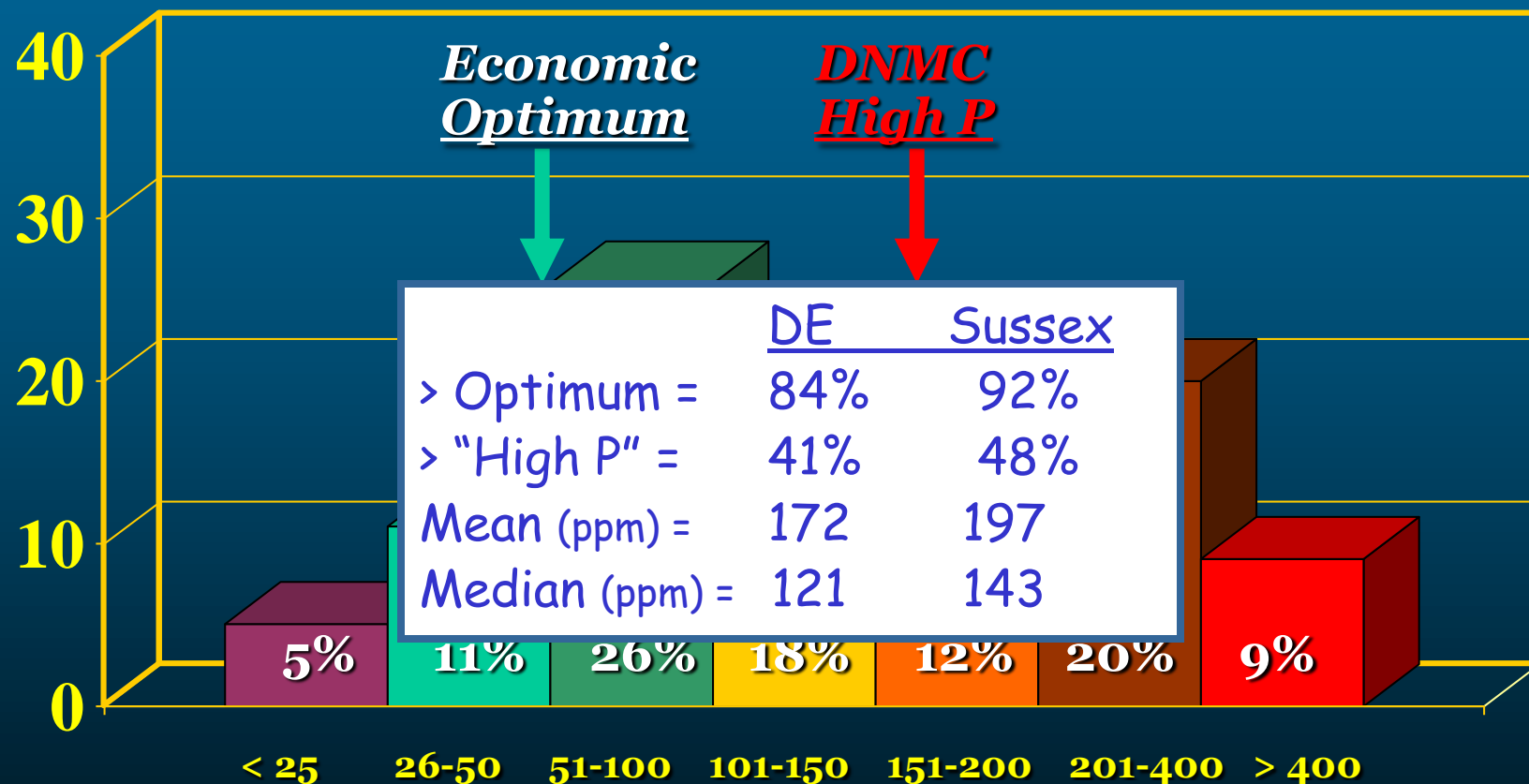# APPROPRIATE USE OF VEGETATED FILTER STRIPS WITHIN THE DELAWARE LANDSCAPE

J. K. Gilbert Jenkins

and J.T. Sims

Soil Test P Summary for Delaware
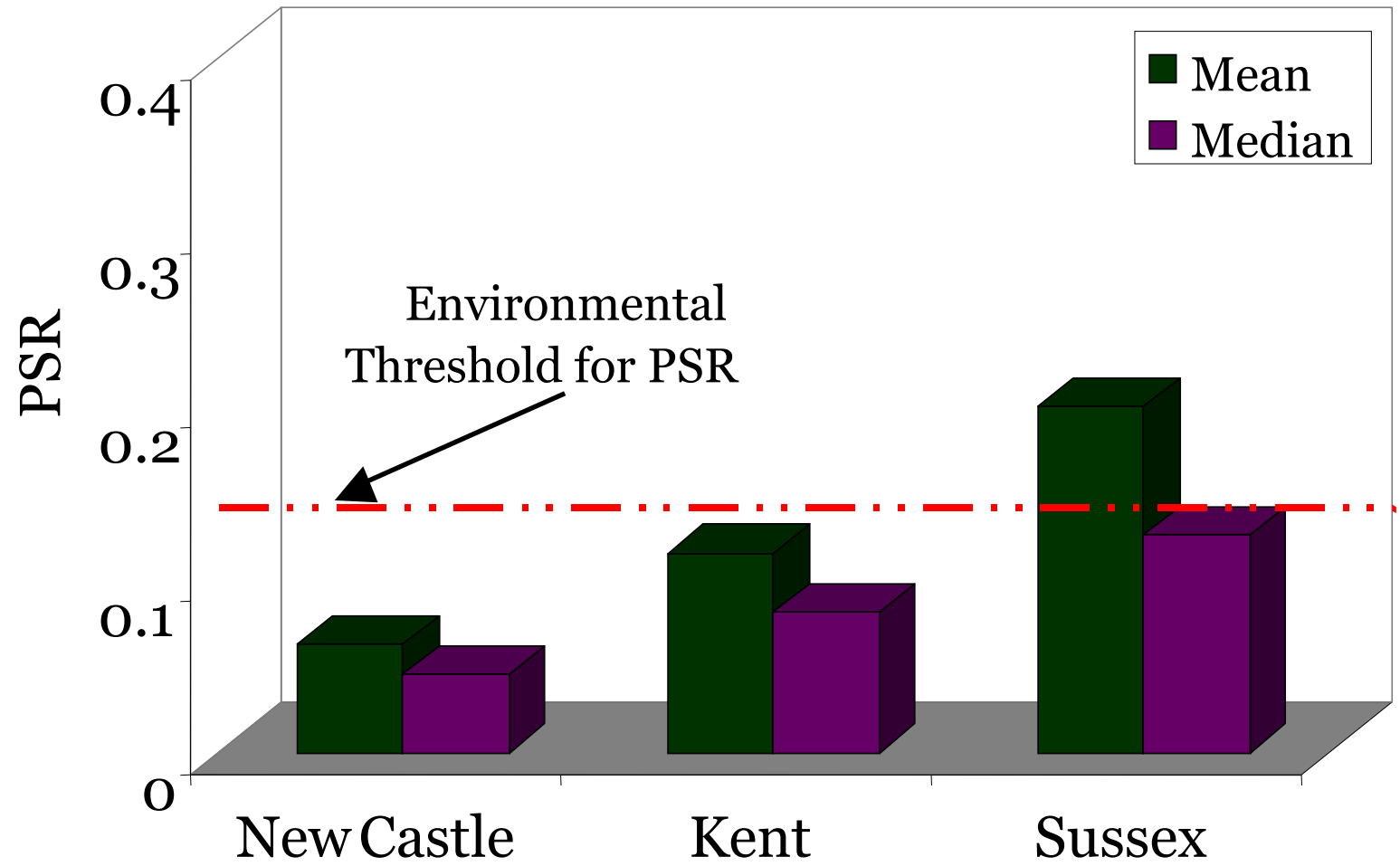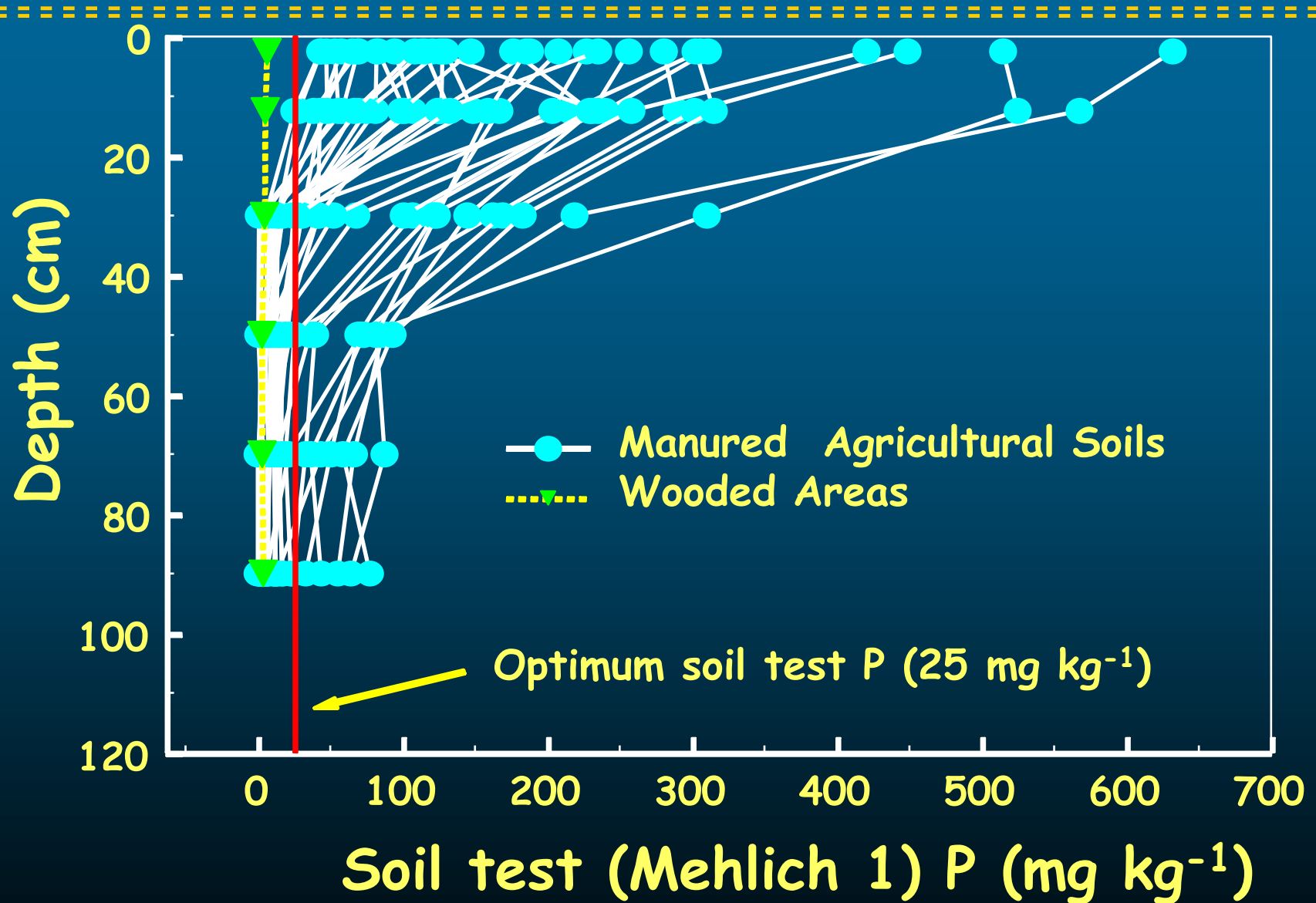
% of Agronomic Samples   *(n=25,890 samples)*

	DE	Sussex
> Optimum =	84%	92%
> "High P" =	41%	48%
Mean (ppm) =	172	197
Median (ppm) =	121	143

Economic Optimum

DNMC High P

Values on bars: 5%   11%   26%   18%   12%   20%   9%

x-axis categories: < 25   26-50   51-100   101-150   151-200   201-400   > 400

y-axis: 0, 10, 20, 30, 40

Mehlich 3 P (mg P kg⁻¹)

Soil Phosphorus Saturation

PSR Summary for DE (2002-2004)

Phosphorus Leaching in Delaware Soils

Depth (cm)

Manured Agricultural Soils
Wooded Areas

Optimum soil test P (25 mg kg^{-1})

Soil test (Mehlich 1) P (mg kg^{-1})

(Mozaffari and Sims, 1994)

The Delaware Agricultural Landscape

What impact does this scenario have on dissolved P transport?

Research Questions

- **1: How are vegetated filter strips (VFS) distributed through the Delaware Agricultural landscape?**

- **2: Can a technique such as soil deep tillage prior to VFS installation improve phosphorus (P) retention with VFS installed in Delaware?**

- **3: Can a matrix be developed to predict the proper placement of VFS within the agricultural landscape?**
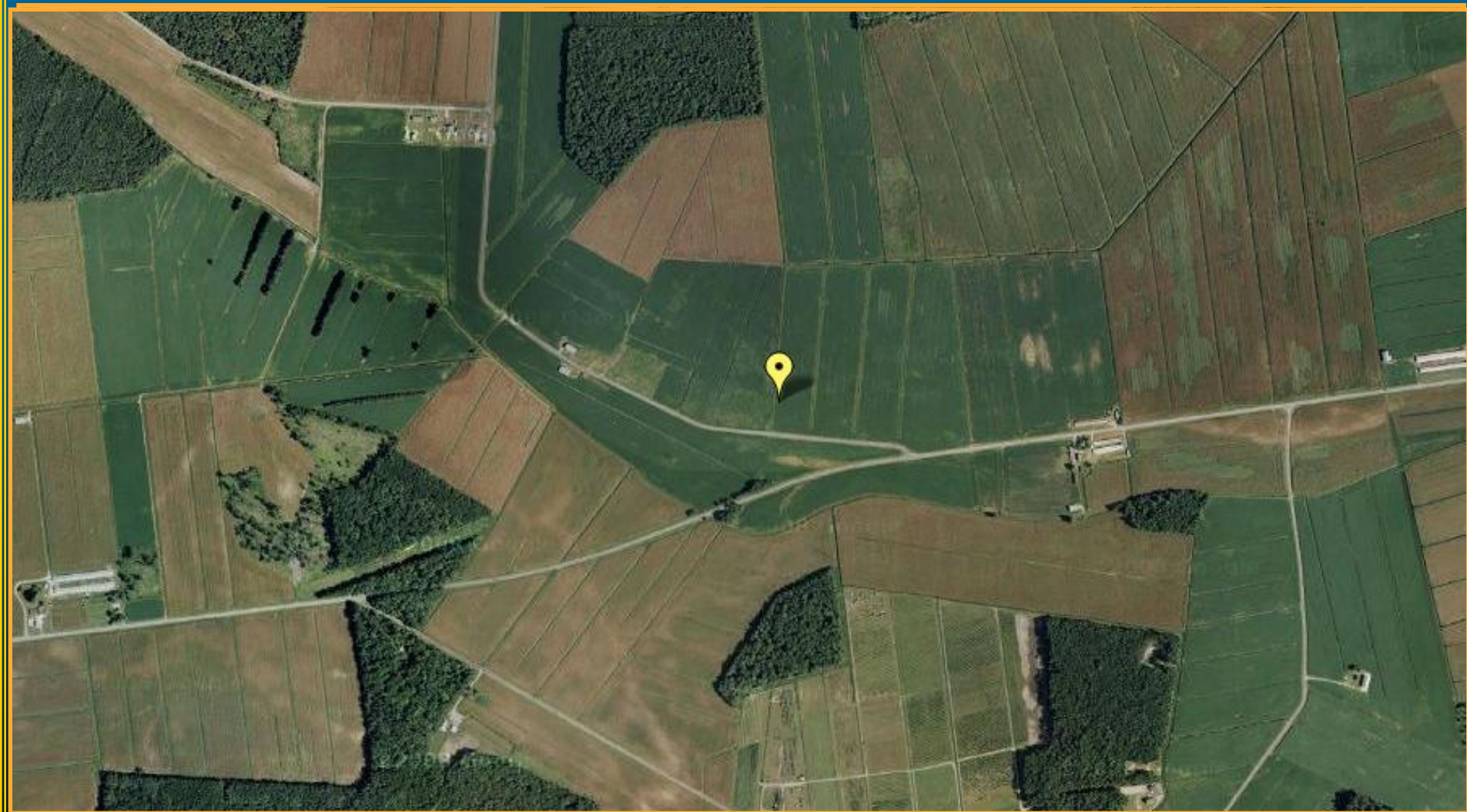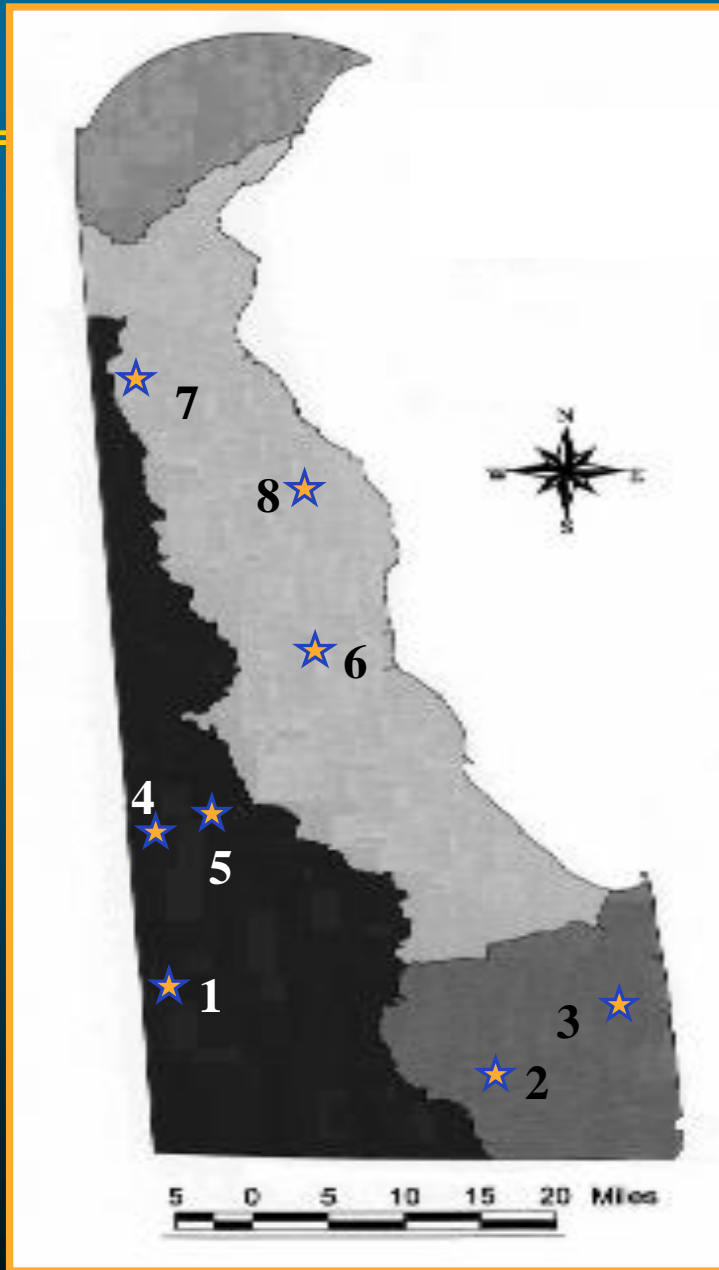
VFS in the Context of the Delaware Landscape
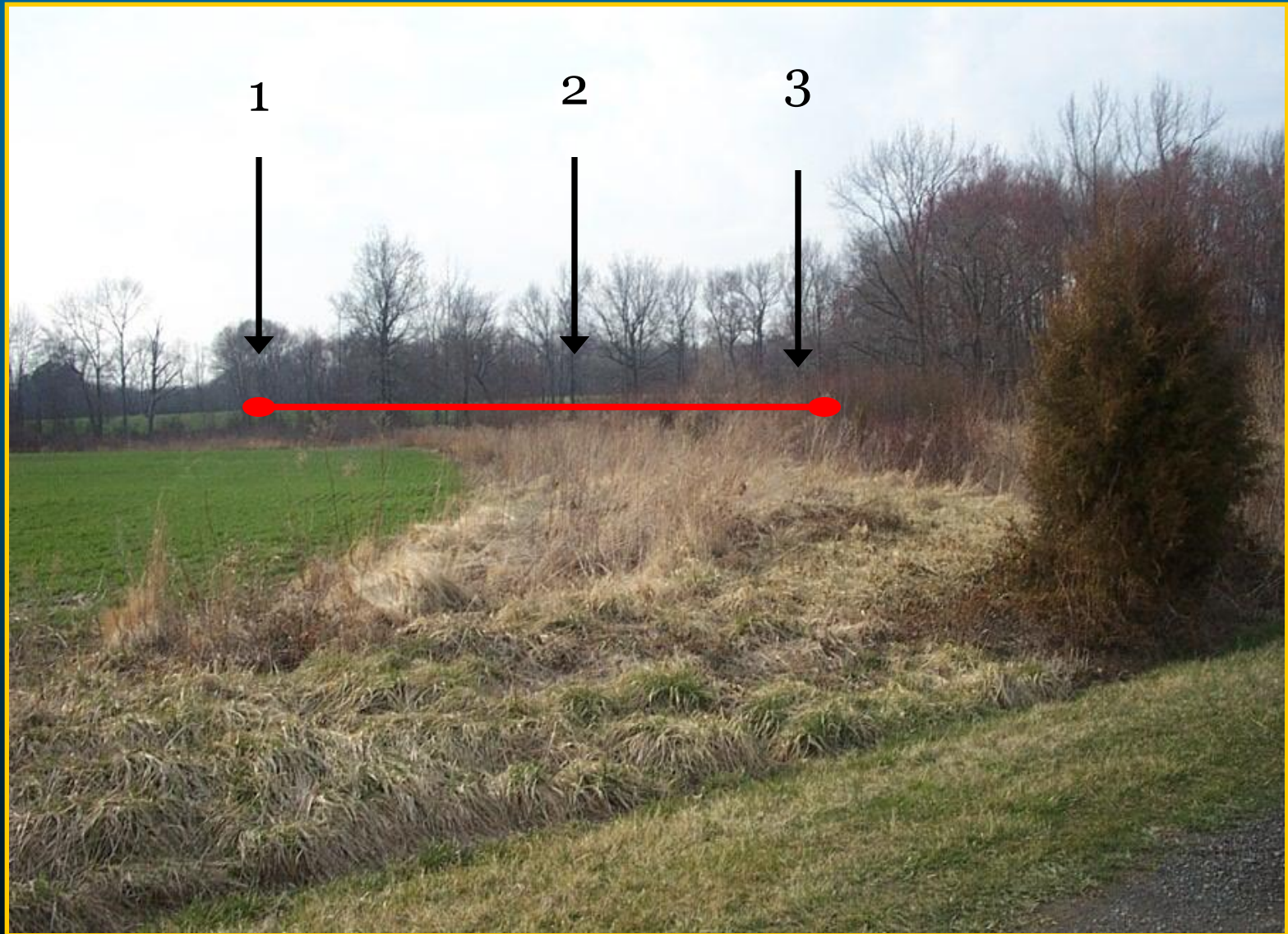
VFS in the Context of the Delaware Landscape

County	VFS	Cropland	M3-P
	ha	%	Mg kg^{-1}
New Castle	35	14	46
Kent	267	32	98
Sussex	99	54	176

Eight sites for addressing VFS soil P sorption and desorption

Crop and VFS Soil Sampling

Basic Properties of 8 VFS Sites

VFS	Soil Series	Width	Vegetation mixture	Time since installation at sampling
		-- m --		-- yr --
1	Rockawalkin loamy sand	33	Cool season	4
2	Mullica-Berryland complex	4	Cool season	3
3	Klej loamy sand	7	Warm season	2
4	Fallsington loam	37	Cool season	3
5	Mullica mucky sandy loam	29	Cool season	4
6	Downer sandy loam	18	Warm season	3
7	Fallsington loam	7	Cool season	3
8	Unicorn loam	18	Cool season	4

Laboratory Soil Analysis

- **Routine analysis by DE-STL including pH, OM, M3-P, Al, Fe**
  - Soil P saturation (PSR) was calculated from the molar ratio of M3-P:(M3-Al+Fe)
  - Soil P Storage Capacity (SPSC) was calculated as: $(0.15 - PSR)*(M3-Al+Fe)$
- **Water soluble phosphorus extraction (WSP)**
- **Batch equilibrium isotherm determination to calculate Langmuir parameters S_{max} and EPC_0**
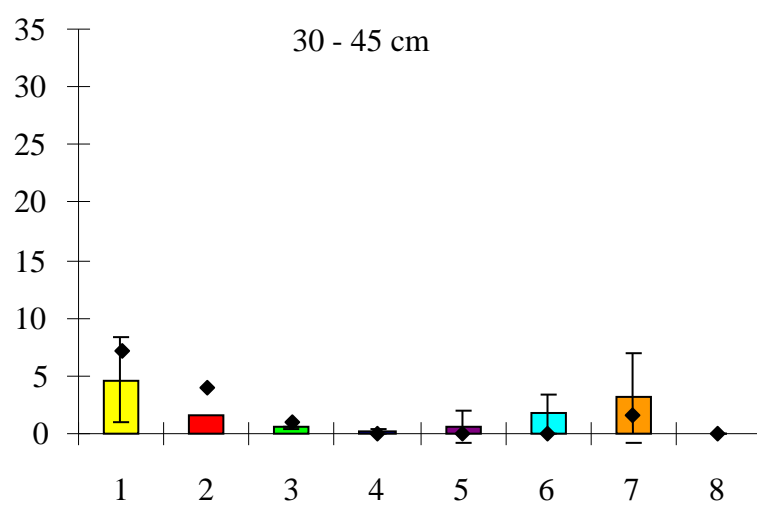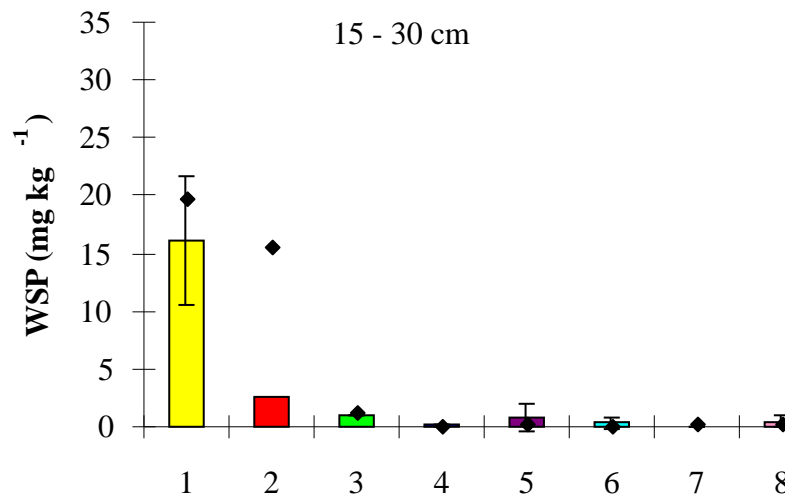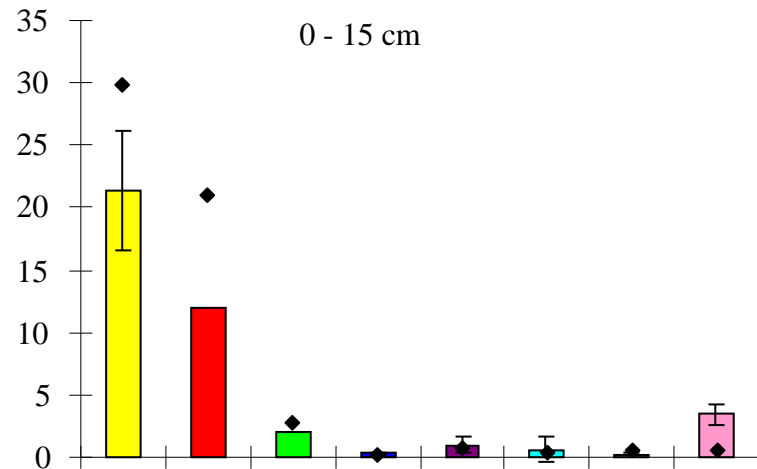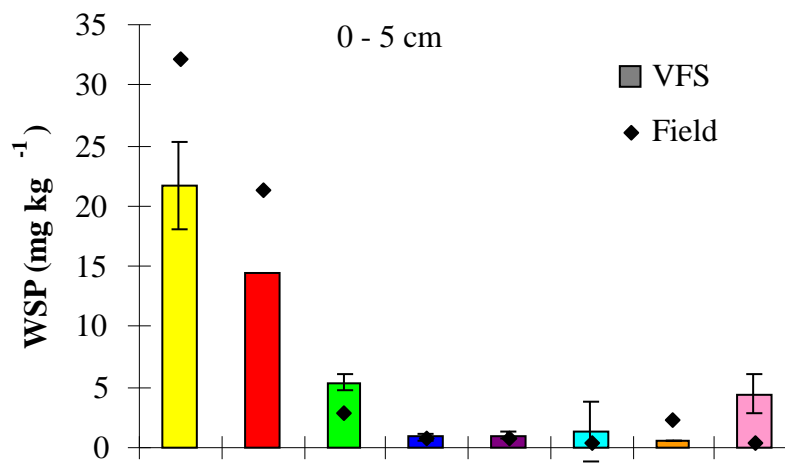- **Simulated deep tillage by mixing equal portions of soils from 0-15, 15-30, and 30-45 cm**
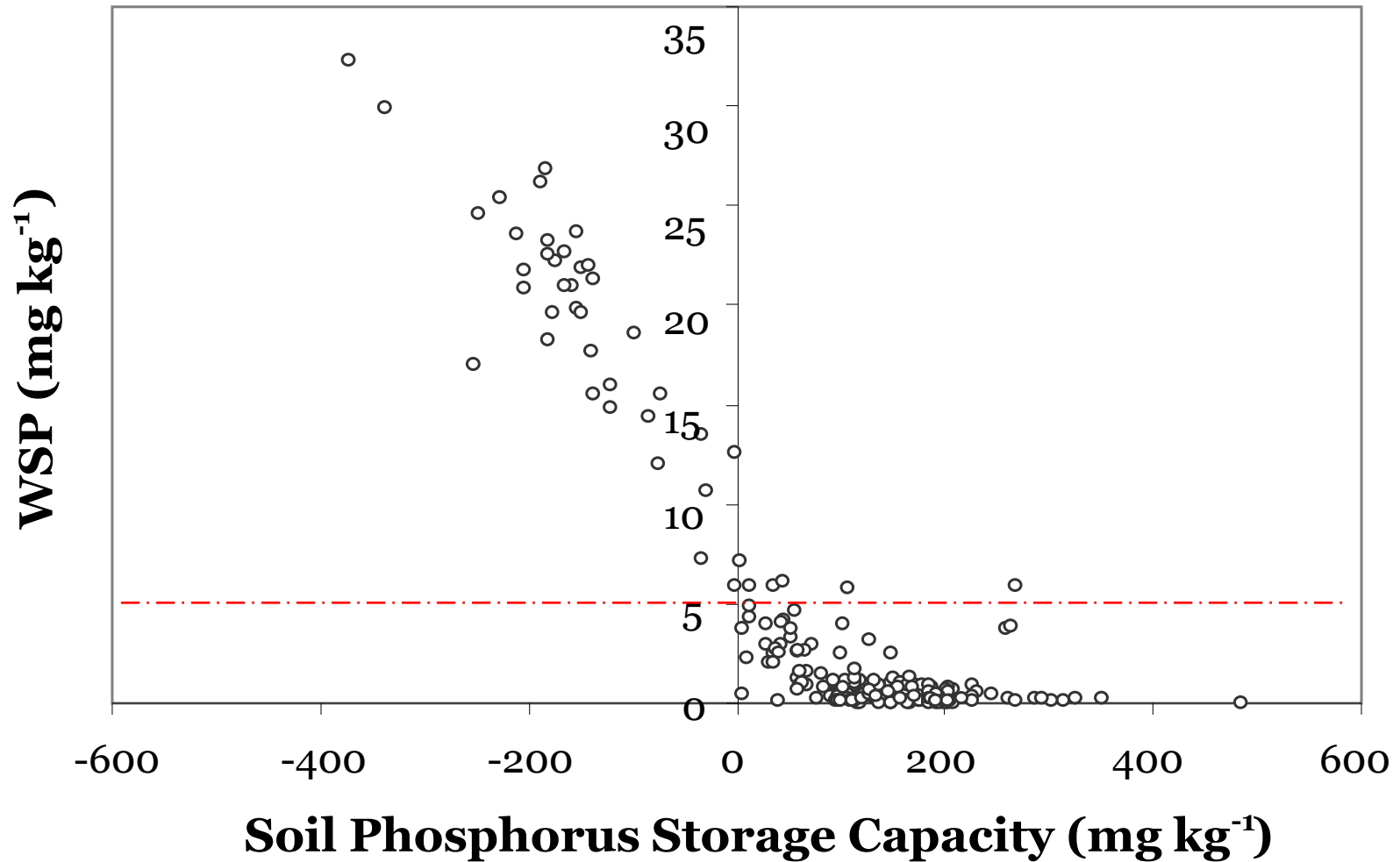 - batch equilibrium isotherm
  - WSP
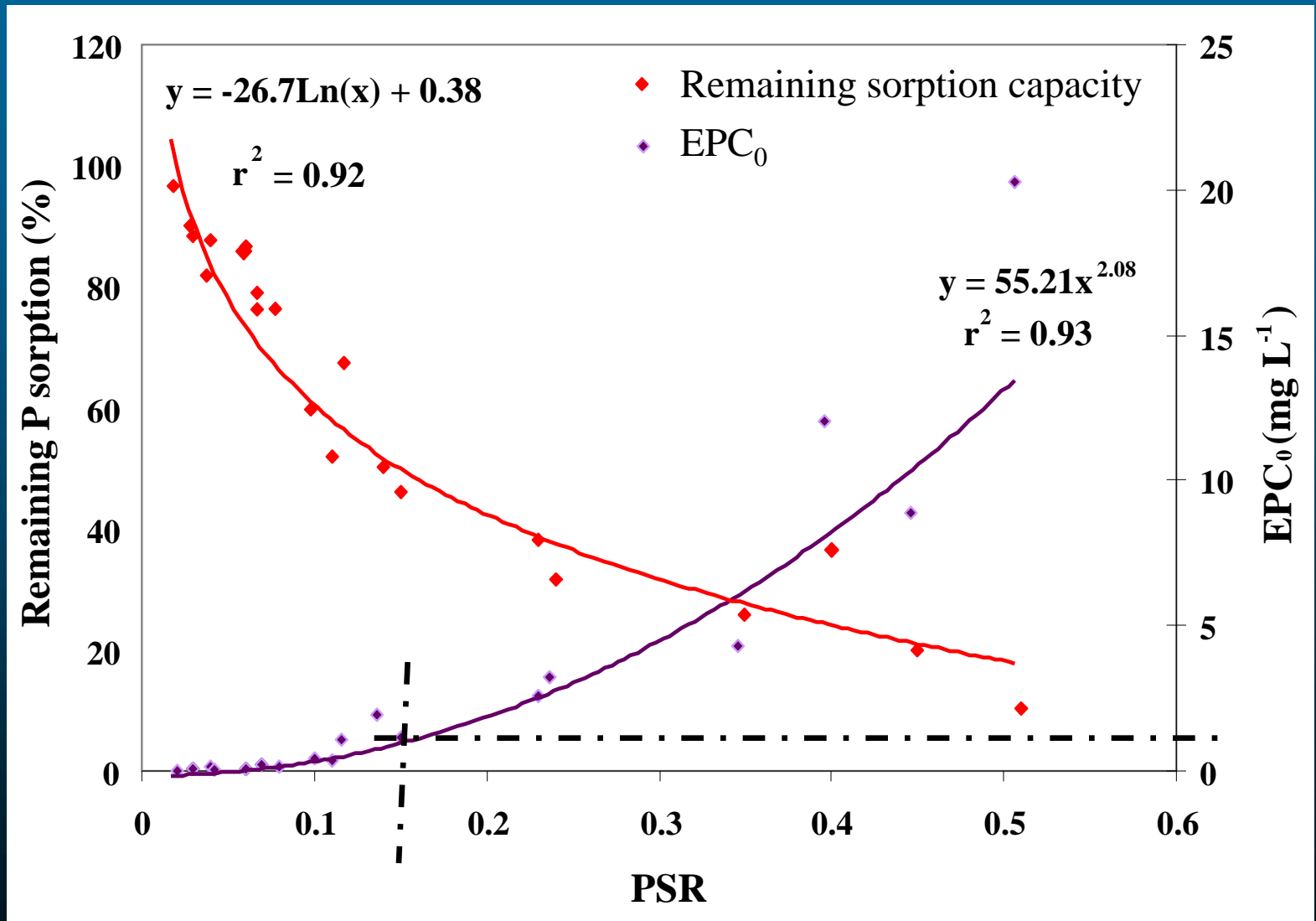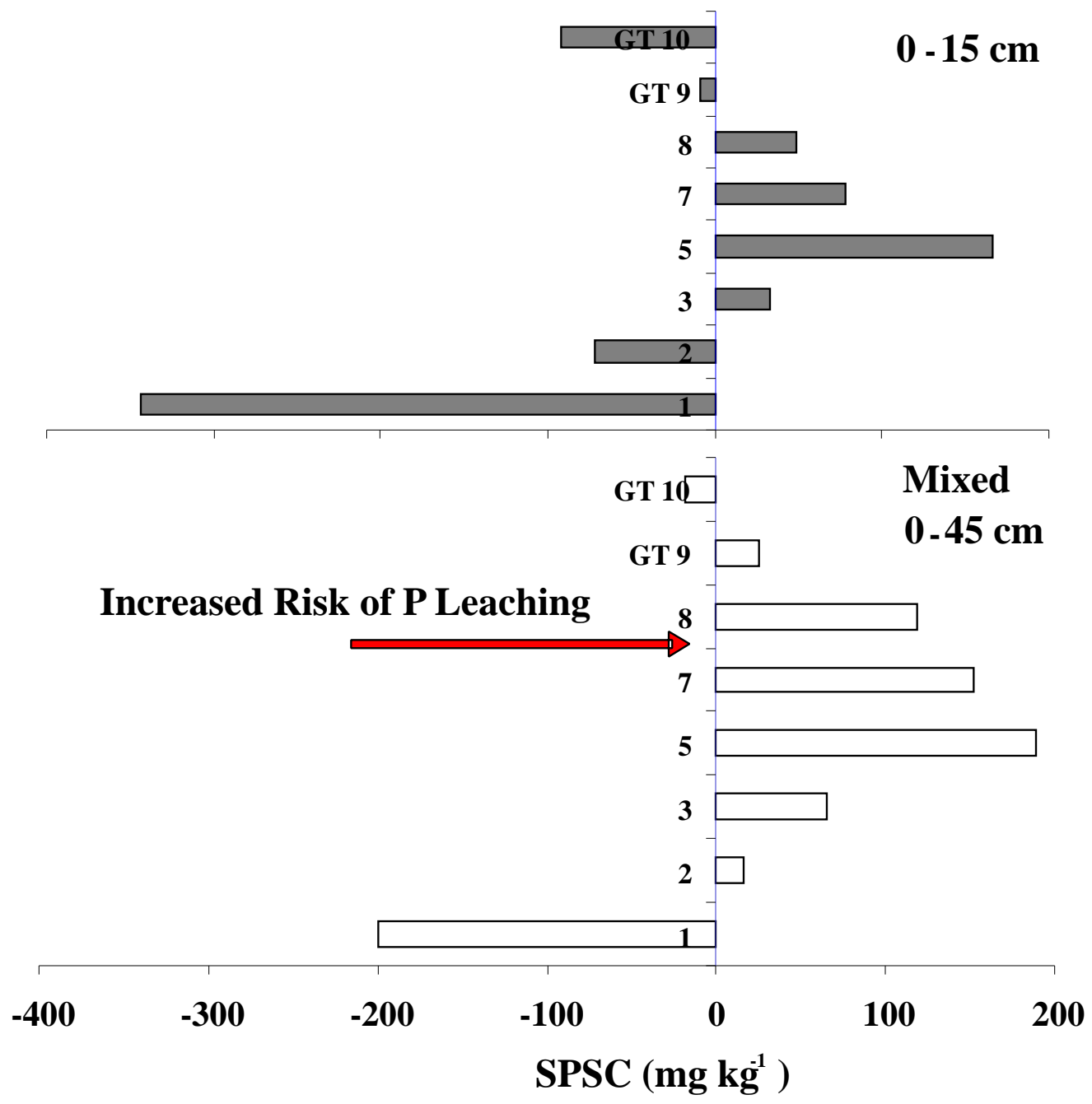 - Textural analysis

Average Field and VFS Soil Properties

Relating Environmental Soil P Measures

Linking Soil Solution P to P Saturation

Simulated deep tillage to 45 cm was successful at increasing SPSC

0 - 15 cm

Mixed 0 - 45 cm

Increased Risk of P Leaching

GT 10, GT 9, 8, 7, 5, 3, 2, 1

-400   -300   -200   -100   0   100   200

SPSC (mg kg^{-1})

Soil P in Deep Tilled versus Disked Plots

- **DT Plots were disk tilled prior to planting to prepare the soil surface**
- **C-DT plots were Chisel plowed to a depth of 35 cm, followed by disk tillage to prepare the soil surface**

depth	DT			C-DT	
	WSP	PSI		WSP	PSI
cm	----mg kg^{-1}----			----mg kg^{-1}----	
Field 9 VFS					
0-15	6.9	189		6.3	134
15-30	3.3	225		3.5	207
30-45	0.9	361		1.3	217
Field 10 VFS					
0-15	4.6	264		7.4	247
15-30	2.5	292		5.0	224
30-45	1.1	333		2.7	216

Tool to Maximize P retention by VFS

Characteristics influencing surface P Transport			
Soil (0-5 cm) PSR	<0.05	0.05 – 0.15	>0.15
Up gradient land use	Well managed pasture/ no till row crop with cover crop	Pasture in moderate condition/ conventional till row crop with cover crop	Pasture in poor condition / conventional till row crop with no cover crop
Up gradient slope (%)	0-3	3-6	>6
Characteristics influencing sub-surface P transport			
Depth to mean high water table			
Depth of PSR>0.15 relative to mean high water table	> 1 m	0.2 – 1 m	Less than 0.2 m
Subsurface return period	Months	Weeks	Days
VFS Width Recommendation	**Small (10 m)**	**Medium (20 m)**	**Large (30 m)**

Best and Worst Case Scenarios

	EXAMPLE 1	EXAMPLE 2
Characteristics influencing surface P Transport		
Soil (0-5 cm) PSR	0.10	0.40
Up gradient land use	Cover crop and no till	No cover crop and conventional till
Up gradient slope (%)	0.5	5.0
Characteristics influencing sub-surface P transport		
Depth to mean high water table	0.5	.1
Depth of PSR>0.15 relative to mean high water table	.5	0
Subsurface return period	Months	Days
VFS Width Recommendation	**(20+10+10+20+20+10) /6 = 15 Small**	**(30+30+20+30+30+30)/6 = 28 Large**

Conclusions

- Phosphorus saturated soils remain a risk of dissolved P loss after VFS installation

- Simulated deep tillage has the potential to significantly reduced the risk of P loss, and increased soil P sorption capacity relative to surface soils prior to deep tillage

- Rapid soil tests (PSR and SPSC) can be used to determine whether VFS soil will be a source or a sink for P

Need for further research

The proposed evaluation matrix must be tested to determine if recommendations are adequate for managing phosphorus losses from agricultural fields with vegetated filter strips.