Runoff Losses from Corn Silage-Manure Cropping Systems

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- Runoff losses of P, N, and sediment from crop fields, especially where manure has been applied, can contribute to degradation of surface waters.
- In a dairy cropping system, the silage corn phase typically poses the most serious threat to water quality.

Objective

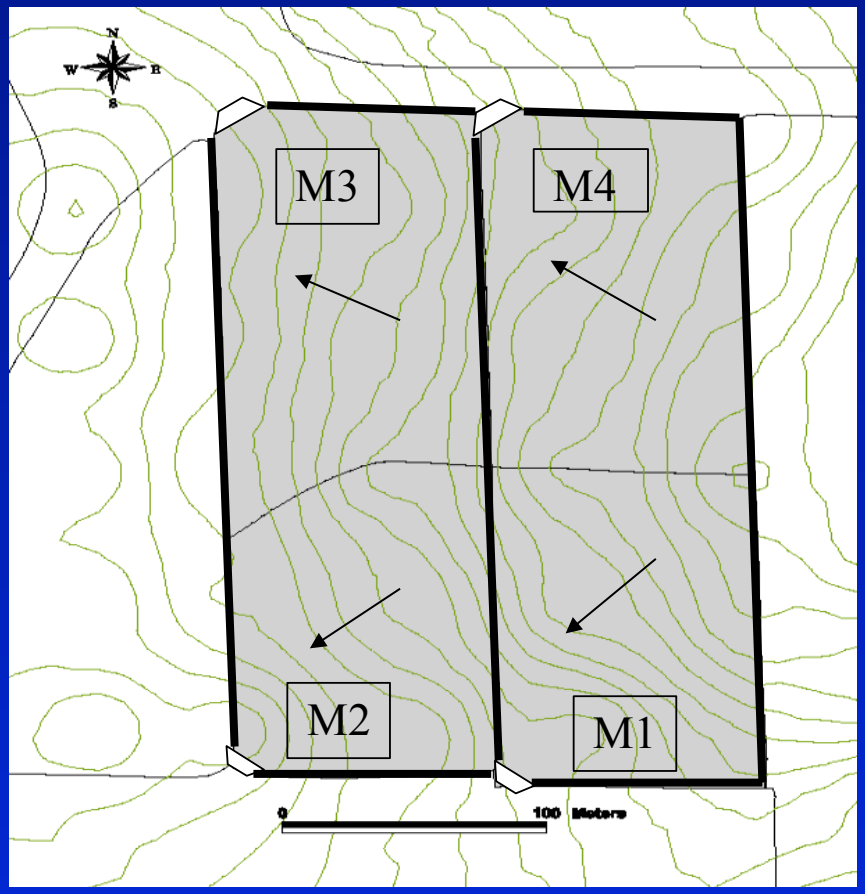
- To evaluate runoff losses of nutrients from different manure/crop/tillage management systems for silage corn production.

Field Site

- UW/USDA-ARS Research Station, Marshfield, WI.
- Somewhat poorly drained Withee silt loam (Aquic Glossudalfs), 1-3% slope
- Surface drainage using drive-through diversion pathways and berms

Paired-Watershed Design

- Field-scale "watersheds"
- Four fields – 3.4-4.4 acre each



6.4 ha, or 16 acres total

Gauge Station: Runoff Monitoring

24-inch H flumes with approach channels

Gauge Station: Runoff sampling

Runoff, Nutrients, and Sediment

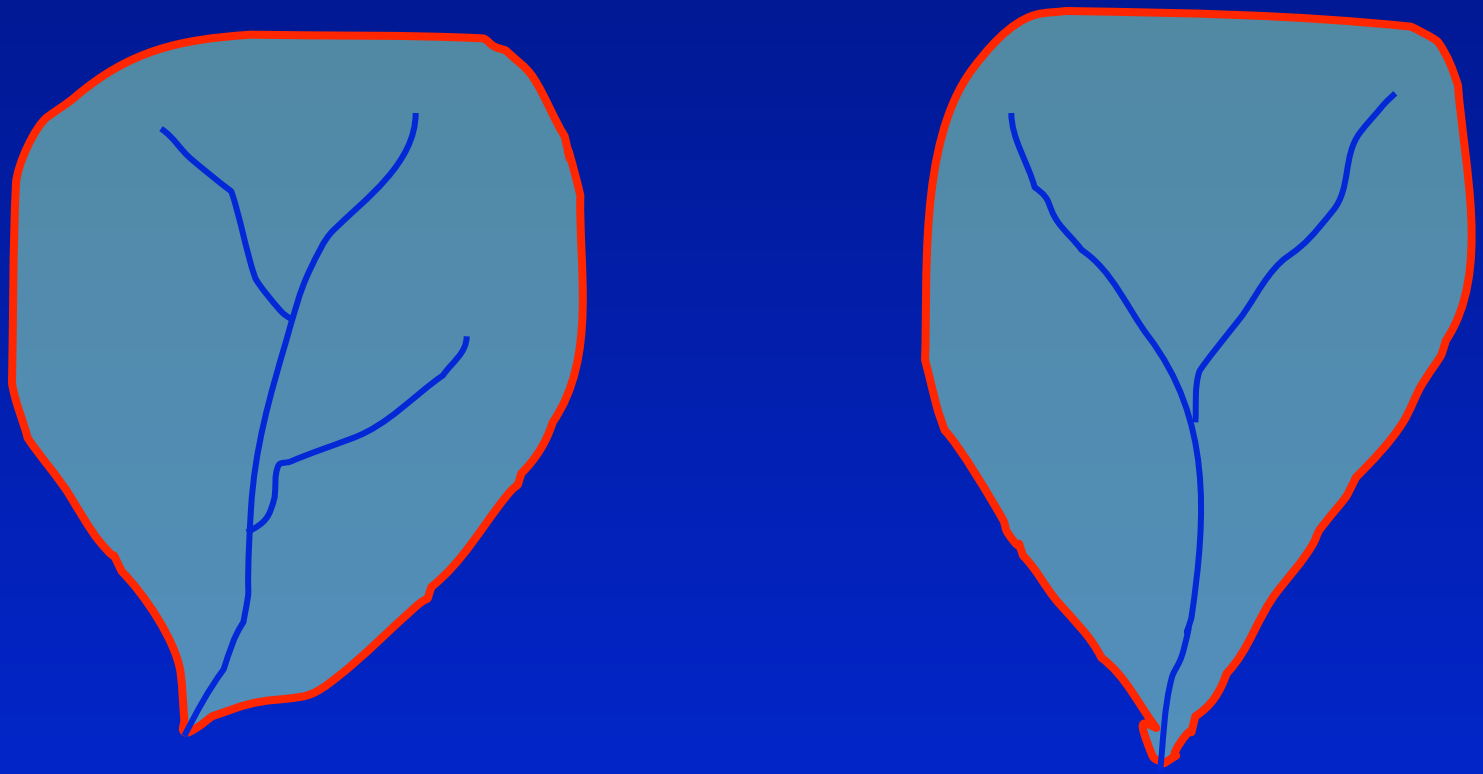
- Runoff quantity
- Suspended sediment (SS)
- Total P (TP)
- Dissolved P (DP)
- TKN, Nitrate-N, Ammonium-N

Individual samples combined into a flow-weighted composite

Protozoan, bacterial, and viral pathogens (not reported here)

Paired Watershed Design

Calibration Period

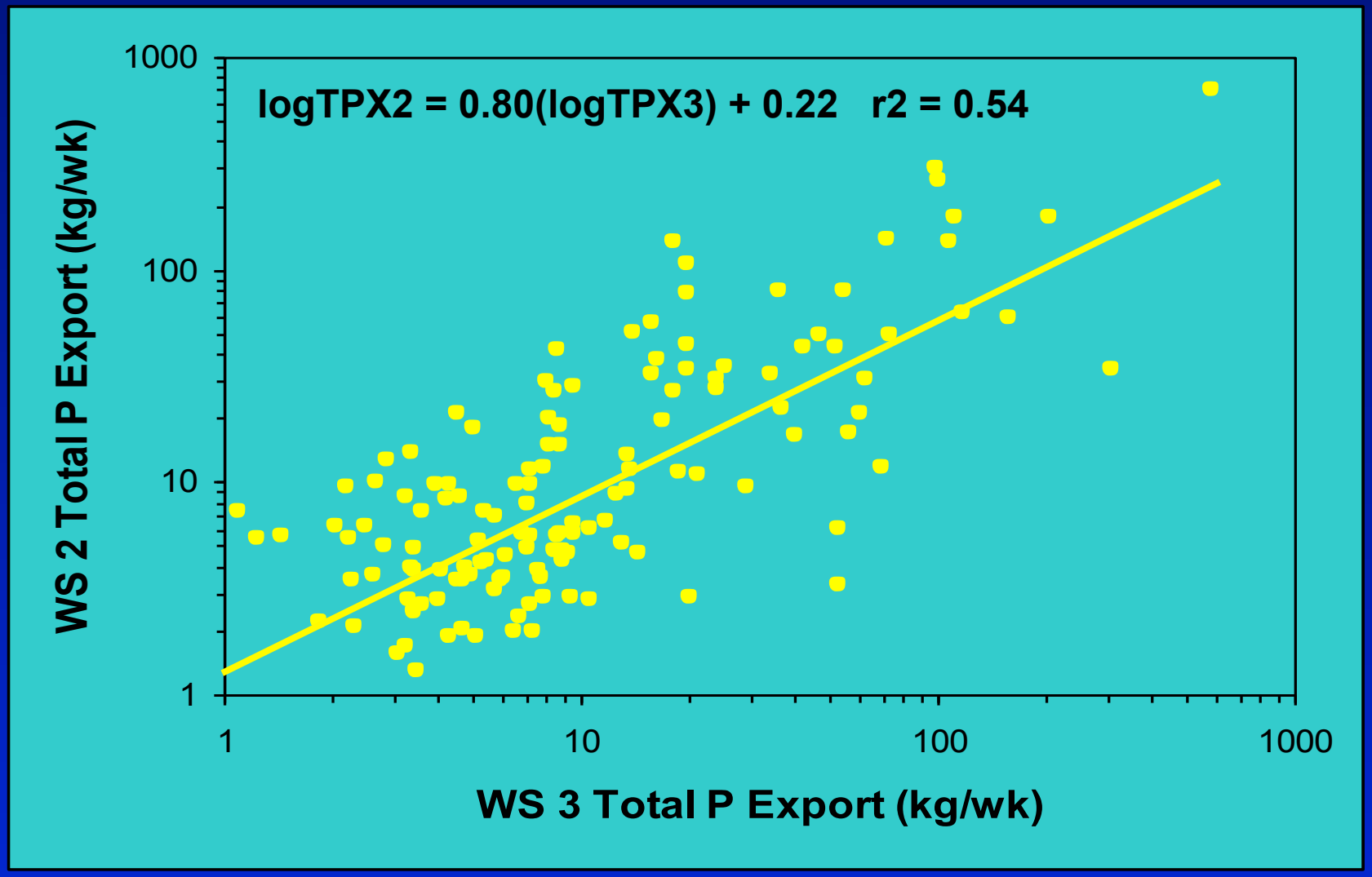


Control Watershed

Treatment Watershed

Credit: D. Meals

Calibration Regression



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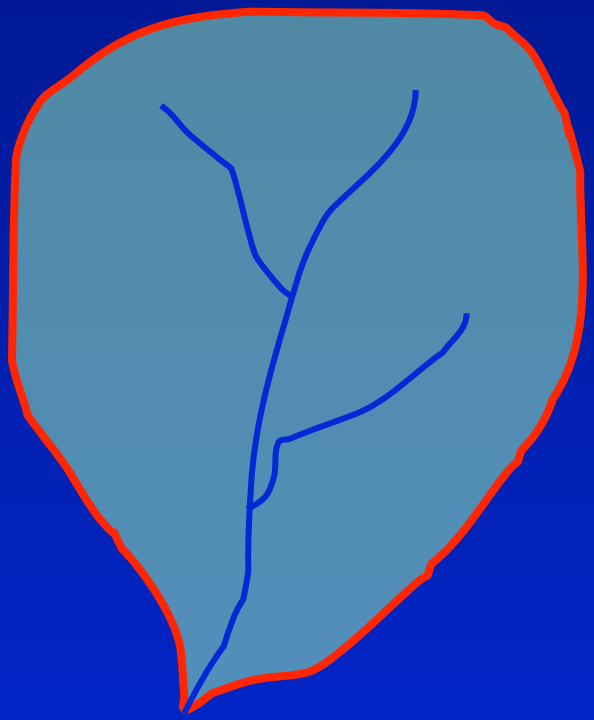
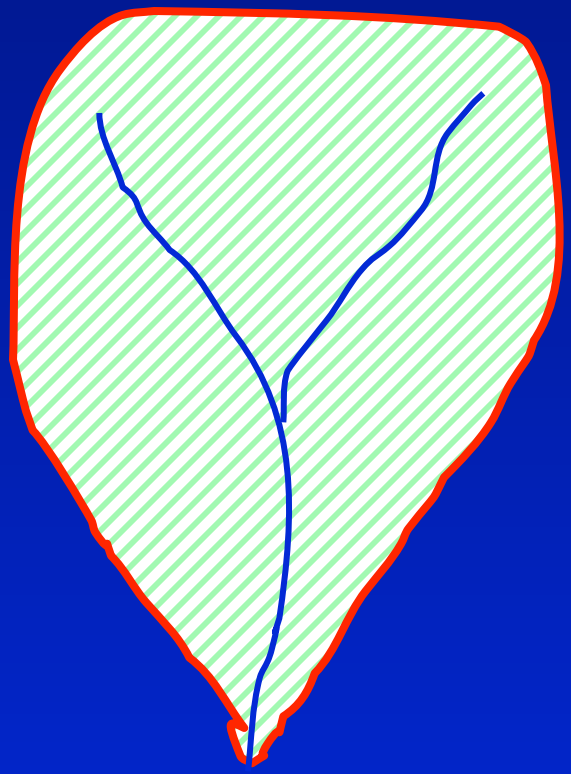
Paired Watershed Design

Treatment Period





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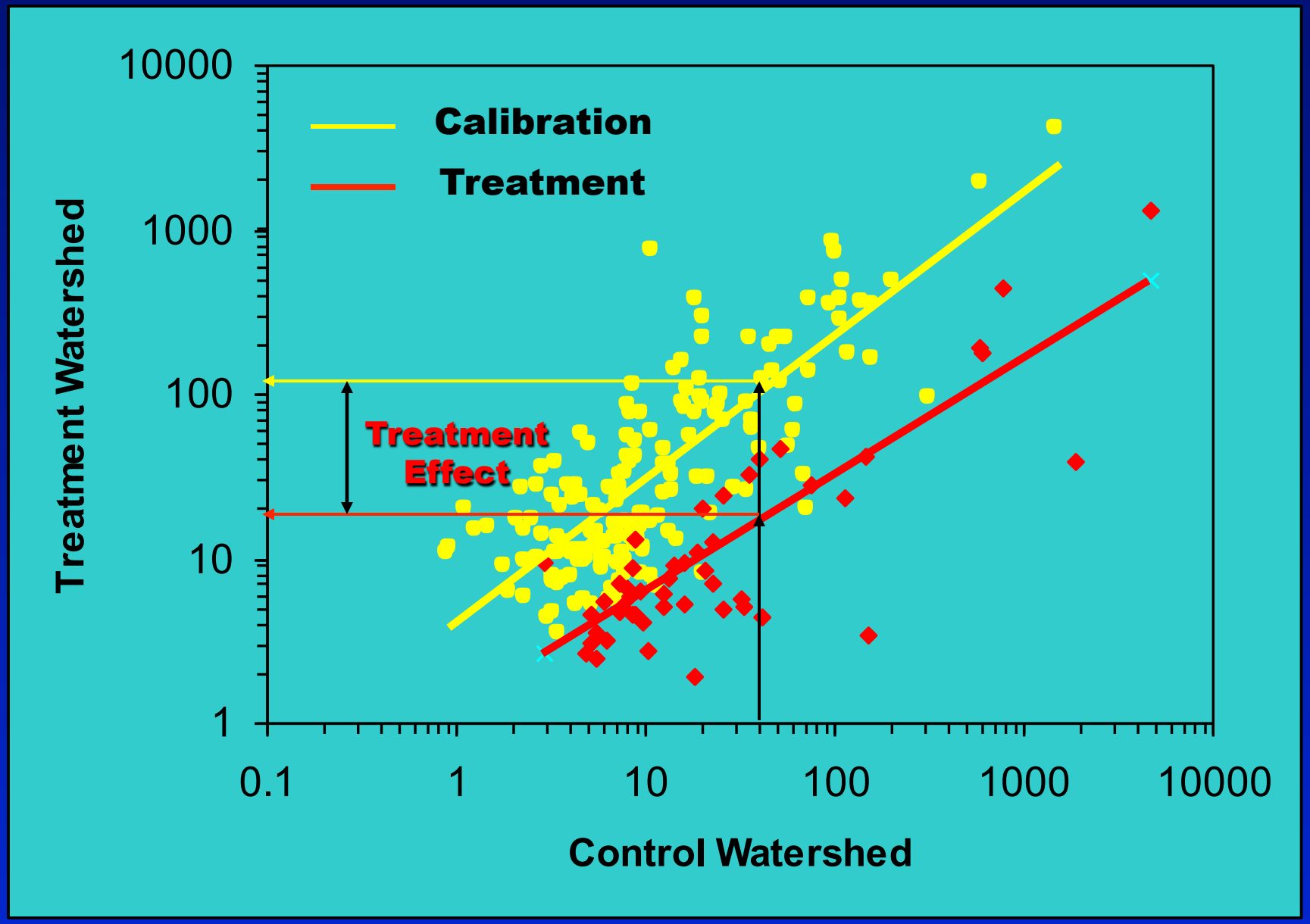

Credit: D. Meals

Paired Watershed Design
Nutrient Management Systems Trial

"Watershed"	Time Period	
	Calibration 2006-2008	Treatment[1] 2008-2012
M1	Control: Fall manure, chisel	Control: Fall manure, chisel
M2	Control	Rye cover -Spring manure, chisel
M3	Control	Fall Manure – Spring chisel
M4	Control	Veg. buffer - Fall manure, chisel

[1]Note: Treatments assigned randomly.

Fall Manure and Chisel Plow (Control, M1)

Manure Rate (avg): 5100 gal/ac, 14% DM, 145 N, 75 NH_4-N, 53 P_2O_5 lb/ac

Fall after chisel plowing

Spring after field cultivate/ plant emergence

Rye Cover Crop with Spring Manure and Chisel Plow (M2)

Fall

11/7/08

Spring

5/8/09

Vegetative buffer/ waterway with fall manure and chisel plow (M4)

Legume-grass mix (alsike clover, timothy, brome)

Fall Surface-applied Manure with Spring Chisel Plow (M3) (surface manure over-winter)

Monthly Precipitation

Monthly Precipitation Totals								
	inches							
Month	2006	2007	2008	2009	2010	2011	2012	1981-2010
Jan	…	0.9	1.2	0.4	0.9	0.7	1.2	0.9
Feb	…	1.0	1.1	0.7	0.3	0.6	0.2	0.8
Mar	…	1.7	0.6	1.3	0.7	1.9	1.3	1.8
Apr	…	1.1	4.2	2.9	0.8	3.6	2.3	2.8
May	…	4.0	3.3	3.7	2.3	3.2	…	3.7
Jun	…	3.4	3.6	2.3	5.2	4.1	…	4.5
Jul	…	3.1	4.2	0.5	9.9	8.2	…	4.0
Aug	…	4.3	1.8	7.3	3.5	2.7	…	4.3
Sep	0.9	4.0	1.5	0.4	7.7	3.6	…	3.9
Oct	1.9	4.2	1.3	6.2	2.2	2.3	…	2.6
Nov	0.9	0.0	1.4	0.5	1.0	0.9	…	2.2
Dec	1.9	3.0	2.2	2.1	0.0	1.3	…	1.3
Total	5.5	30.8	26.4	28.2	34.3	33.1		32.7

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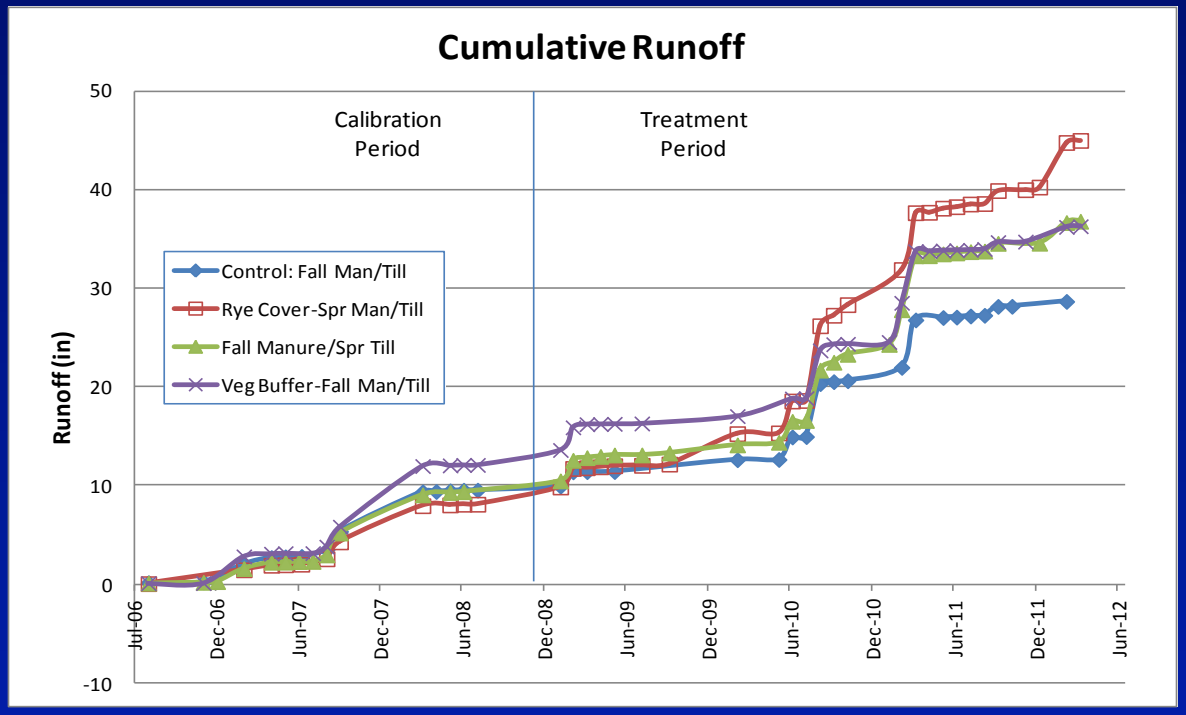
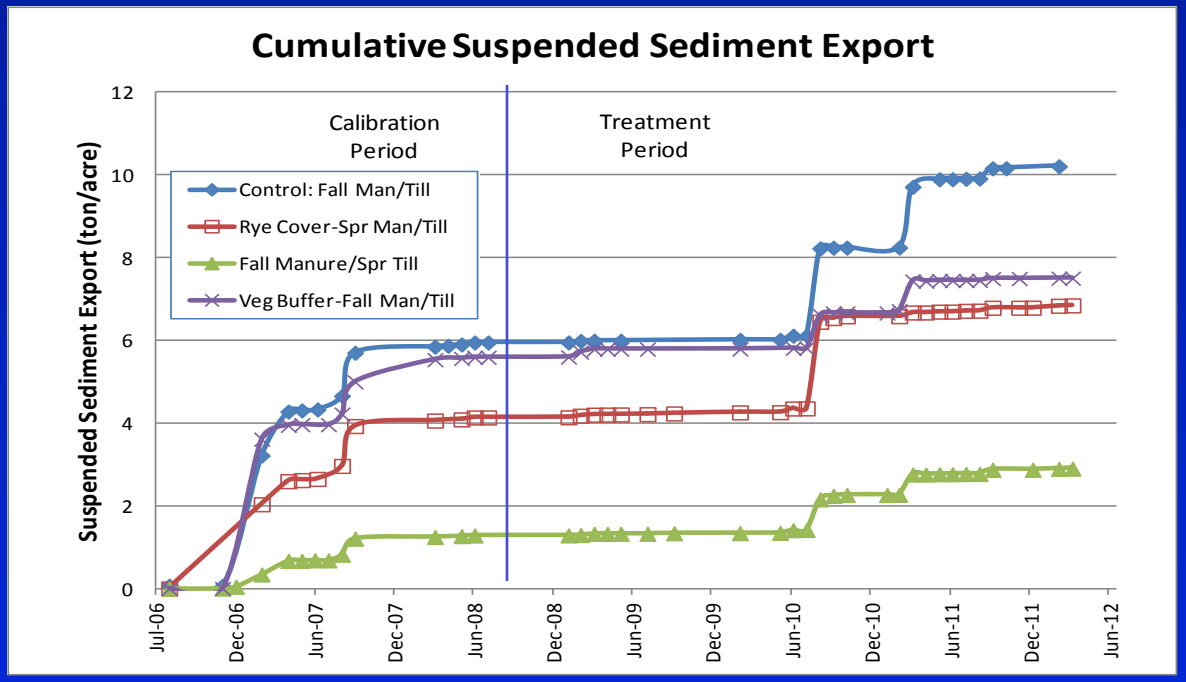
Treatment Period Results

Annual Runoff and N and P Loads

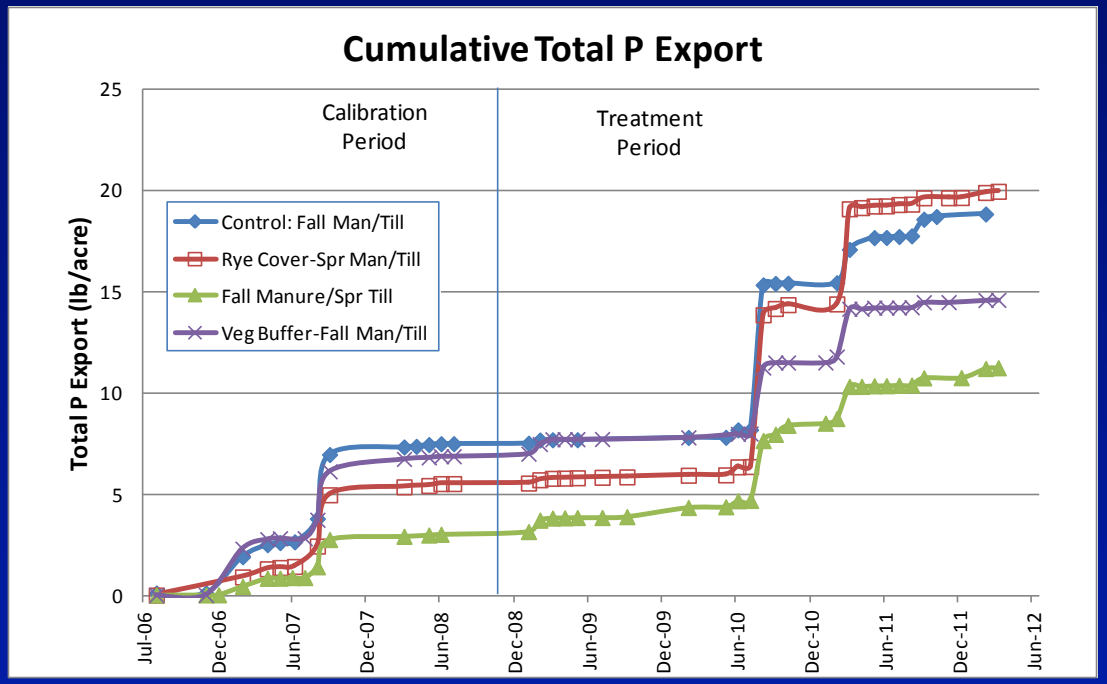
Mean	Runoff	Suspend Sediment	Total P	Dissolved P	Total N	NO_3-N
	inches	lb/acre				
Annual Load	8.5	1680	3.2	0.33	16.9	4.7
Snowmelt /Total	0.39	0.05	0.11	0.45	0.24	0.35



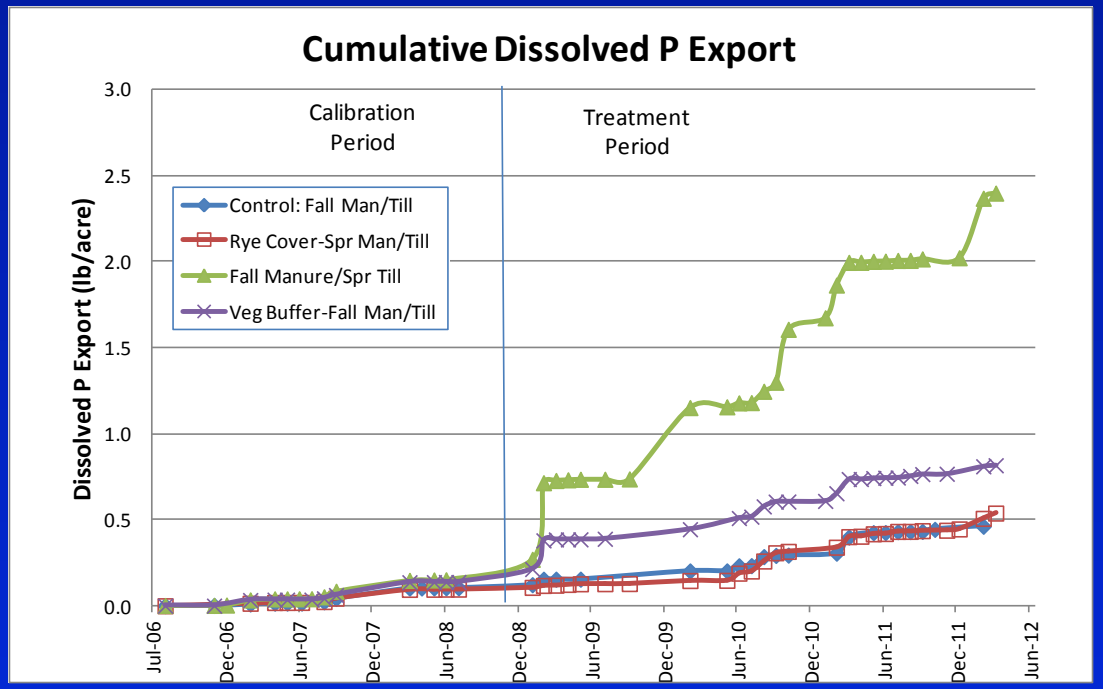
Cumulative Runoff



Cumulative Suspended Sediment Loss



Cumulative Total P Loss

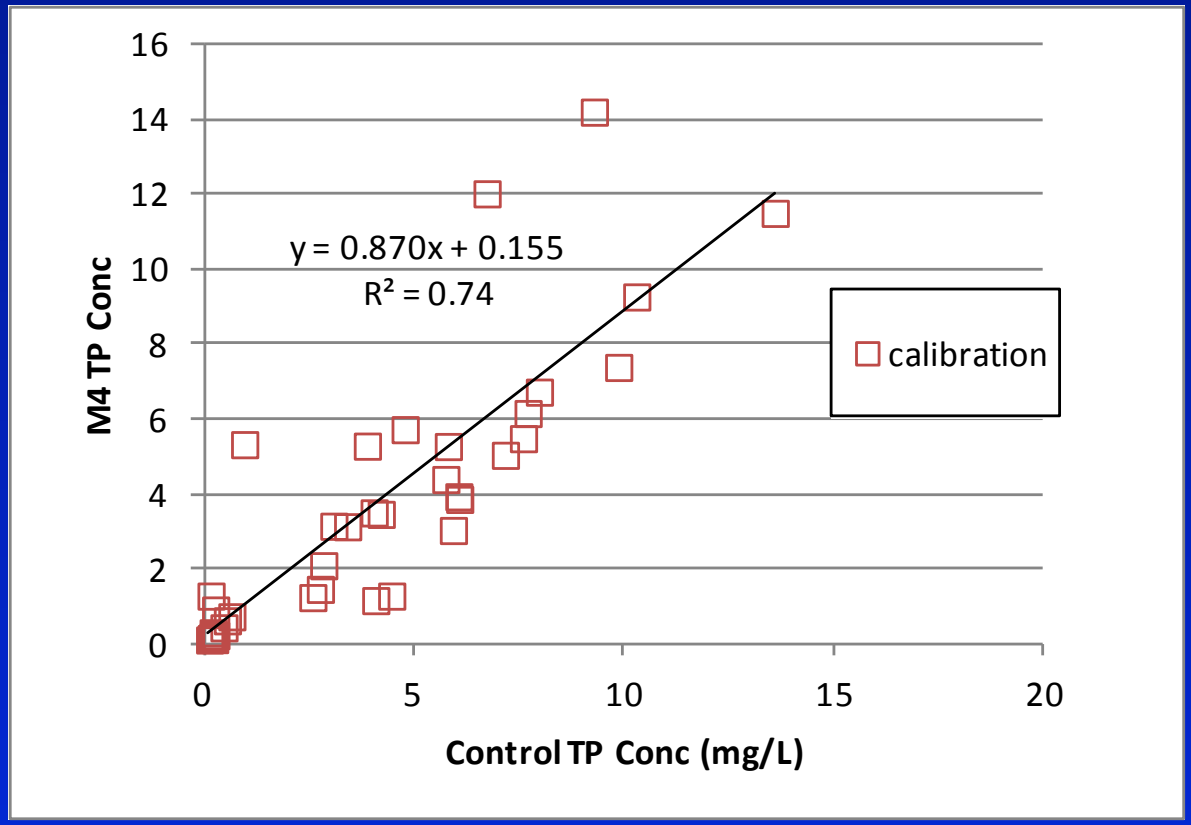


Cumulative Dissolved P Loss

Did management treatment significantly affect runoff nutrients?

Compare Treatment vs Control regression during Calibration and Treatment Period

Example: Total P Conc. - Veg. Buffer-Fall Manure/Till



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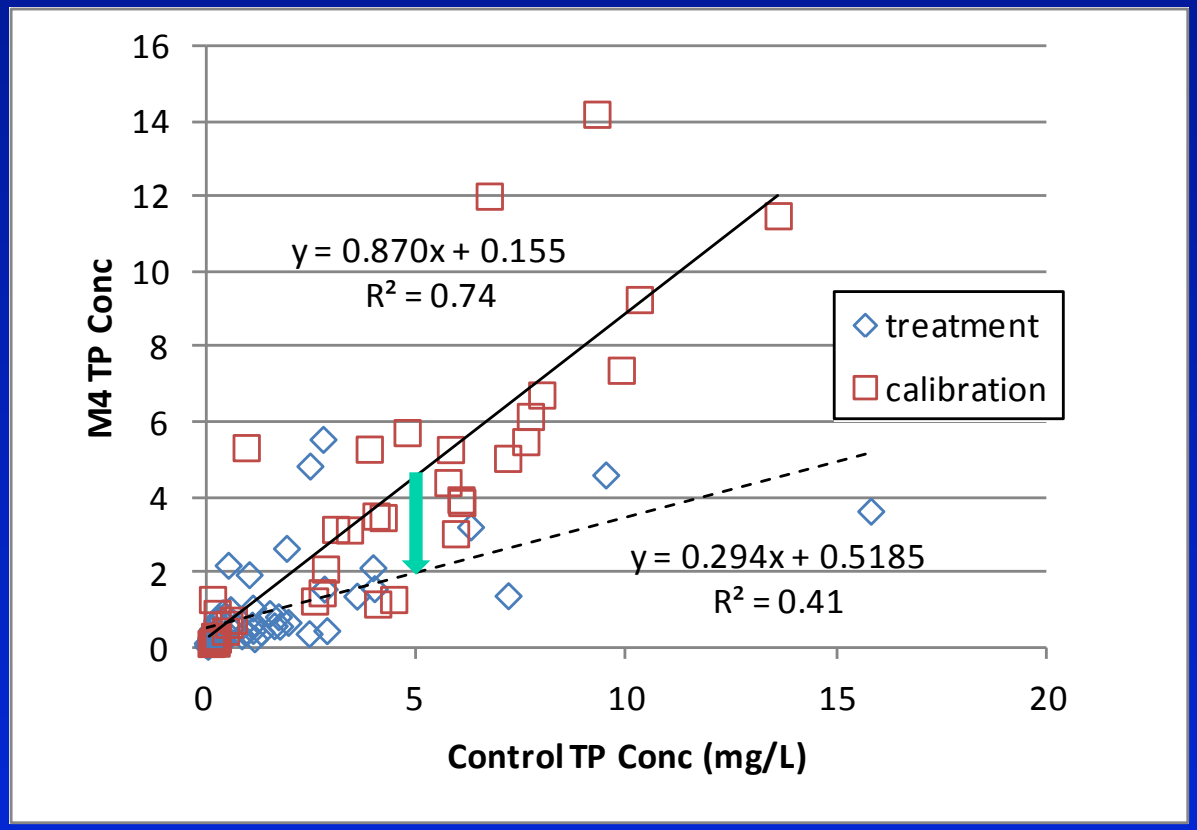


Statistical Signif. (permutation test)

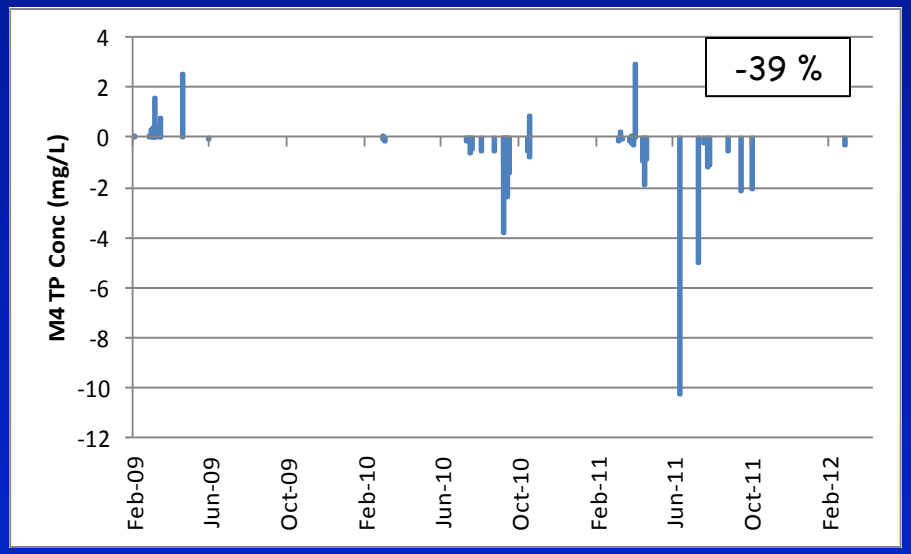
- Slope **
- Mean **

What was magnitude of treatment effect?

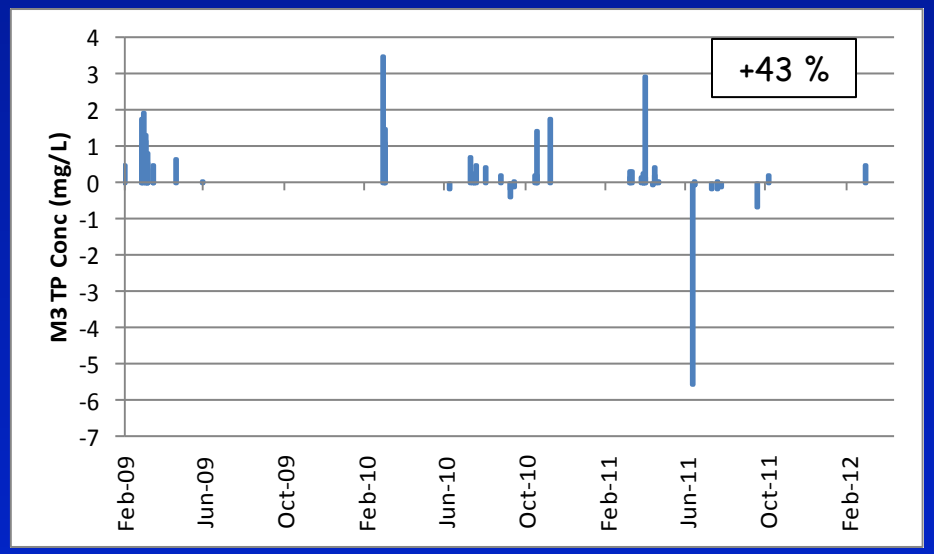
Compare values observed during treatment period to values predicted from calibration period (Observed-Predicted)

Example: Total P Concentration

Veg. Buffer-Fall Manure/Till/ (M4)



Fall Manure/Spring Till (M3)



Negative = Decrease from treatment

Positive = Increase from treatment

Observed-Predicted: % Change

	Rye cover – Spring Man/Till	Veg Buffer – Fall Man/Till	Fall manure – Spring Till
		Concentration	
Susp Sed.	-47	-45	-36
Total P	-28	-39	43
Dissolved P	-16	81	127

*NS indicates mean and slope difference of Calibr-Trt regressions nonsignificant at P-value of 0.10.

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	Rye cover – Spring Man/Till	Veg Buffer – Fall Man/Till	Fall manure – Spring Till
		Concentration	
Susp Sed.	-47	-45	-36
Total P	-28	-39	43
Dissolved P	-16	81	127
		Total Loss*	
Susp Sed.	-9	-62	NS
Total P	NS	-42	NS
Dissolved P	57	25	237

*NS indicates mean and slope difference of Calibr-Trt regressions nonsignificant at P-value of 0.10.

Summary

- Snowmelt runoff is important: 11 to 45% of P and N loads (avg. across treatments).
- Surface over-winter manure (fall manure/ spring till) increased TP and, especially, DP concentration and DP load, but decreased SS concentration.
- Rye cover crop-spring manure/till decreased SS, TP, and DP concentrations and SS load, not TP or DP load.
  - Limited growth of rye in fall
  - Increased runoff

Summary

- Vegetative buffer/waterway-fall manure/till decreased runoff (slightly) and concentration and load of SS and TP (but not DP); the most effective management system in this study.
- None of the manure-crop management systems were effective in controlling dissolved P in runoff.

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