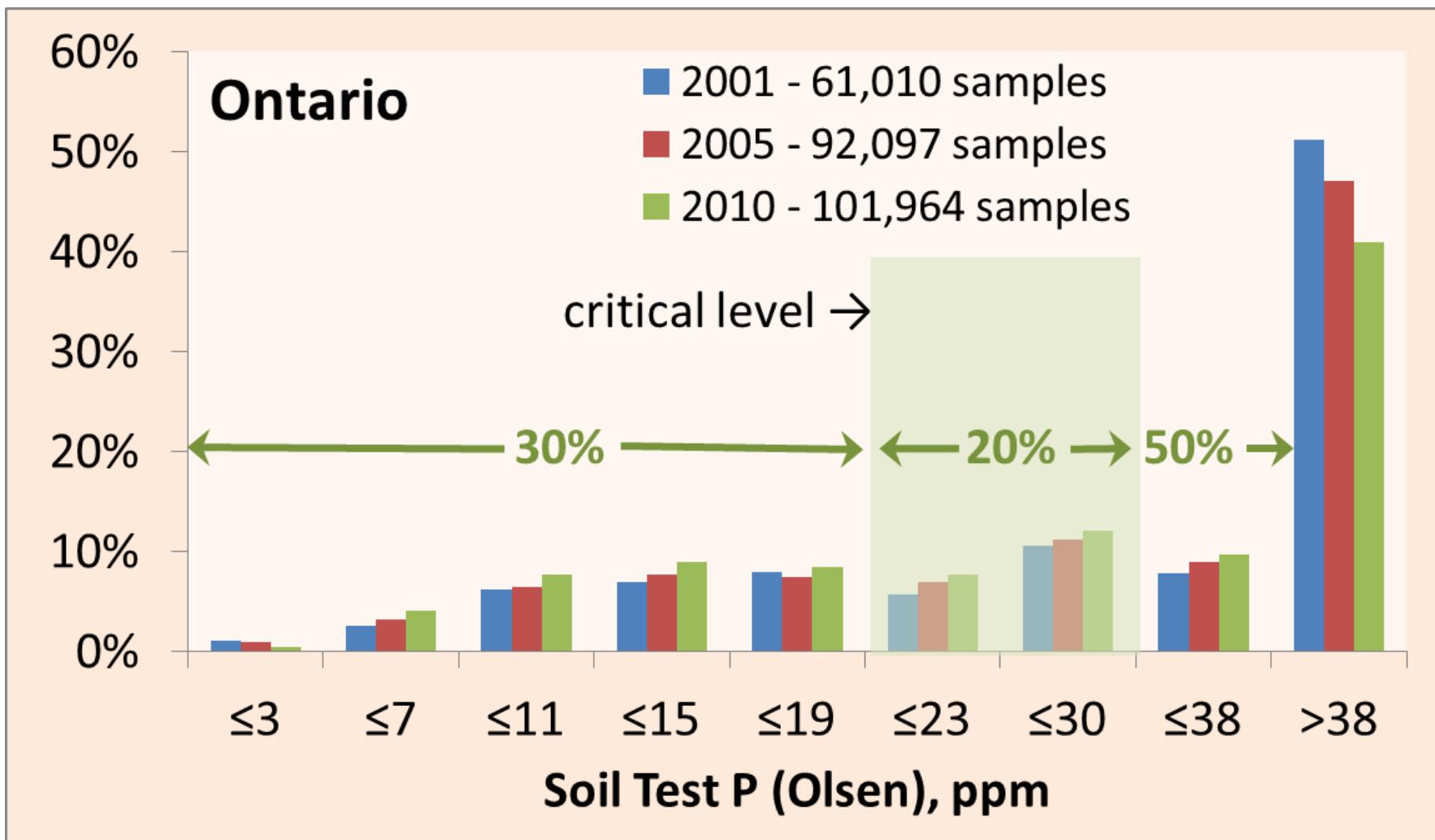
- At the soil:water interface, soil test P levels influence [P] in drainage water
- Nutrient balance influences soil test P levels
- Stratification may result in higher soil test P at the soil:water interface than at the soil:root interface
- Tillage and P placement influence stratification

# 48% of Ohio soils test optimum for P



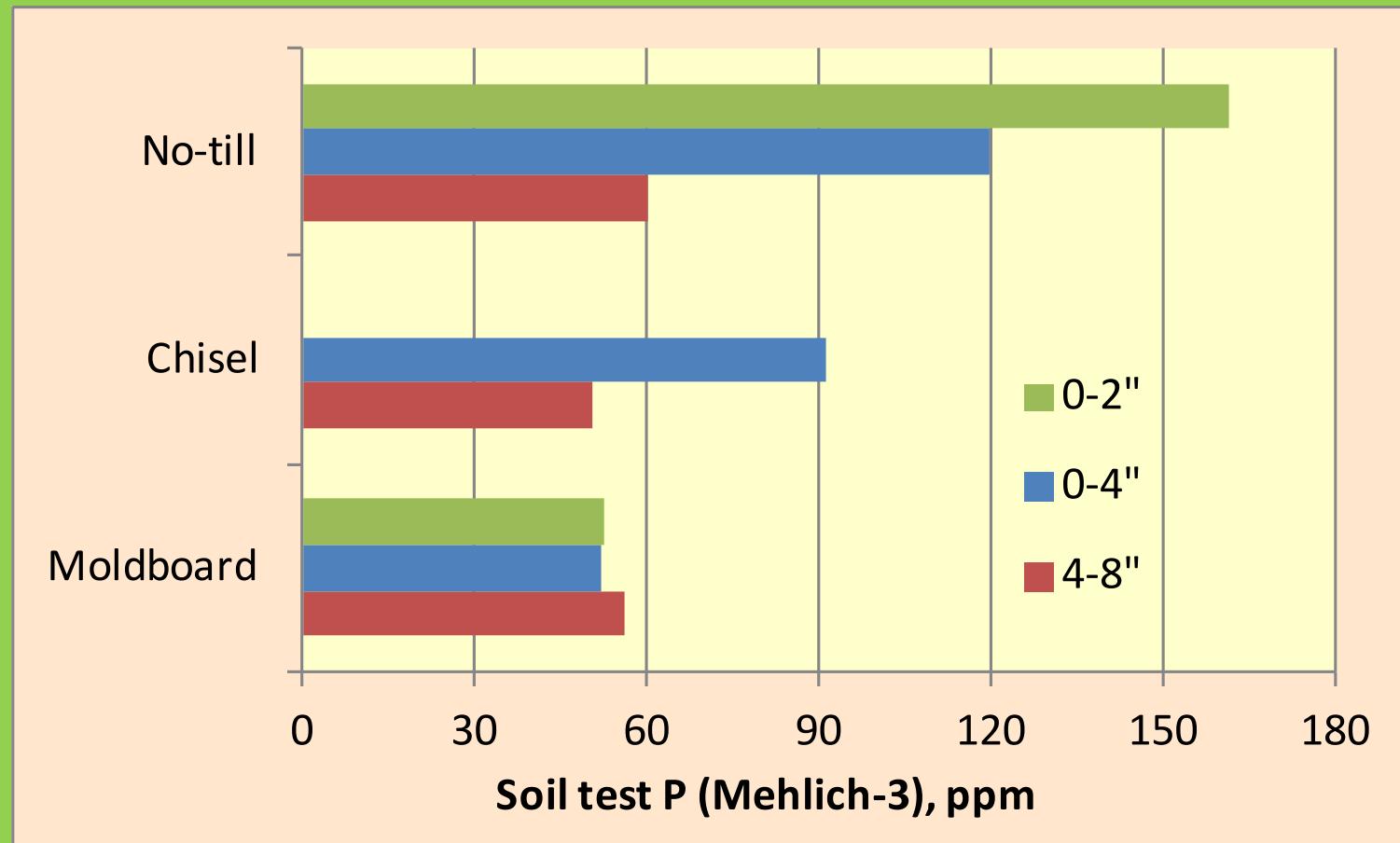


# Ontario's cropland has higher soil test P than Ohio's



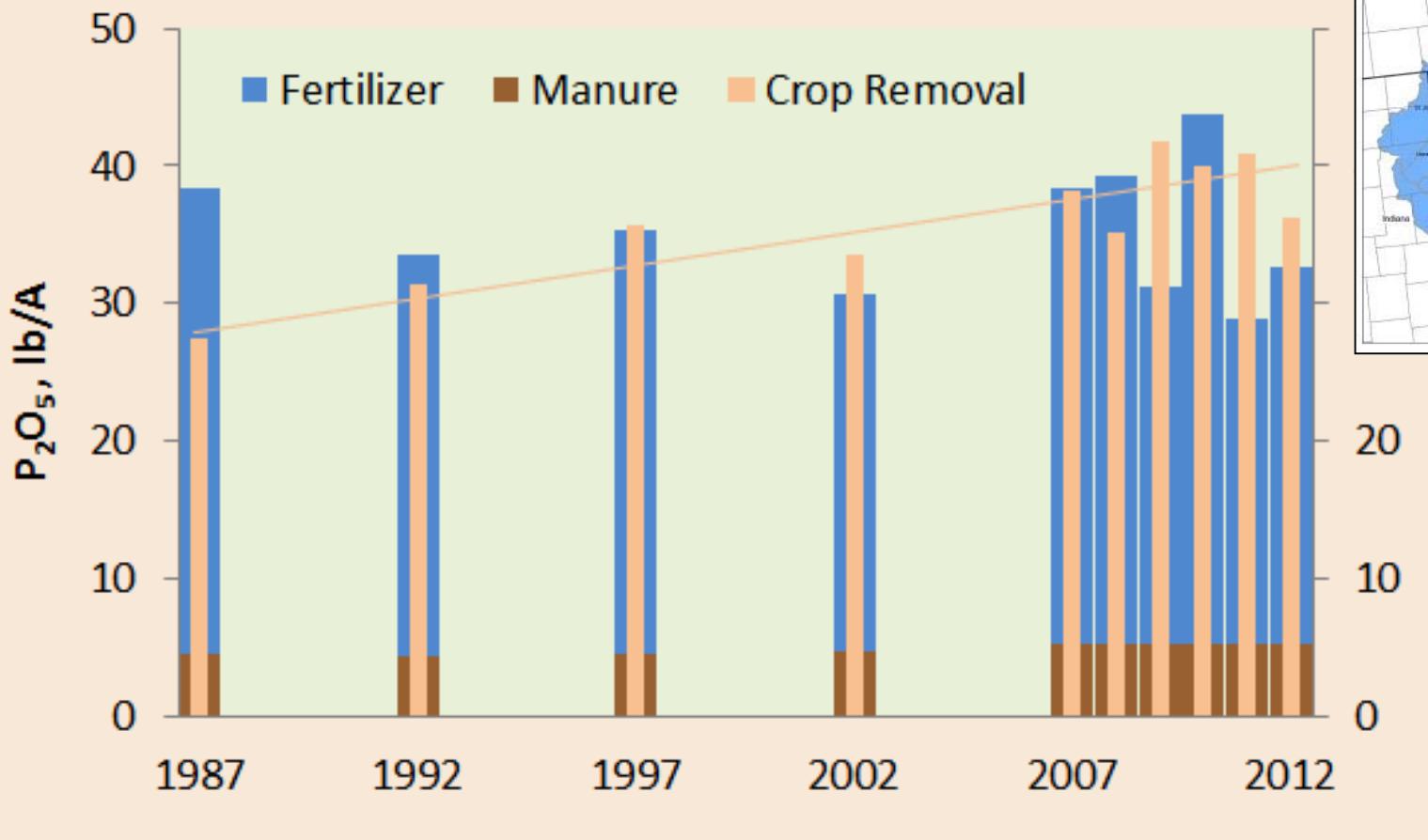


# Soil test P stratifies without moldboard plowing



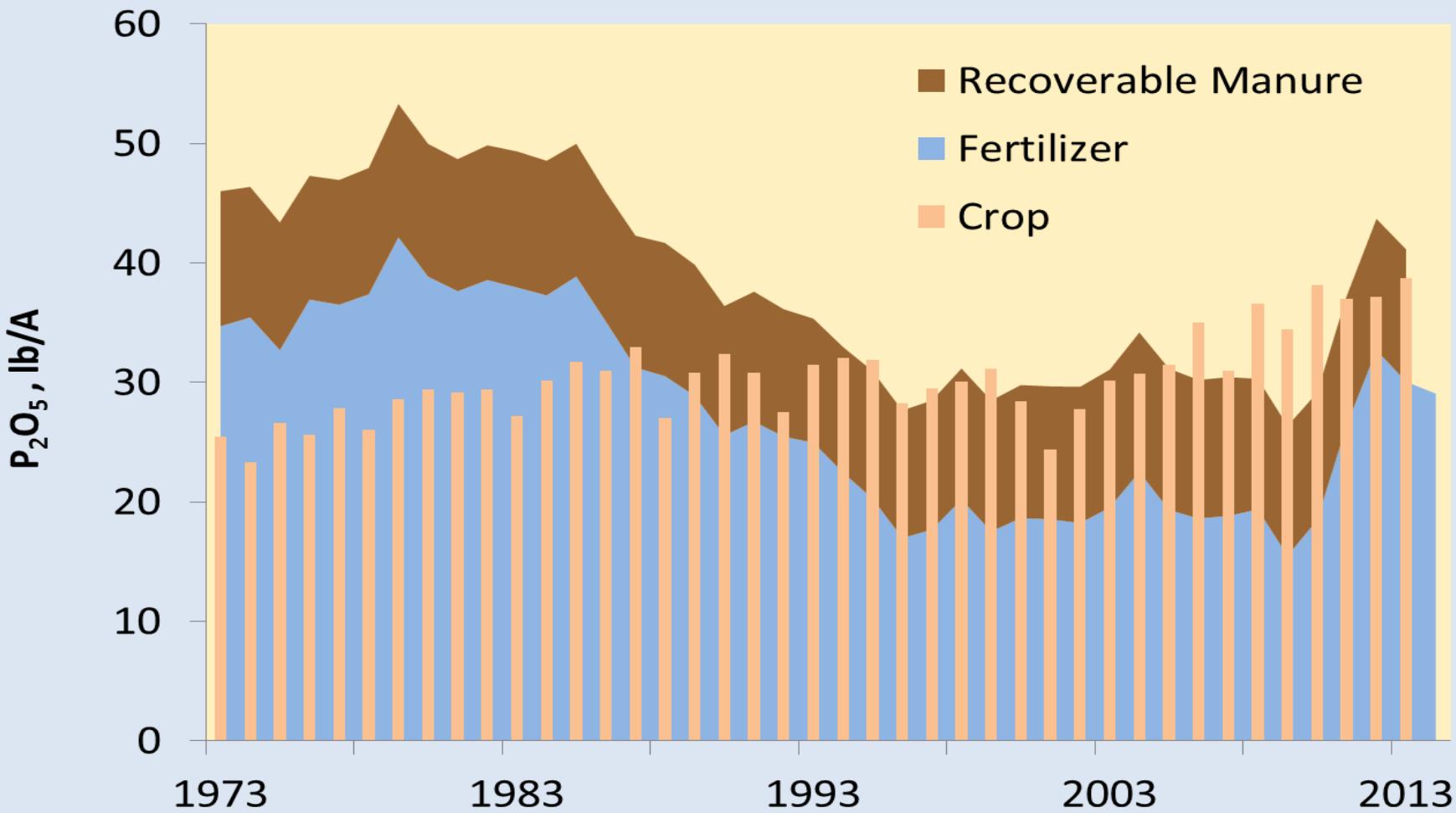
Soil test P distribution with depth in a long-term tillage experiment on a poorly drained Chalmers silty clay loam soil near West Lafayette, Indiana. Moldboard and chisel plots were plowed annually to a depth of 8". Data from Gál (2005) and Vyn (2000). Fertilizer P applied broadcast.

## Cropland P Balance, Western Lake Erie Watershed



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

# Ontario Cropland Phosphorus Balance



Ontario's P balance: more manure than in the western Lake Erie watershed, but a similar historical legacy

## 4. Soil:Society Interface

- Placement and timing practices optimal for minimizing P loss to the environment may cost more than those optimal for agronomic operational efficiency
- Recognition of producer adoption of “right” management needed
- Research to quantify BMP effectiveness needs public support



# Developing 4R Nutrient Stewardship Certification

**The Andersons**



**The Fertilizer Institute**  
Nourish, Replenish, Grow

**The Nature Conservancy**  
Protecting nature. Preserving life.™

corn Marketing Program of Michigan  
Michigan Corn Growers Association



SOIL AND WATER RESOURCES  
Ohio Department of Natural Resources



**IPNI**  
INTERNATIONAL PLANT NUTRITION INSTITUTE



**Ohio**  
AgriBusiness Association



**NRCS**

**EDF**  
ENVIRONMENTAL DEFENSE FUND™  
Finding the ways that work



**MICHIGAN STATE UNIVERSITY**

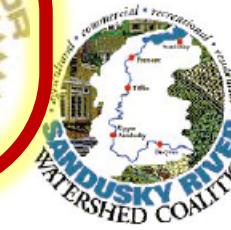
**Nester Ag, Inc.**

**THE OHIO STATE UNIVERSITY**

**F3**  
OHIO FARM BUREAU



**Ohio Corn & Wheat Growers Association**





# 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 P on frozen or snow-covered fields; no broadcast prior to a predicted heavy rainfall.
- **Place:** P is applied below the soil surface whenever possible.

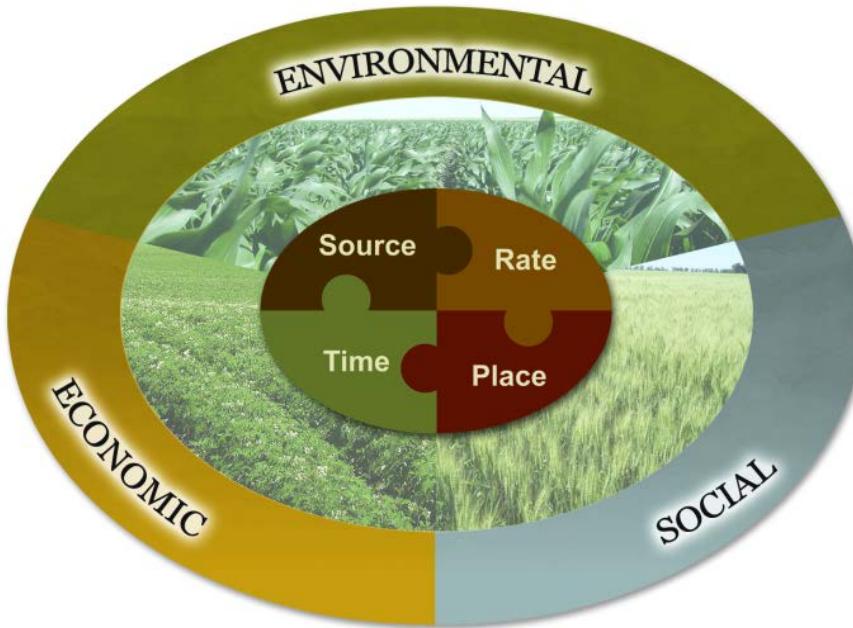
<http://4Rcertified.org/>

# 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: “right” means sustainable



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The Keystone Alliance for Sustainable Agriculture



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**How to Make a Difference -  
Fertilizer optimization**



FARM & FOOD  
*Care* ONTARIO

# Phosphorus & Water Quality

## 4R Soil Interfaces



Interface	Right Place	Right Time	Right Rate	Right Source
1. Soil:Root				
2. Soil Matrix:Macropore				
3. Soil Drainage:Water surface & tile				
4. Soil:Society				

[nane.ipni.net](http://nane.ipni.net)

