# Surface Runoff from Manured Cropping Systems Assessed by the Paired-Watershed Method, Part 1: P, N, and Sediment Transport

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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

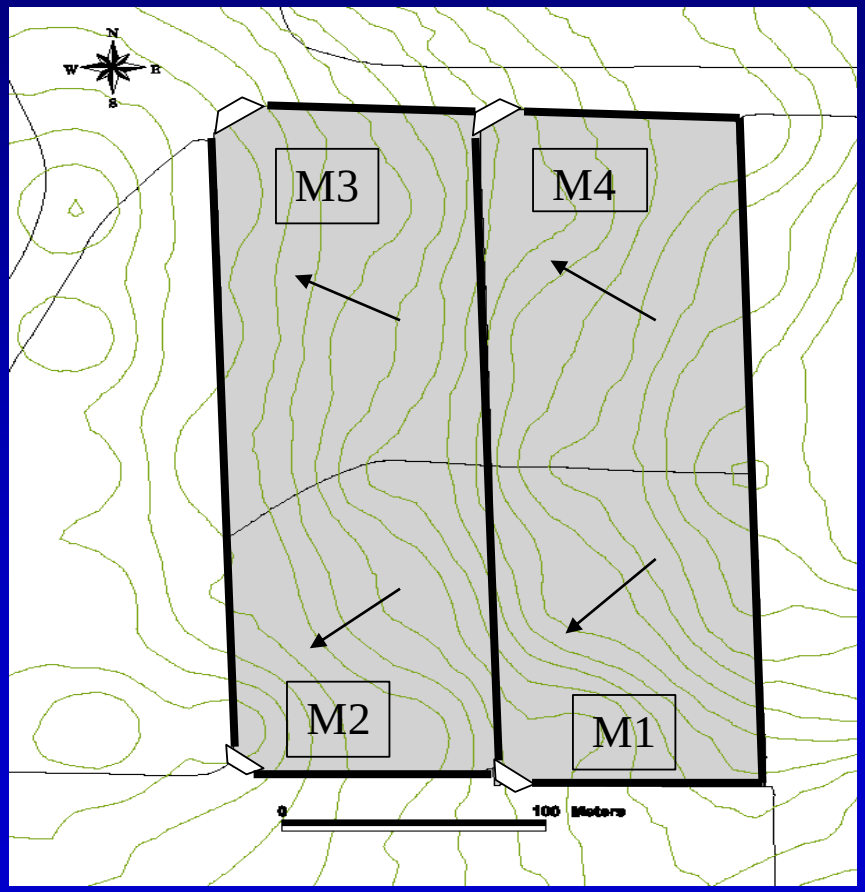
- To evaluate runoff losses of nutrients and pathogens from different manure/crop/tillage management systems for silage corn production.

## 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

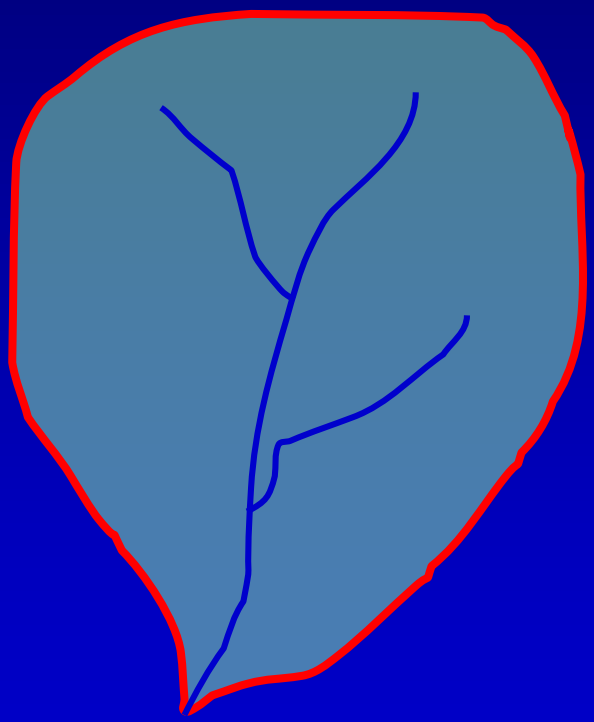
- Runoff quantity
- Suspended sediment (SS)
- Total P (TP)
- Dissolved P (DP)
- TKN, Nitrate-N, Ammonium-N

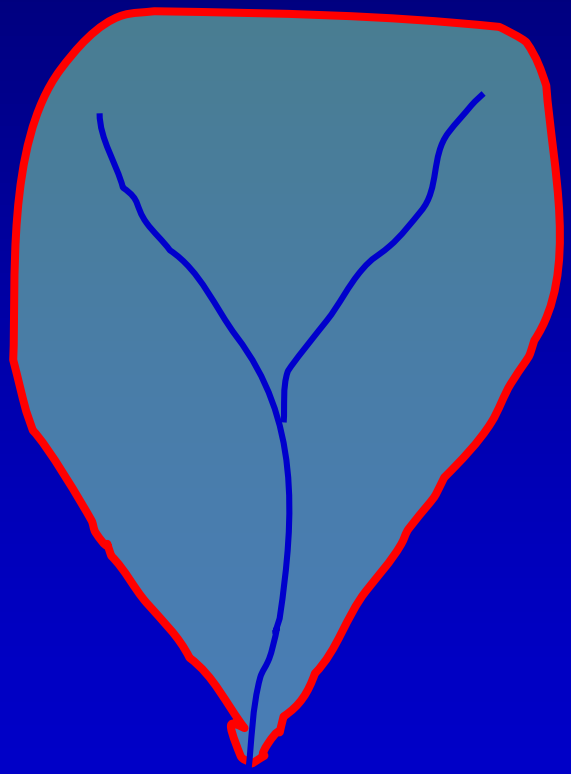
Individual samples combined into a flow-weighted composite

Protozoan, bacterial, and viral pathogens (See M. Borchardt presentation)

# Paired Watershed Design

## Calibration Period



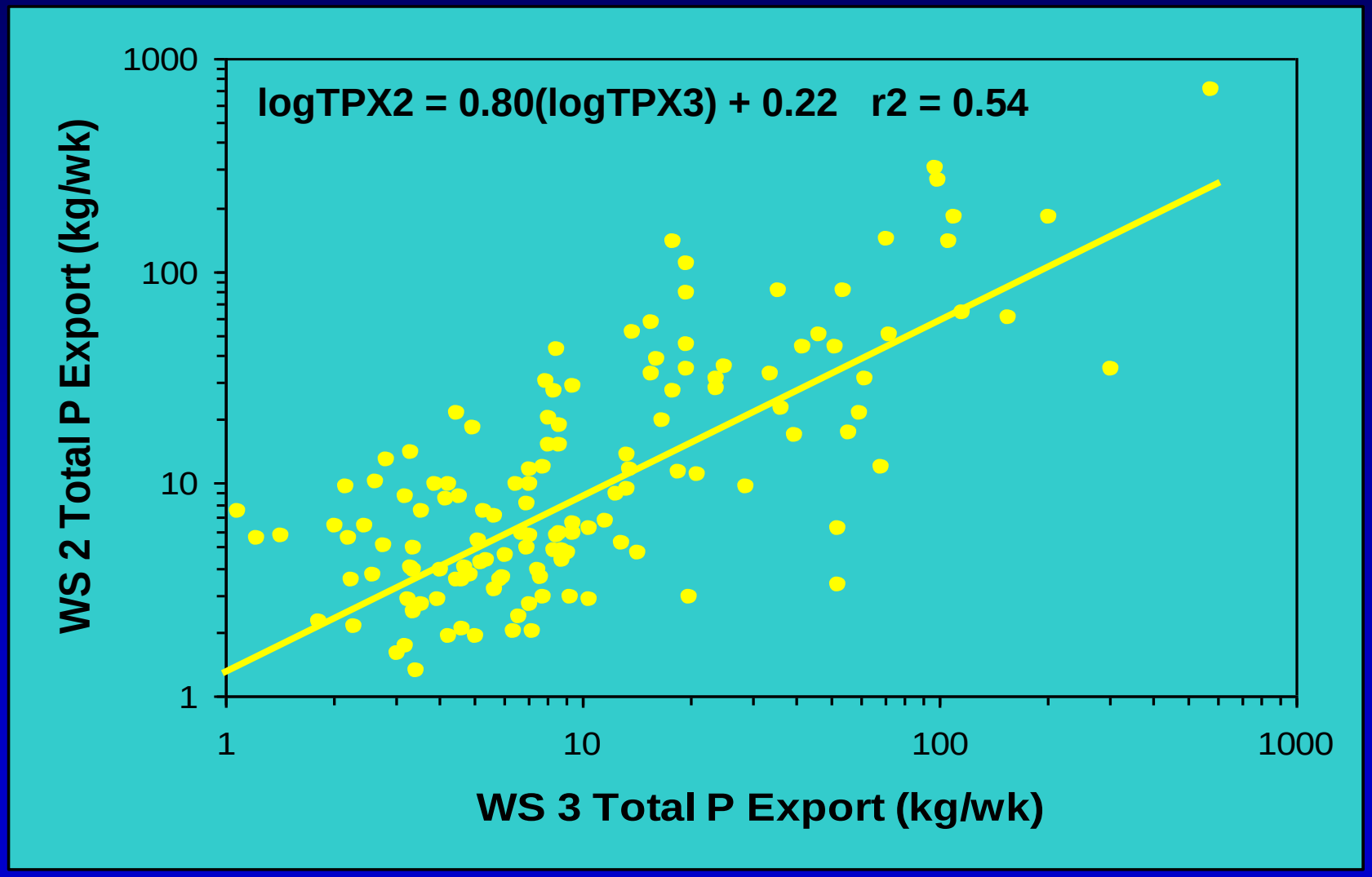


**Control Watershed**

**Treatment Watershed**

Credit: D. Meals

# Calibration Regression

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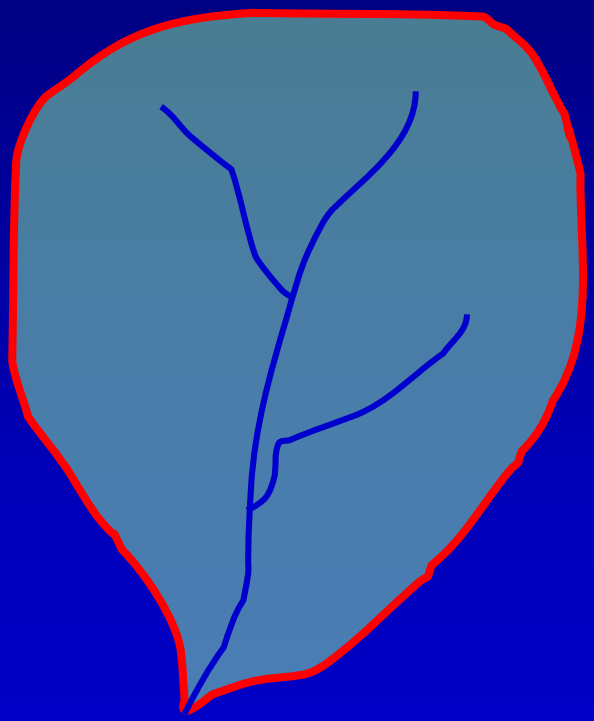
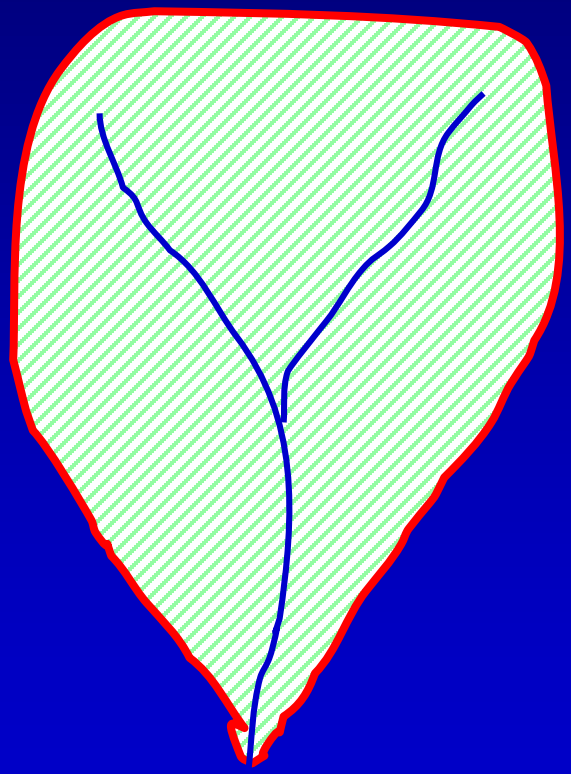
# Paired Watershed Design

**Treatment Period**





**Control Watershed**

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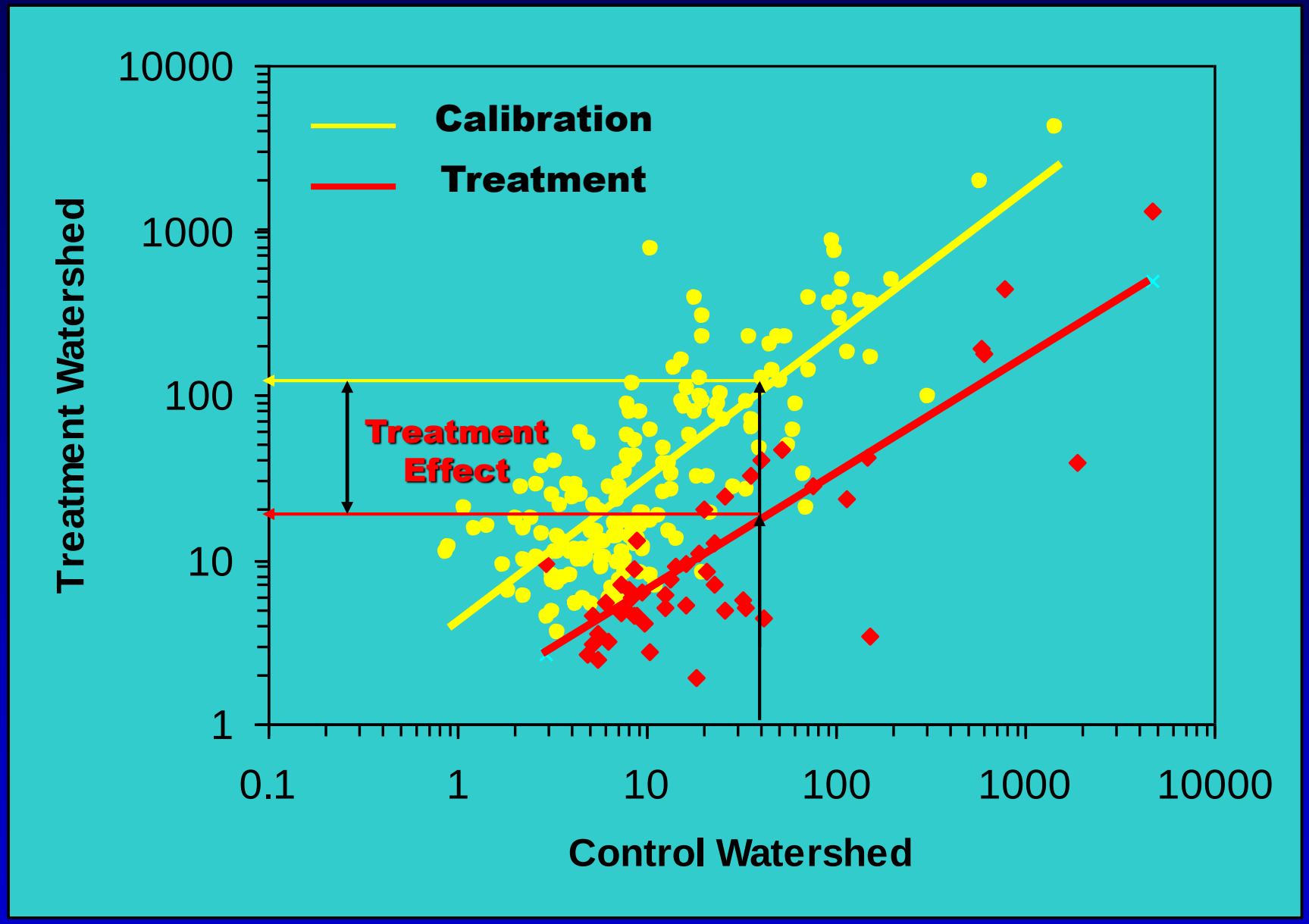



Credit: D. Meals

# 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

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

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

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

Fall

Spring

11/7/08

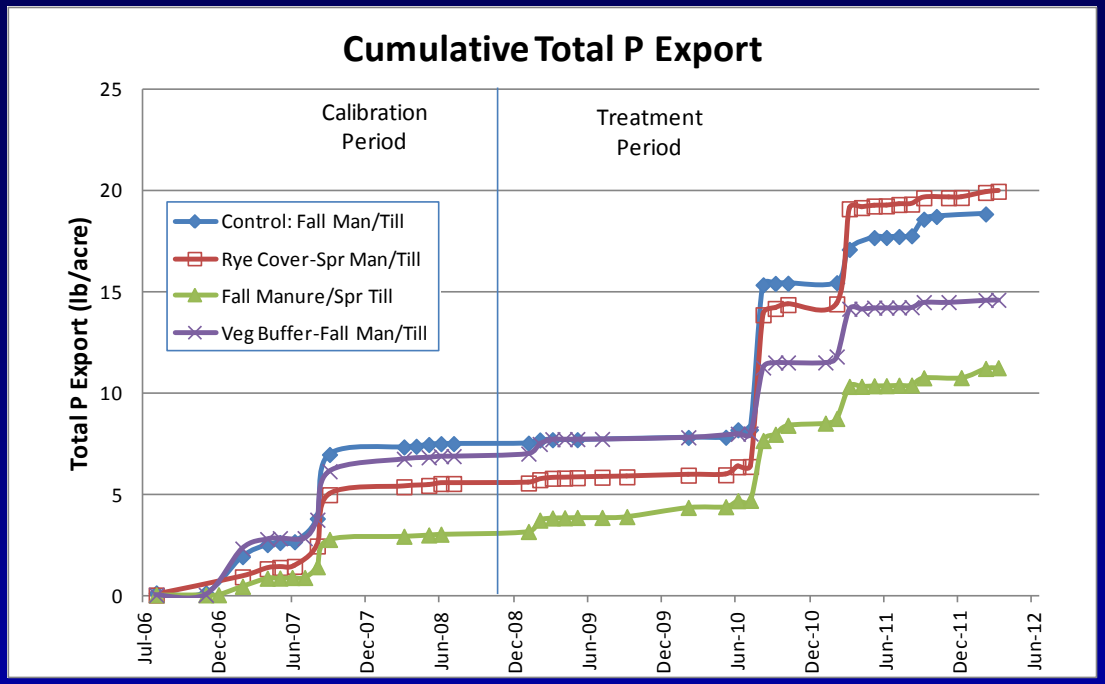
5/8/09

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

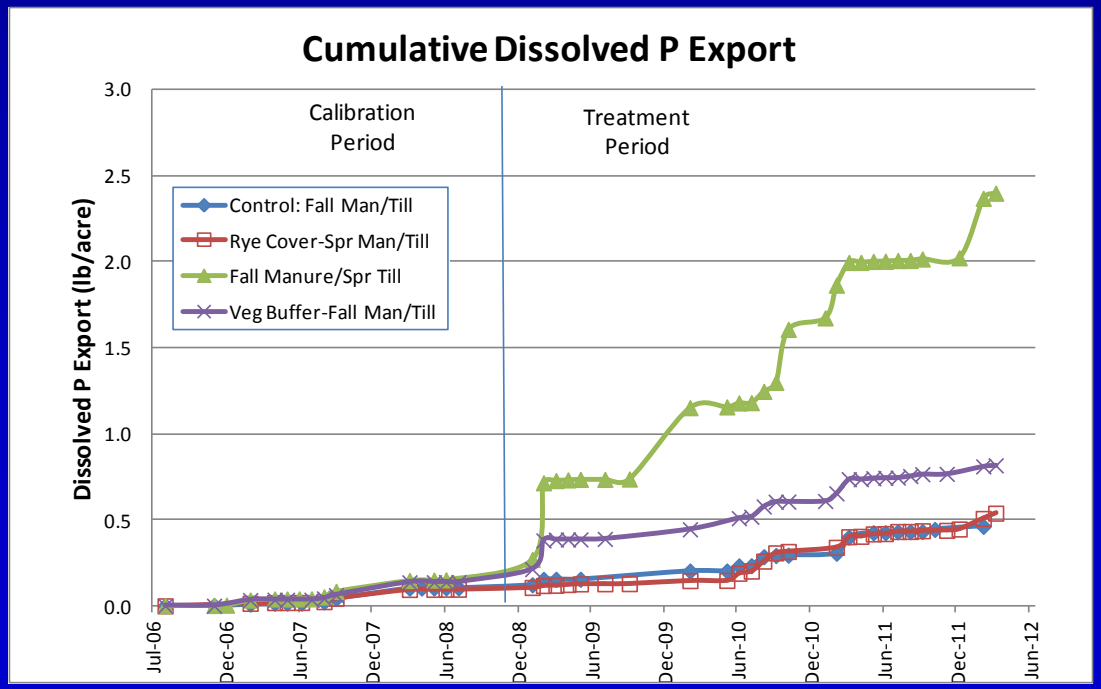
# Treatment Period Results

## 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 Total P Export

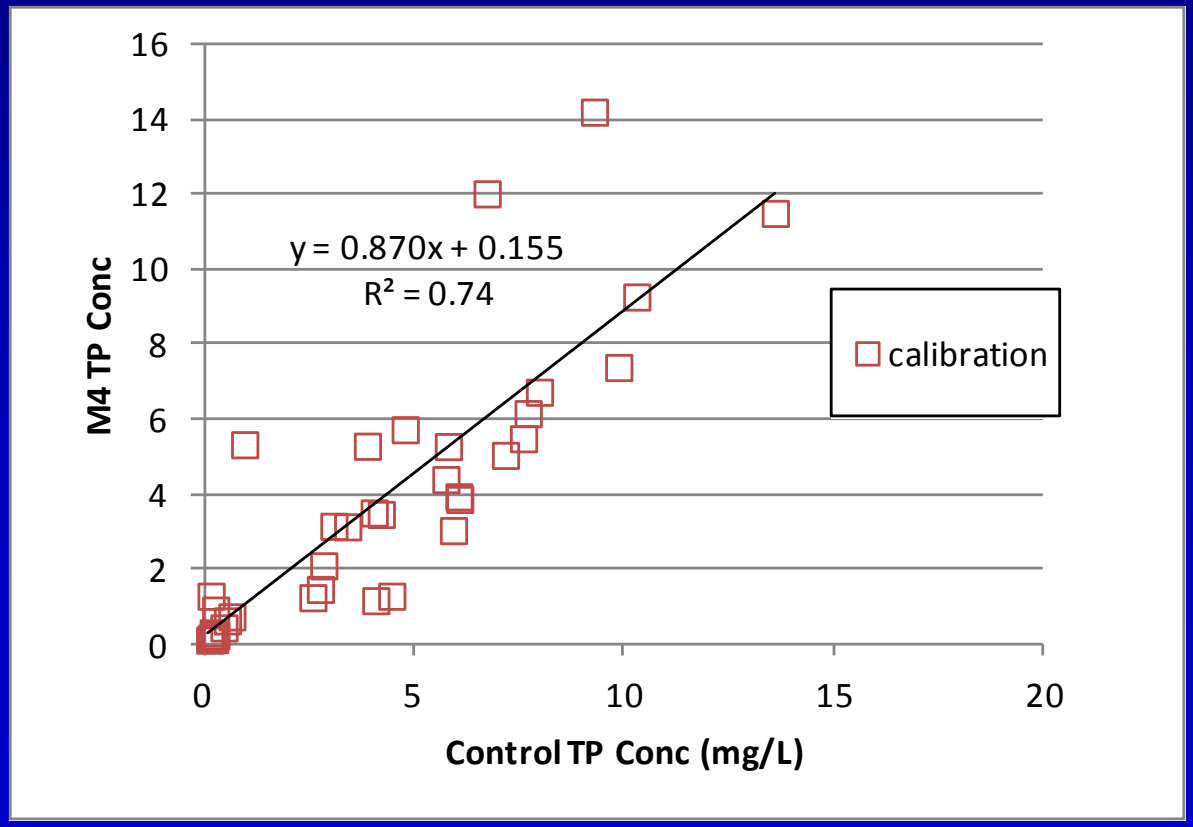



Cumulative Dissolved P Export

# 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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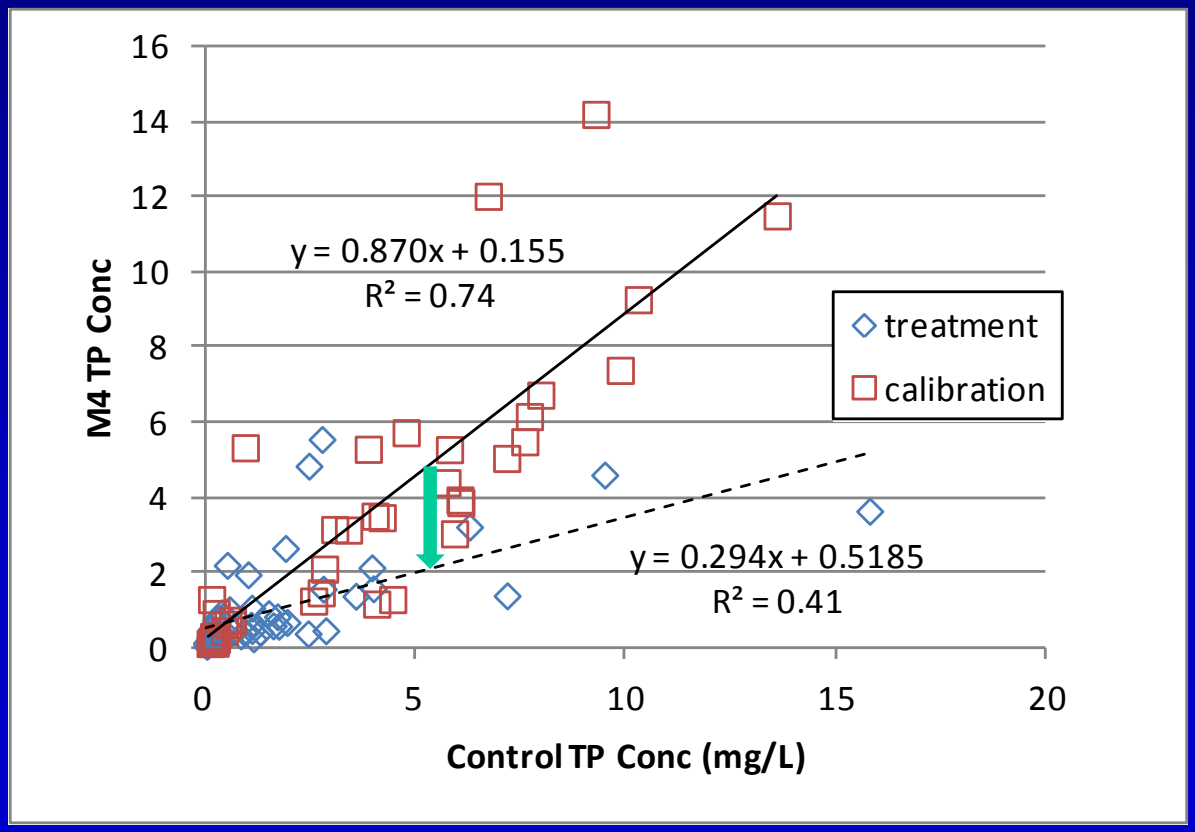



Statistical Signif. (permutation test)

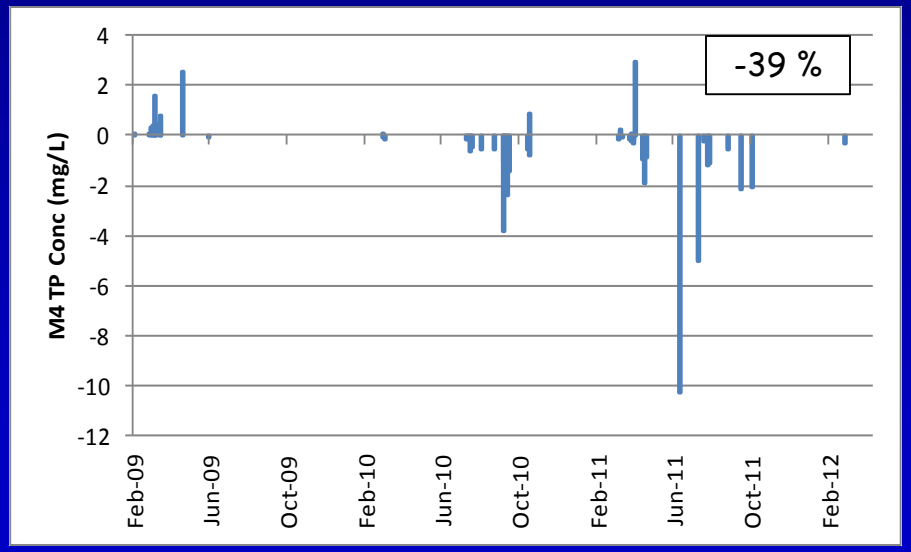
- Slope **
- Mean **

# What was magnitude of treatment effect?

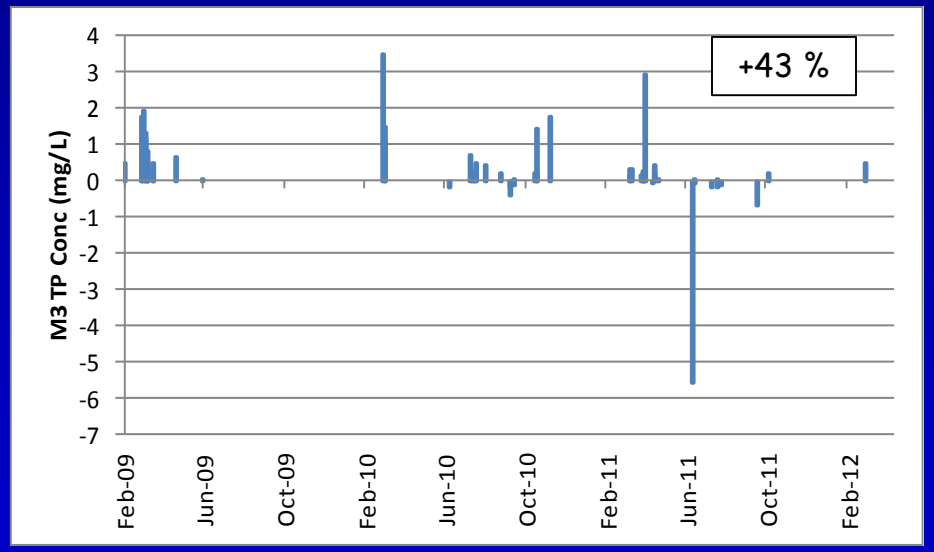
## Compare values observed during treatment period to values predicted from calibration period (Observed-Predicted)

### 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.

# 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 |
| | | Export (Load)* | |
| 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 export (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.

USDA United States Department of Agriculture

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