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Field Scale Modeling to Estimate Phosphorus and Sediment Load Reductions using a Simplified GUI for SWAT

Aaron Mittelstet

Oklahoma State University, USA

Erin Daly, Dan Storm, Alex Tobergte,

Mike White, and Greg Kloxin

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Project Objectives

- Estimate reduction in P and sediment loads from implementing conservation practices from 238 fields sites in the North Canadian watershed using TBET, a simplified SWAT interface

- Evaluate the cost efficiency for both the landowner and the federal government per kg of P and ton of sediment reduced

Why is this important?

Leads to the implementation of more cost effective practices and an improvement in the overall effectiveness of water quality programs

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North Canadian Watershed in NW Oklahoma, USA

- 1,790 km^2 drainage area
- Wheat and cattle producing area
- Streams impaired due to nutrients and sediment

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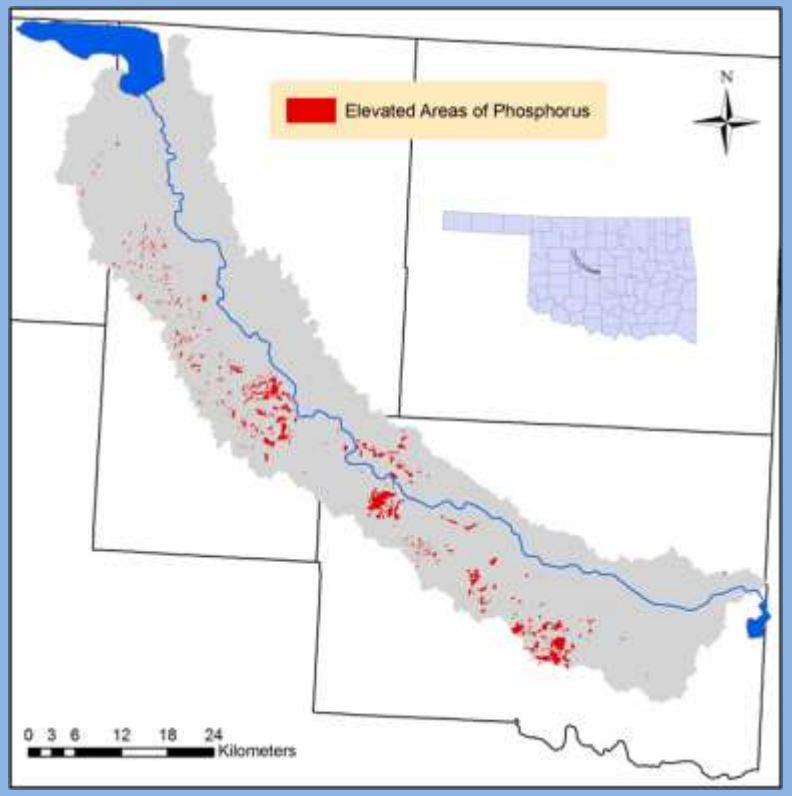
SWAT Model to Simulate Phosphorus Loads



- SWAT model utilized to identify targeted areas (fields with elevated P loads)
- 60% of P contribution from 20% of land area
- Non-urban landcovers with elevated P loads
  - small grains
  - row crops
  - bare soil

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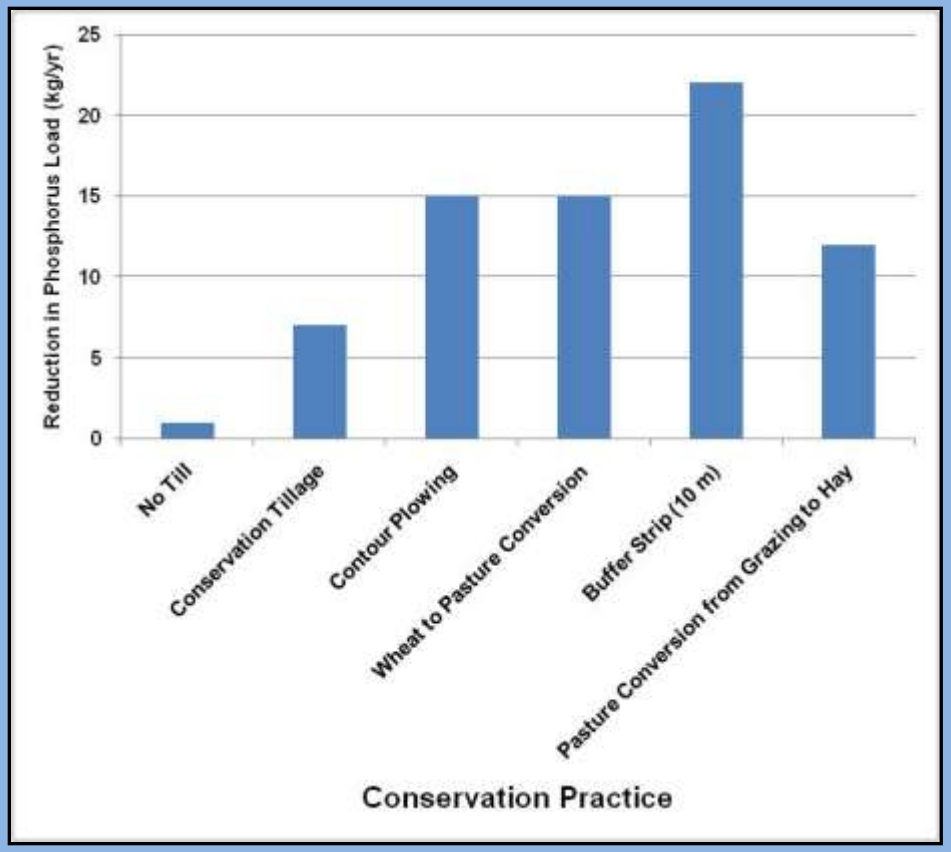
Best Management Practice Scenarios



- Simulated P load reductions from various conservation practices

- Largest P load reductions
  - 10 m buffer strips
  - Contour plowing
  - Converting wheat to pasture

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Implementation of Conservation Practices

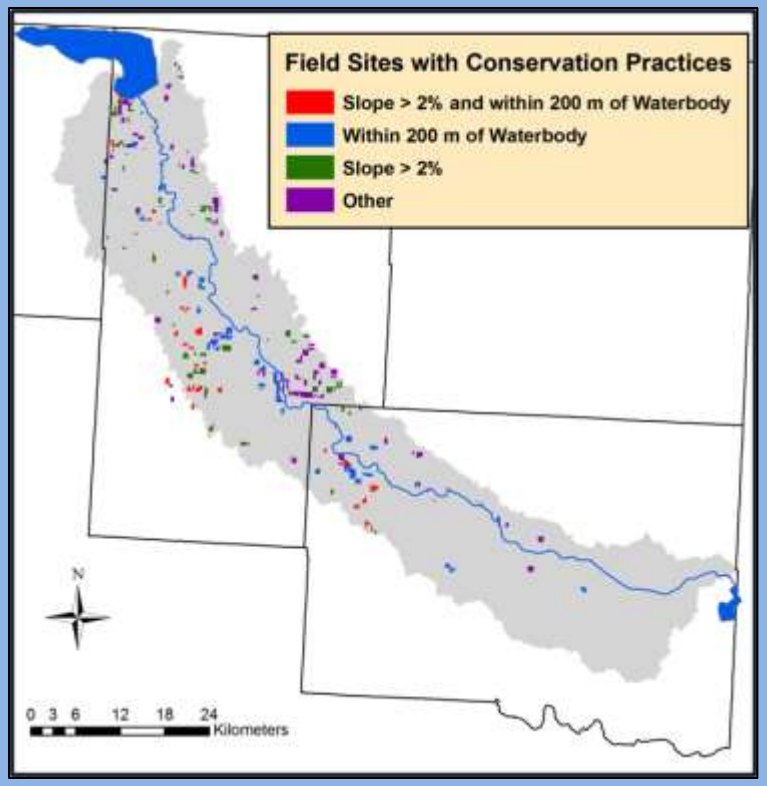
- Six types of conservation practices implemented in the basin to reduce P and sediment loads

- US Environmental Protection Agency Section 319(h) project

- Implemented on 238 field sites (65 km^2) targeting elevated areas

- Landowner participation major factor

- Mutual occurrence on 44 of 238 field sites (14 km^2)



Conservation Practices

No Till

Buffer Strips

Riparian
Exclusion

Wheat Conversion to
Bermuda or Native Range

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Model to Estimate Reductions Due to Conservation Practice Implementation

- TBET chosen to estimate P and sediment load reductions
- Easy to use and applicable at the field scale
- Based on SWAT
- Designed to put the predictive power of a complex model into the hands of people who make daily decisions that affect water quality

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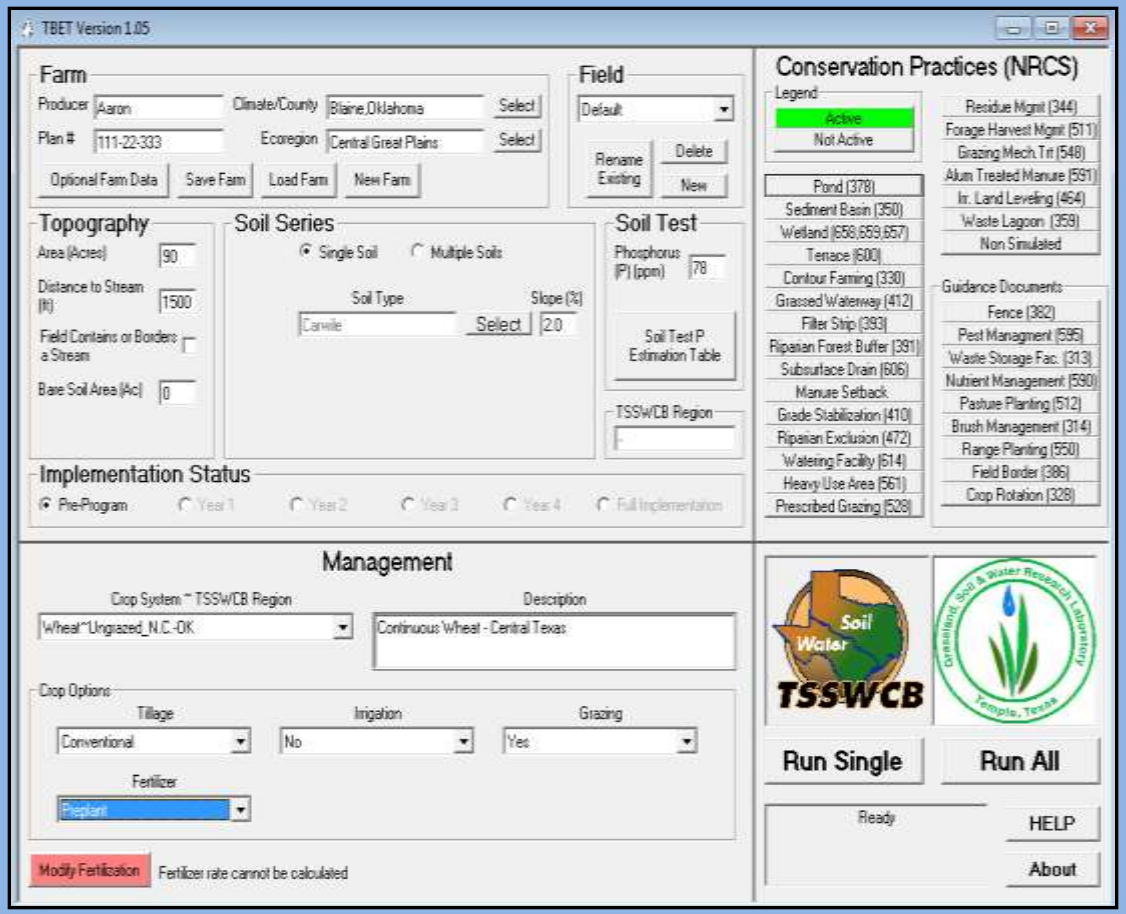
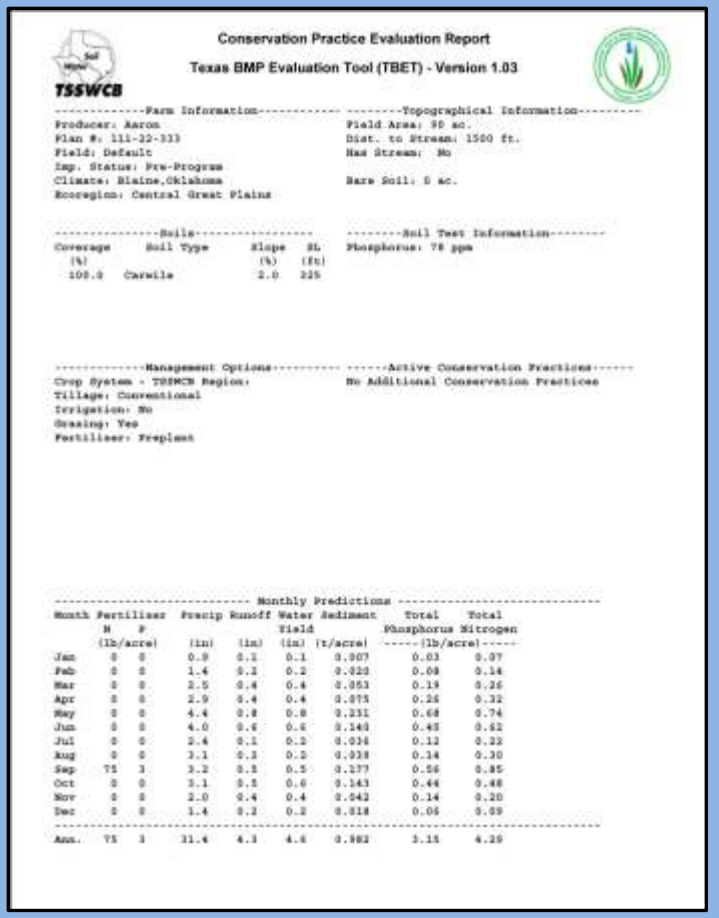
TBET: A GUI for SWAT





Conservation Practice Evaluation Report

Texas BMP Evaluation Tool (TBET) - Version 1.03

TSSWCB

----------Farm Information---------- --------Topographical Information--------
Producer: Aaron
Plan #: 111-22-333
Field: Default
Imp. Status: Pre-Program
Climate: Blaine,Oklahoma
Ecoregion: Central Great Plains

Field Area: 90 ac.
Dist. to Stream: 1500 ft.
Has Stream: No

Bare Soil: 0 ac.

----------Soils---------- --------Soil Test Information--------
Coverage Soil Type Slope SL Phosphorus: 78 ppm
(%) (%) (ft)
100.0 Carwile 2.0 225

----------Management Options---------- -----Active Conservation Practices-----
Crop System - TSSWCB Region: No Additional Conservation Practices
Tillage: Conventional
Irrigation: No
Grazing: Yes
Fertilizer: Preplant

---------- Monthly Predictions ----------

Month	Fertilizer N (lb/acre)	Fertilizer P (lb/acre)	Precip (in)	Runoff (in)	Water Yield (in)	Sediment (t/acre)	Total Phosphorus (lb/acre)	Total Nitrogen (lb/acre)
Jan	0	0	0.9	0.1	0.1	0.007	0.03	0.07
Feb	0	0	1.4	0.1	0.2	0.020	0.08	0.14
Mar	0	0	2.5	0.4	0.4	0.053	0.19	0.26
Apr	0	0	2.9	0.4	0.4	0.075	0.26	0.32
May	0	0	4.4	0.8	0.8	0.231	0.68	0.74
Jun	0	0	4.0	0.6	0.6	0.140	0.45	0.62
Jul	0	0	2.4	0.1	0.2	0.036	0.12	0.22
Aug	0	0	3.1	0.3	0.2	0.038	0.14	0.30
Sep	75	3	3.2	0.5	0.5	0.177	0.56	0.85
Oct	0	0	3.1	0.5	0.6	0.143	0.46	0.68
Nov	0	0	2.0	0.4	0.4	0.042	0.14	0.20
Dec	0	0	1.4	0.2	0.2	0.018	0.06	0.09
Ann.	75	3	31.4	4.1	4.6	0.982	3.15	4.20

TBET Model Simulations

Soil: SSURGO

Slope:

- 10 m Digital Elevation Model
- Range: 0.01-12.7%; Average: 2.2%

Crop System:

- National Agricultural Statistics Service
- Winter wheat, Bermuda grass, native range

Crop Management Data: Oklahoma State Extension, Surveys

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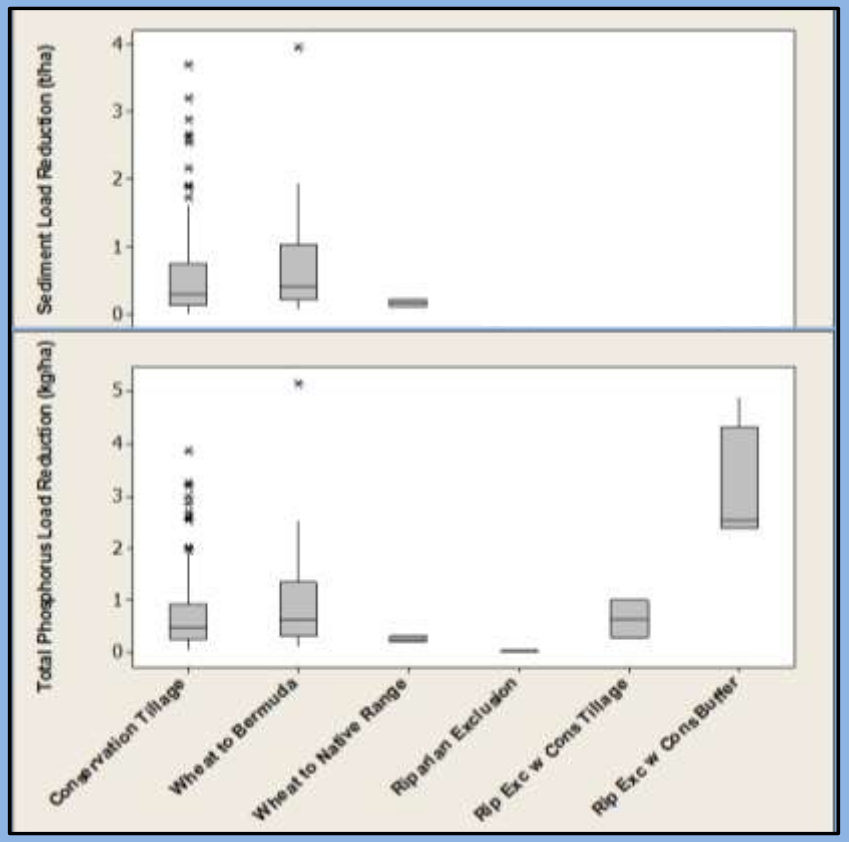
Crop System	Fertilizer Rates and Time of Application	Grazing Management (animal unit/ha)	Soil Test Phosphorus (ppm)
Winter Wheat	34 kg N, 2.7 kg P (Pre-plant)	0.82	39-41
Bermuda Grass	136 kg N, 34 kg P (Spring)	1.85	40
Native Range	None	0.62	26-30

Each field site simulated with and without the conservation practice

Conservation Practices and their Costs

Conservation Practice	Number of Fields	Total Area (ha)	Cost to Federal Government	Cost to Farmer or Rancher	Practical Life (yrs)	Total Cost per Year
Conservation Tillage	205	6040	$48.70/ha	$0.00	1	$48.70/ha
Wheat to Bermuda	23	305	$190.69/ha	$47.67/ha	10	$23.84/ha
Wheat to Native Range	2	37	$55.62/ha	$13.91/ha	10	$6.95/ha
Riparian Exclusion	2	13	$3.99/ linear m fence $3.99/linear m pipe Watering facility-$139.10 Solar water pump-$3.93	$1.00 /linear m fence $1.00/linear m pipe Watering facility-$34.77 Solar water pump-$0.98	20 20 10 15	$0.25/m $0.25/m $17.38 $0.33
Riparian Exclusion with Conservation Tillage	2	45	$3.99/ linear m fence $3.99/linear m pipe Watering facility-$139.10 Solar water pump-$3.93 $48.70 ha^{-1}	$1.00/linear m fence $1.00/linear m pipe Watering facility-$34.77 Solar water pump-$0.98 $0.00	20 20 10 15 1	$0.25/m $0.25/m $17.38 $0.33 $48.70/ha
Riparian Exclusion with Buffer	4	33	$3.99 linear m fence $3.99/linear m pipe Watering facility-$139.10 Solar water pump-$3.93 $223.20 ha^{-1}	$1.00/linear m fence $1.00/linear m pipe Watering facility-$34.77 Solar water pump-$0.98 $0.00	20 20 10 15 15	$0.25/m $0.25/m $17.38 $0.33 $14.88/ha

TBET Simulation Results



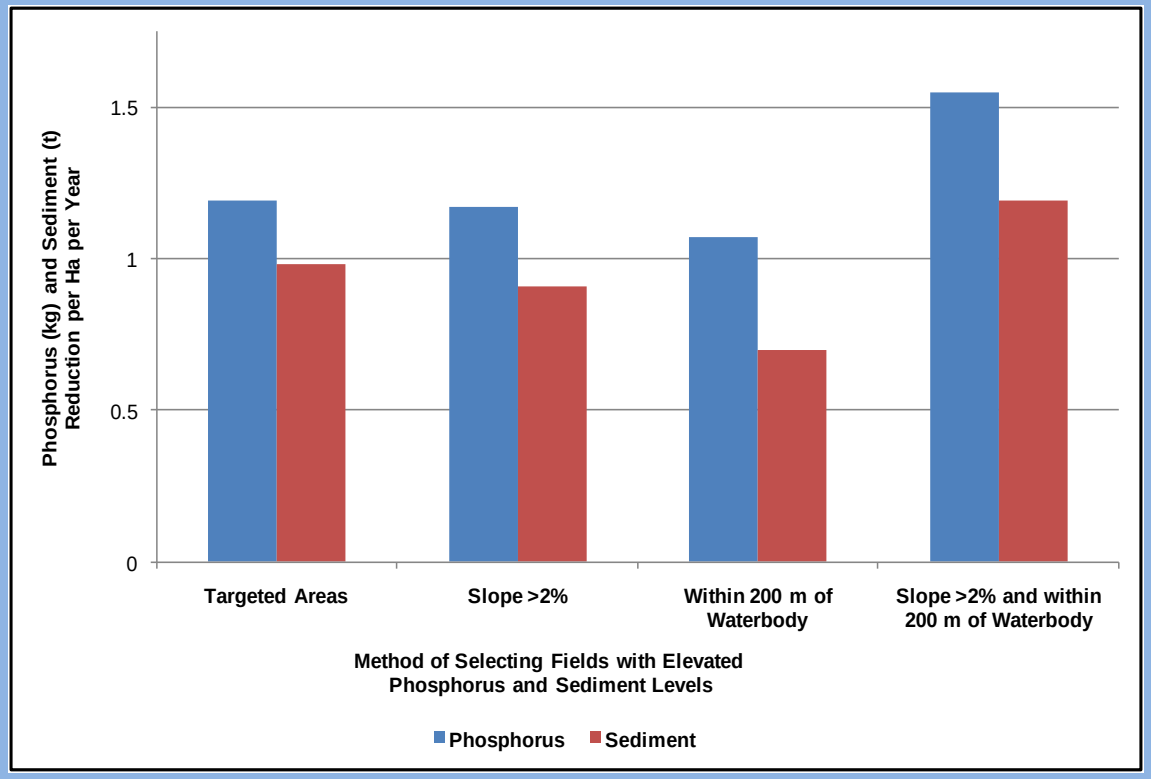
- Average P reduction
  - 4,200 kg/yr
  - 0.65 kg/ha/yr
  - 9 percent annual reduction
- Average sediment reduction
  - 3,000 tons/yr
  - 0.47 tons/ha/yr
- Largest P reduction
  - riparian exclusion with conservation buffer
- Largest sediment reduction
  - Wheat to Bermuda

- '***converting wheat to Bermuda***' compared to '***conservation tillage***'
  - Mann-Whitney Ranked Sums Test
  - median P reduction not significantly greater
  - median sediment reduction was significantly greater

Forty of the 238 Field Sites Previously Identified as Targeted Areas

Significantly greater reductions compared to non-targeted areas

- Phosphorus (1.13 vs. 0.41 kg/ha/yr; 180%)
- Sediment (0.88 vs. 0.24 tons/ha/yr; 370%)



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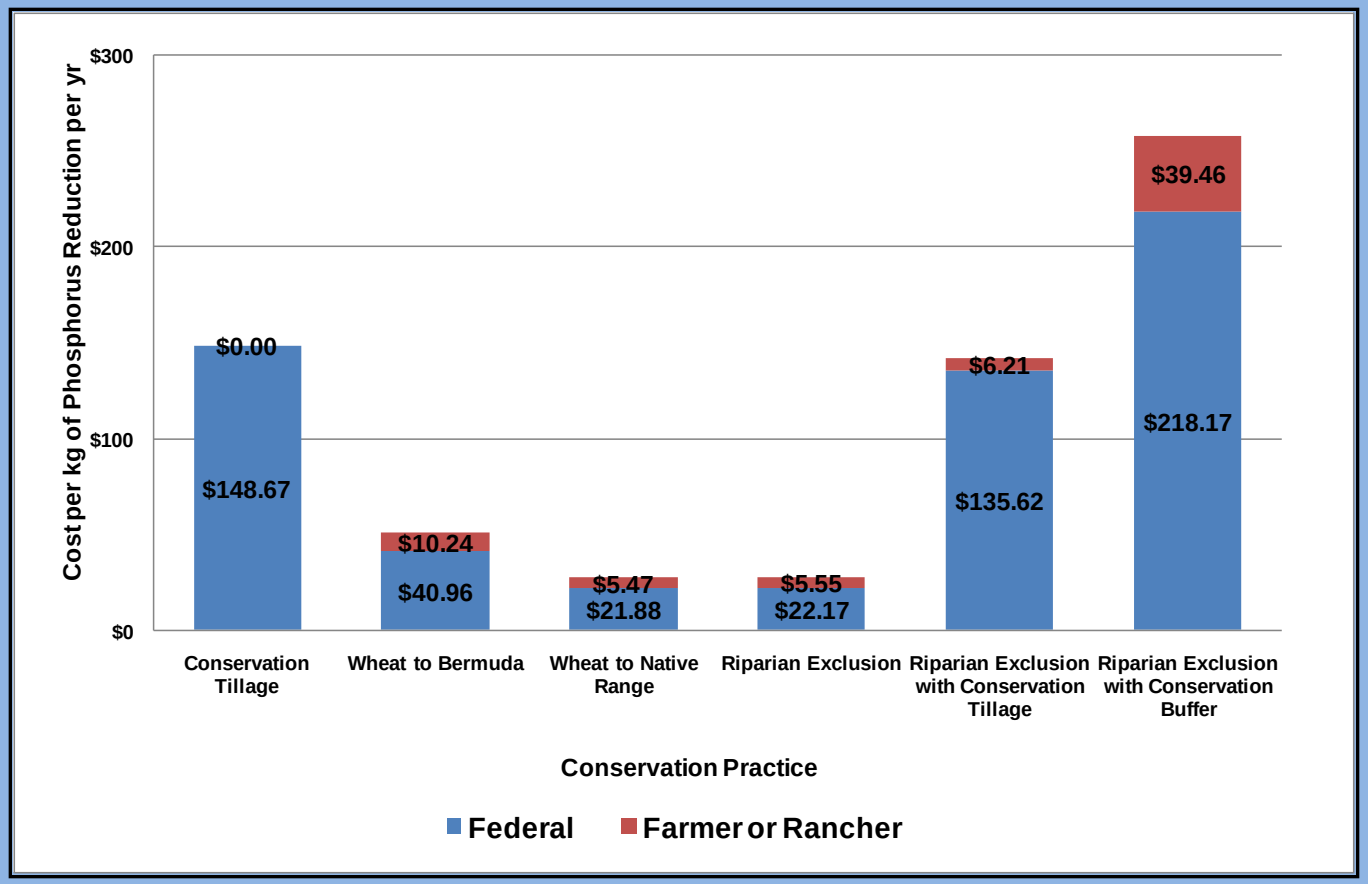
Cost of Phosphorus Reduction



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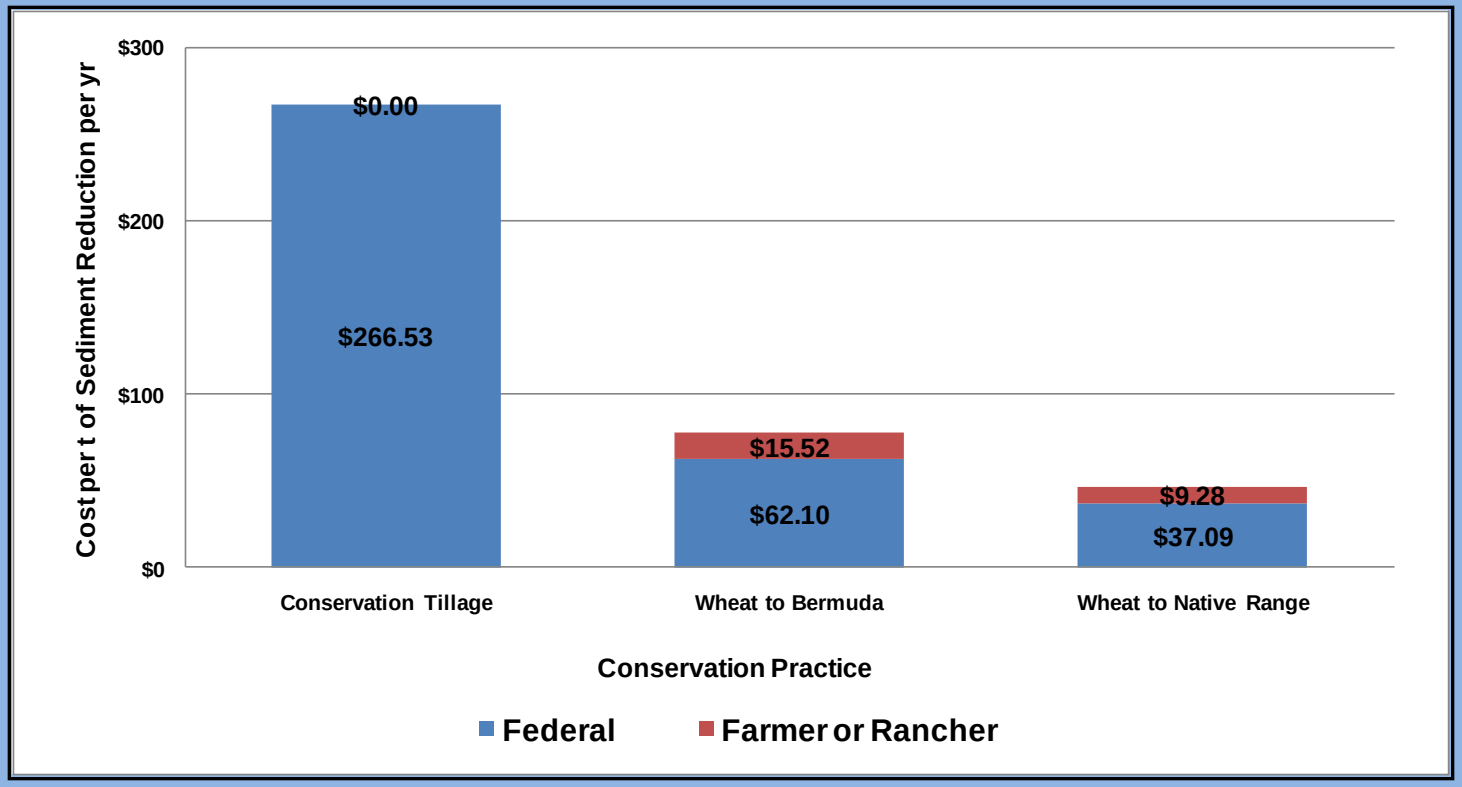
Cost of Sediment Reduction



Project Implications

- Costs to landowner to implement conservation practices must be considered

- Cost per mass of pollutant must be the primary consideration when setting cost share rates

- TBET provided an easy to use and cost effective and efficient tool to provide information to help determine cost share rates for new water quality programs

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E-mail

aaron.mittelstet10@okstate.edu