A New Twist on Old Conservation Practices

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Situation

- Substantial demand for agricultural products that are dependent on row-crop production
- Increased concern and demand for clean water
- How can we be more/most effective with conservation practice placement?

Topics

- Cost-effectiveness of conservation practices
- Improved design of buffers
- Overall performance of buffers under uncontrolled flow conditions
- Conservation drainage

Cost-Effectiveness and Cost-Benefit Analysis of Conservation Practices

- Used WEPP to simulate sediment loss from field-scale watersheds
- Evaluated sediment loss with various conservation practices
- Considered costs of production practices from ISU Ag. Decision Maker
- Used long-term yields from tillage studies (Al-Kaisi)
- Considered on-site and off-site costs of soil loss (Hansen and Ribaudo, 2008) - \$6.1 T^{-1} (\$1.4 T^{-1} on-site and \$4.7 T^{-1} off-site)

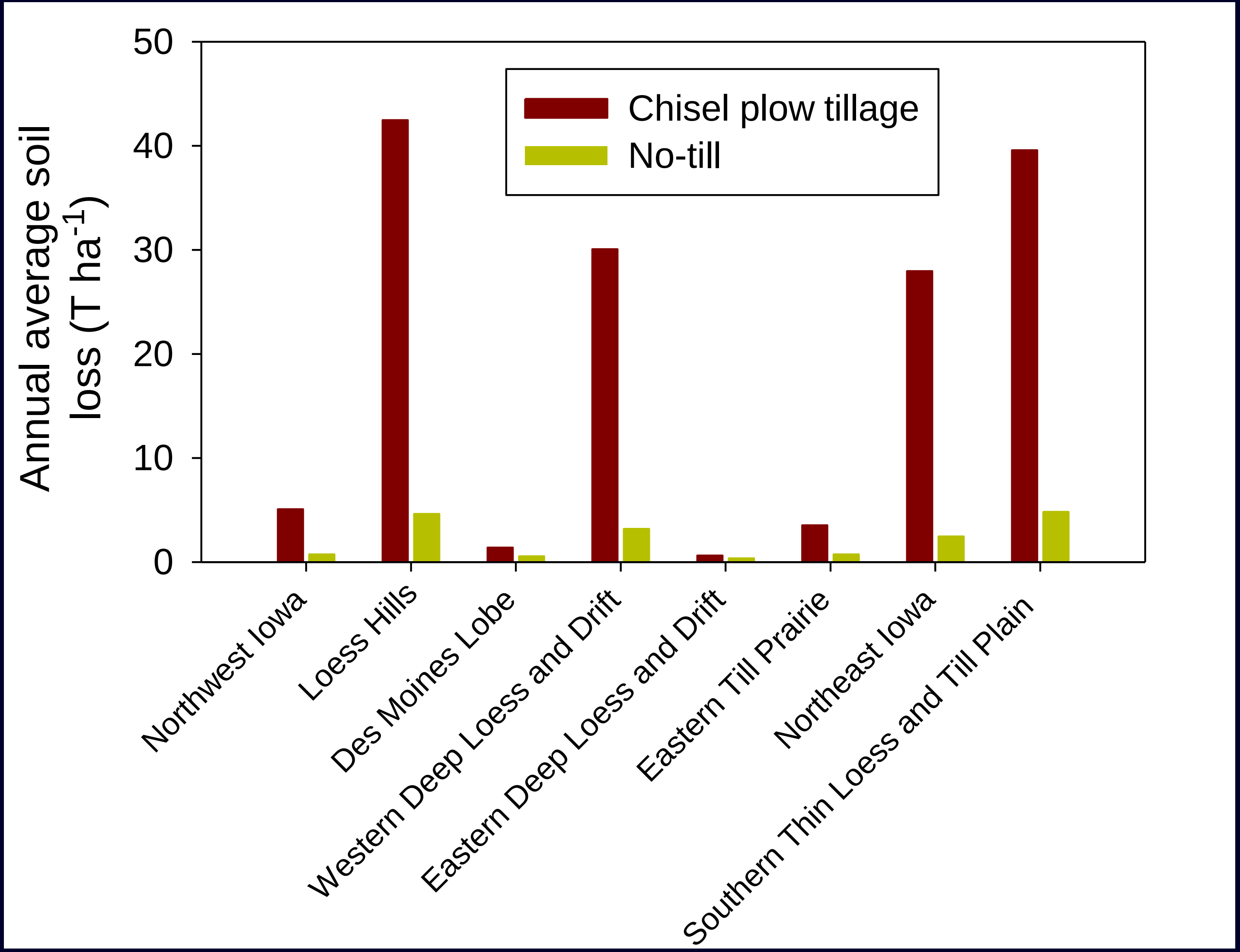
Evaluated Total Return Considering Value of Soil

- Total Return ($/acre) = [Return from Crop Yield] – [Costs]
- Costs = [Production cost] + [Establishment and Maintenance Cost of Conservation Practices] + [Cost of Soil Loss]

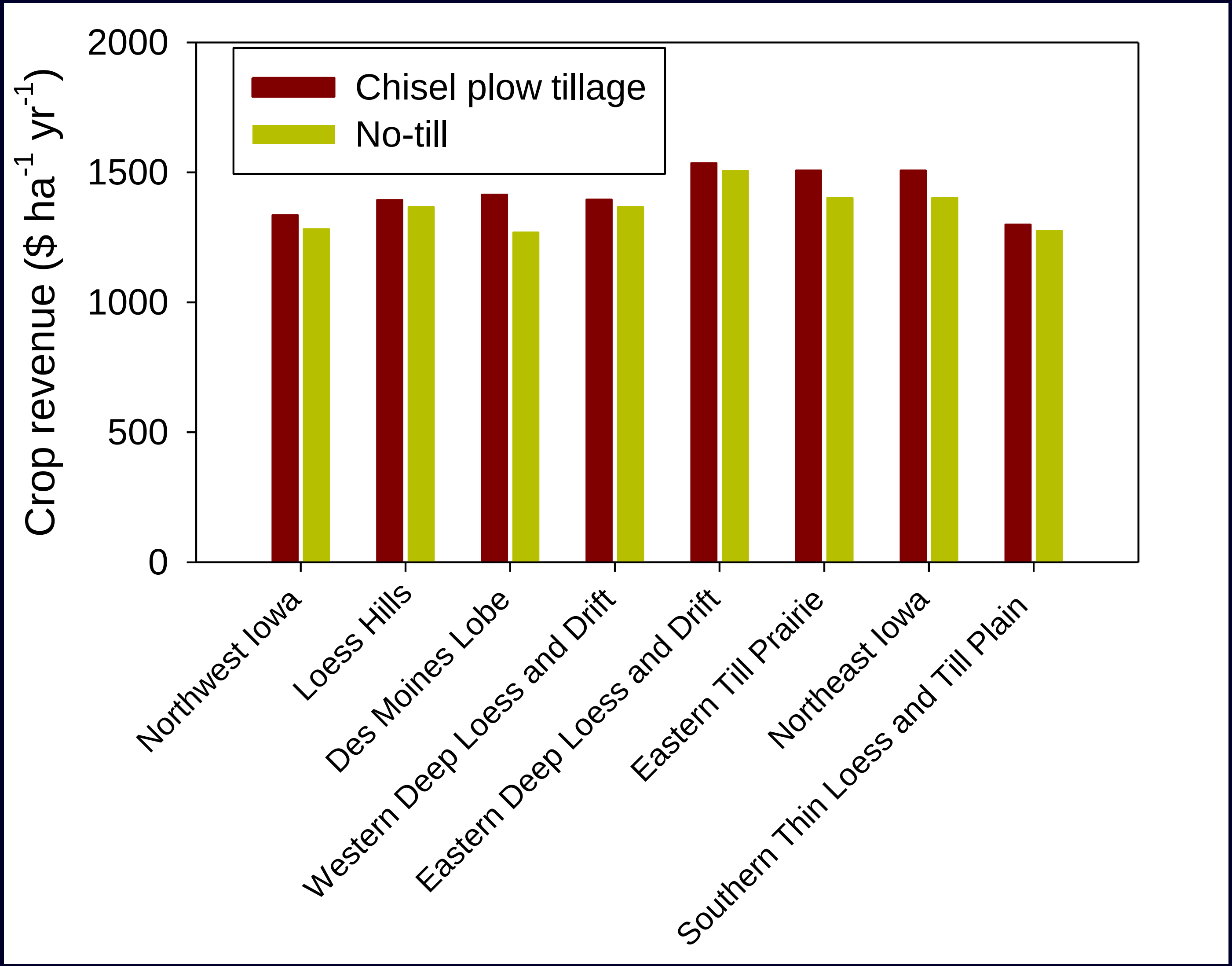
Site Characteristics

Site	Area (ha)	Mean Slope (%)	Primary Soil
Northwest Iowa	44.9	2.1	Galva silty clay loam
Loess Hills	39.6	10.8	Ida silt loam
Des Moines Lobe	45.7	1.0	Nicollet loam
Western Deep Loess and Drift	35.9	7.1	Sharpsburg silty clay loam
Eastern Deep Loess and Drift	77.5	0.9	Nira silty clay loam
Eastern Till Prairie	79.6	3.2	Kenyon loam
Northeast Iowa	122.1	9.5	Fayette silt loam
Southern Thin Loess and Till Plain	22.8	7.5	Grundy silt loam

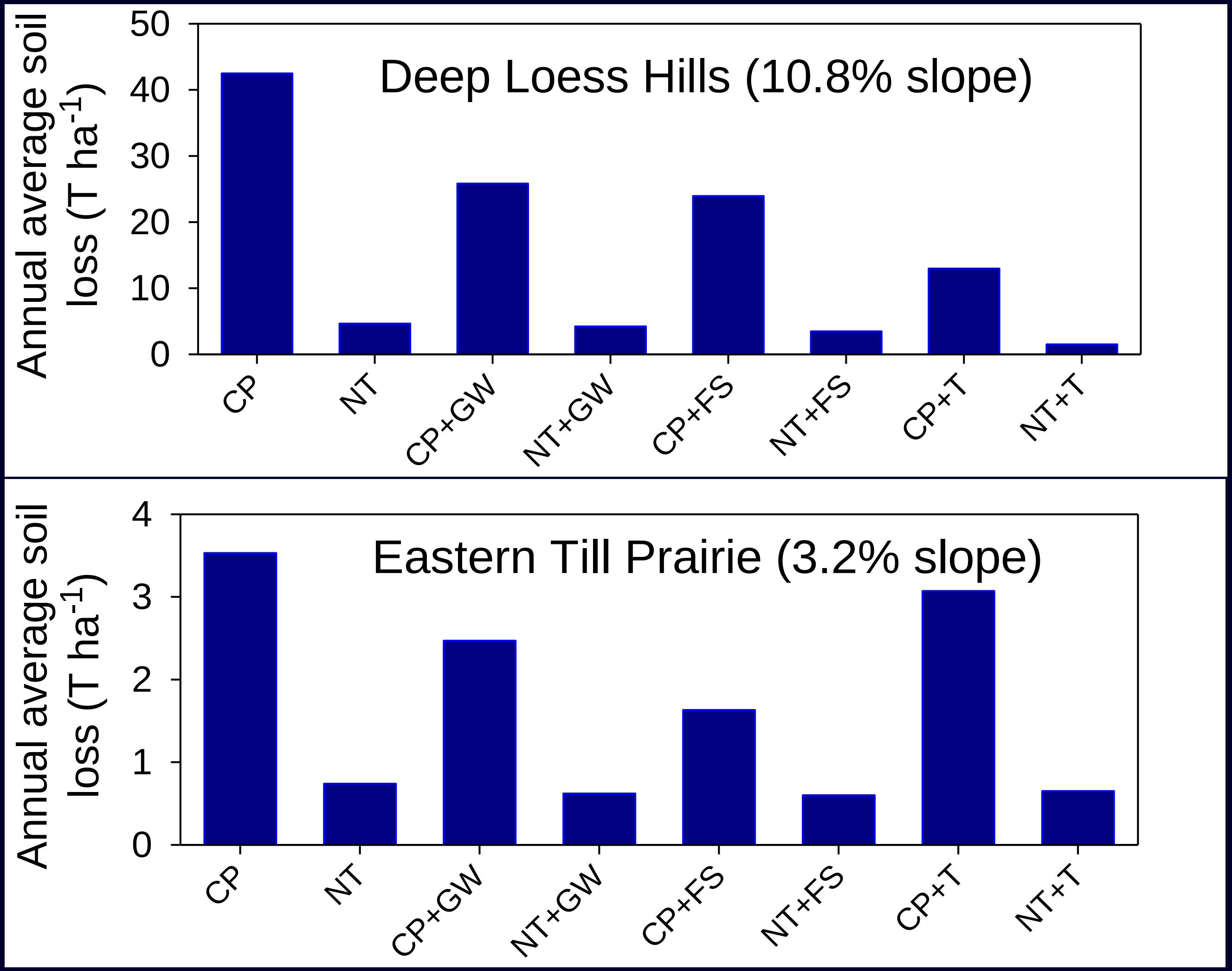
Simulated Soil Loss



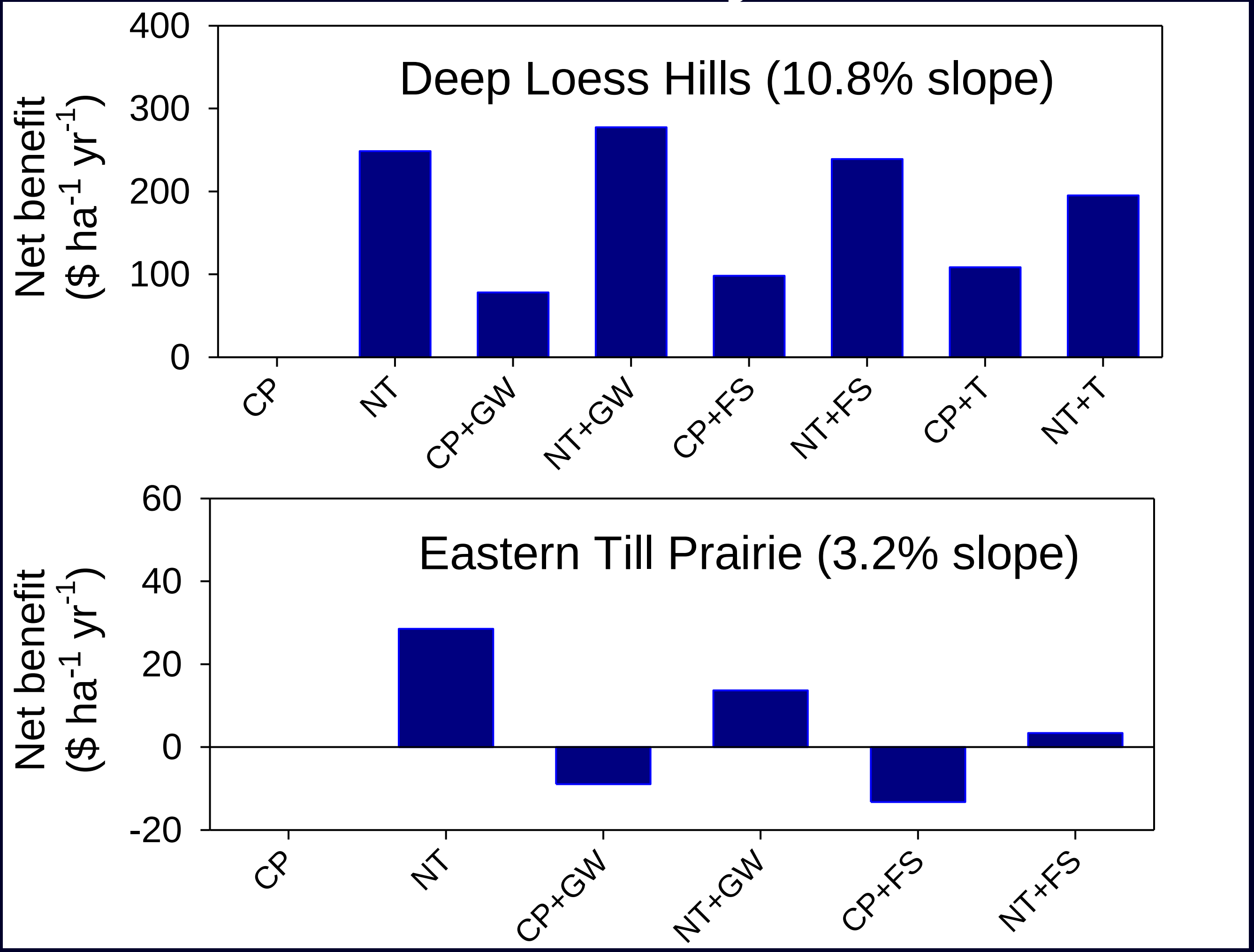
Crop Revenue



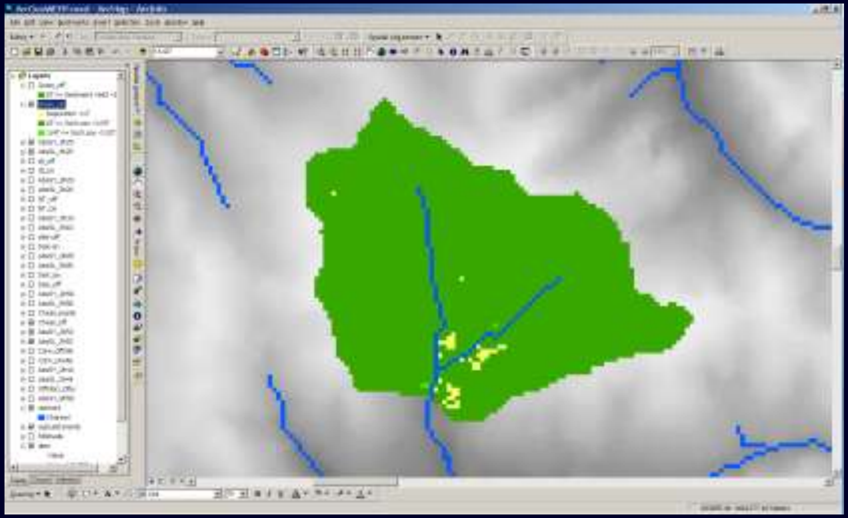
Impact of Conservation Practices



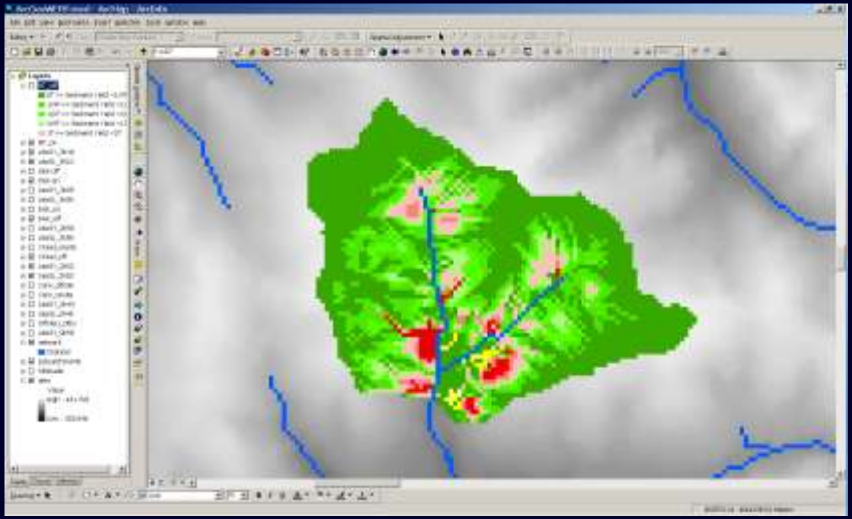
Estimated Net Benefit – compared to chisel till system



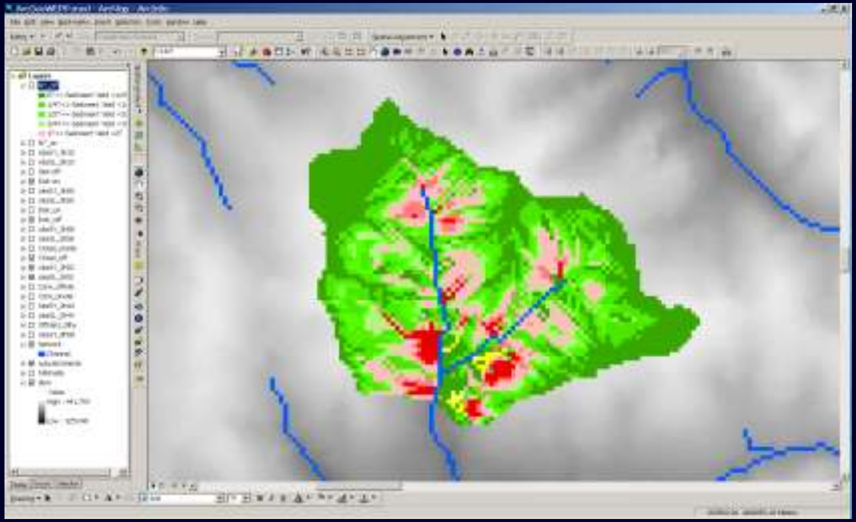
Complete Landuse Change



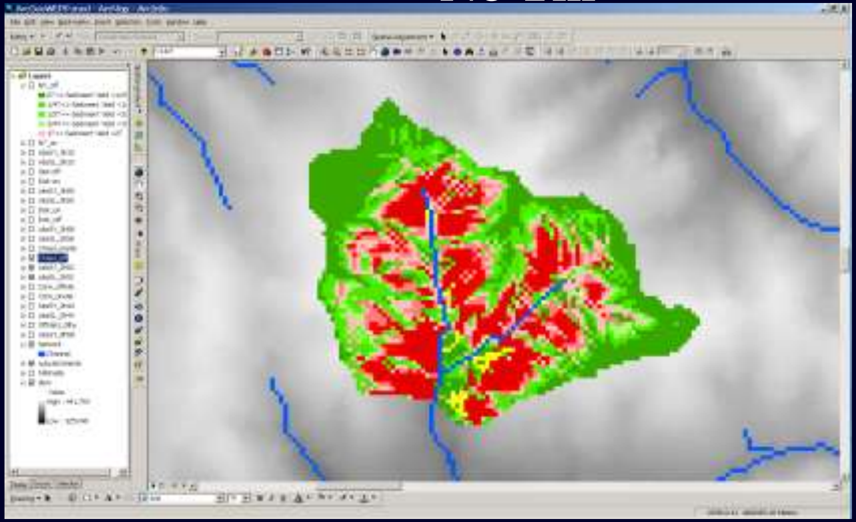
Grass



No Till



Strip Till



Chisel Till

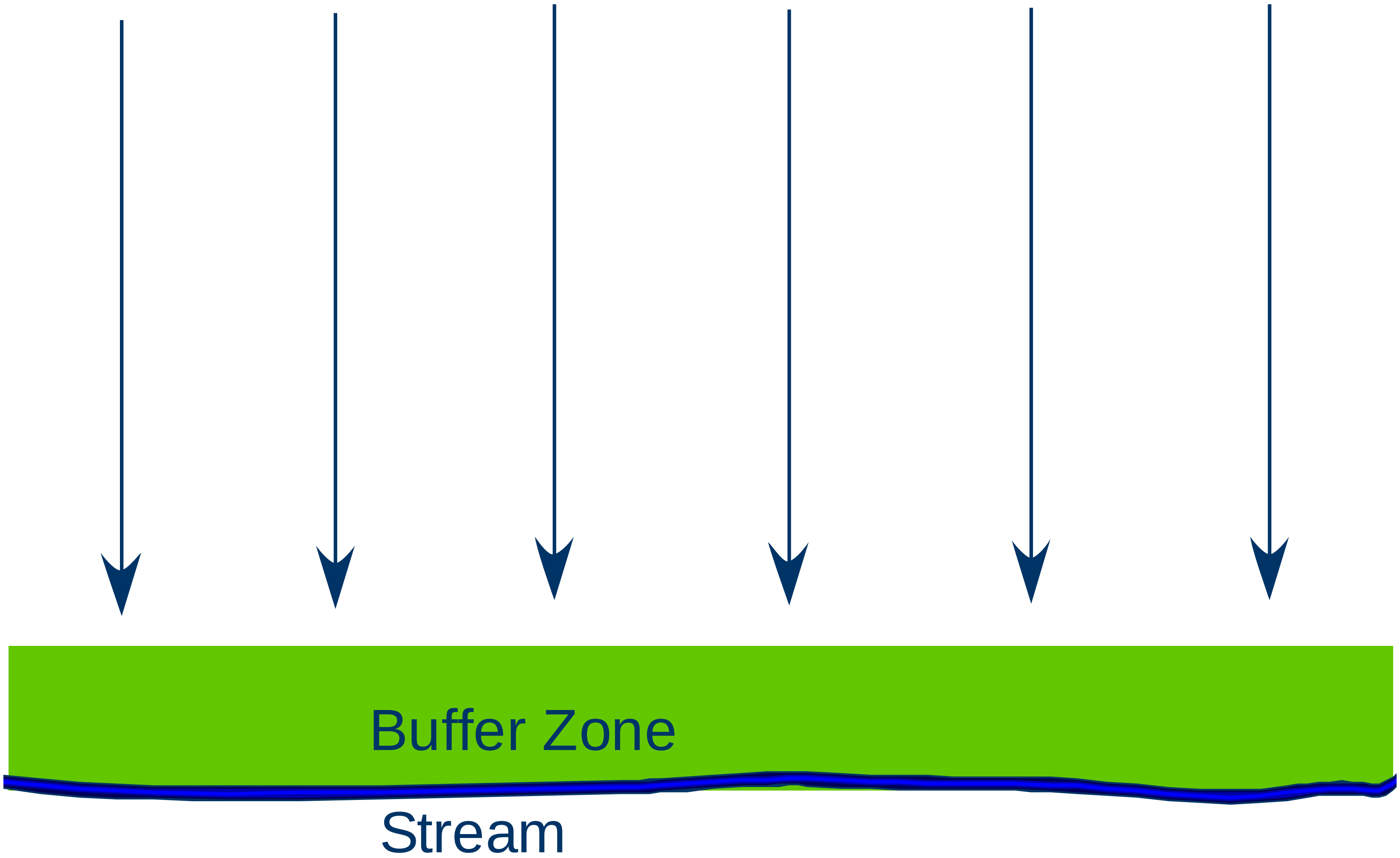
Buffers

29% Yield Increase
Conv. vs Undrained

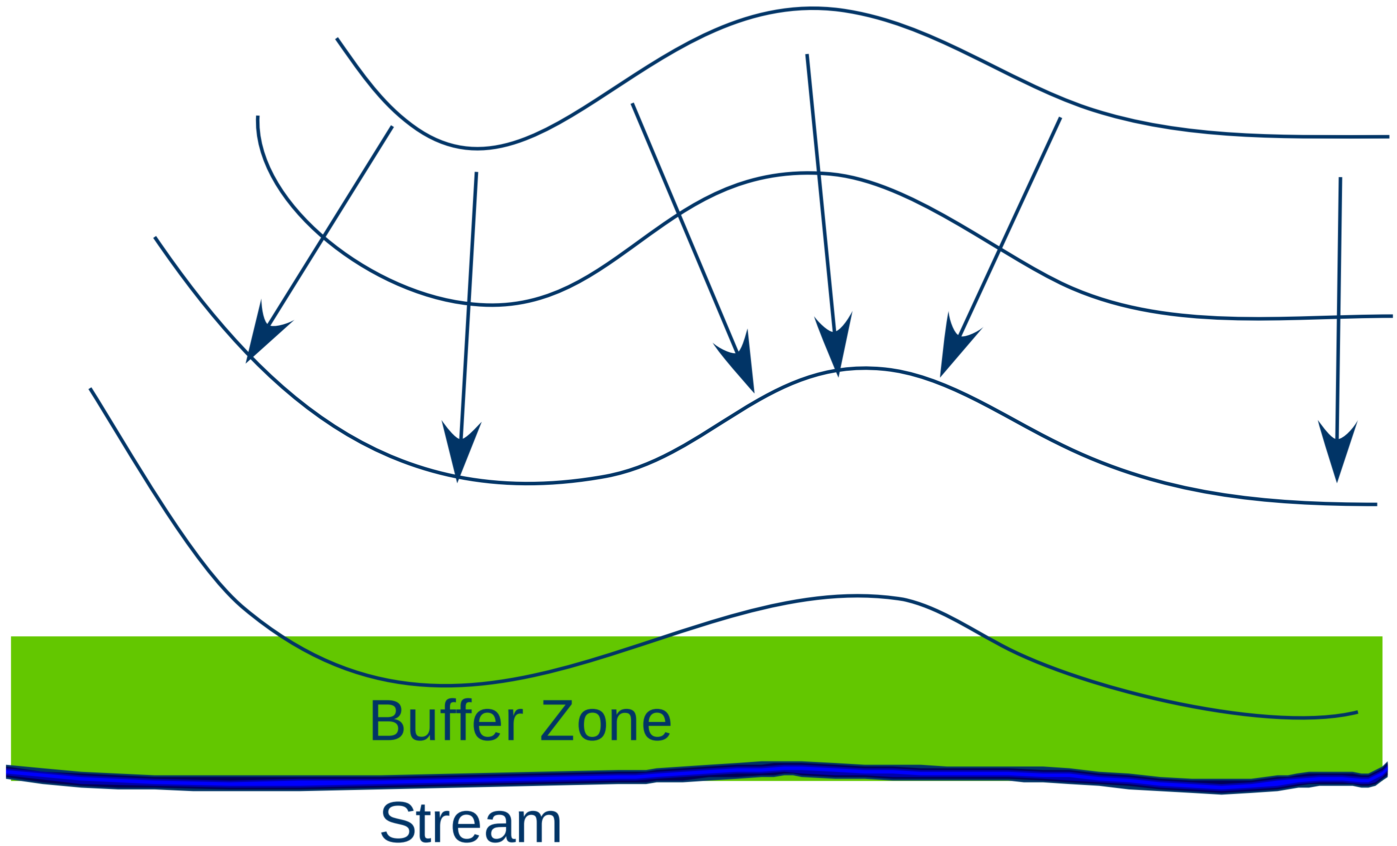
- Vegetative buffer strips are vegetated areas between fields and water bodies;
- Buffers can remove pollutants (sediment and nutrients) from surface runoff and/or shallow groundwater;
- Using appropriate buffer widths at prioritized locations is essential for maximizing the benefits and effectiveness of conservation buffers.

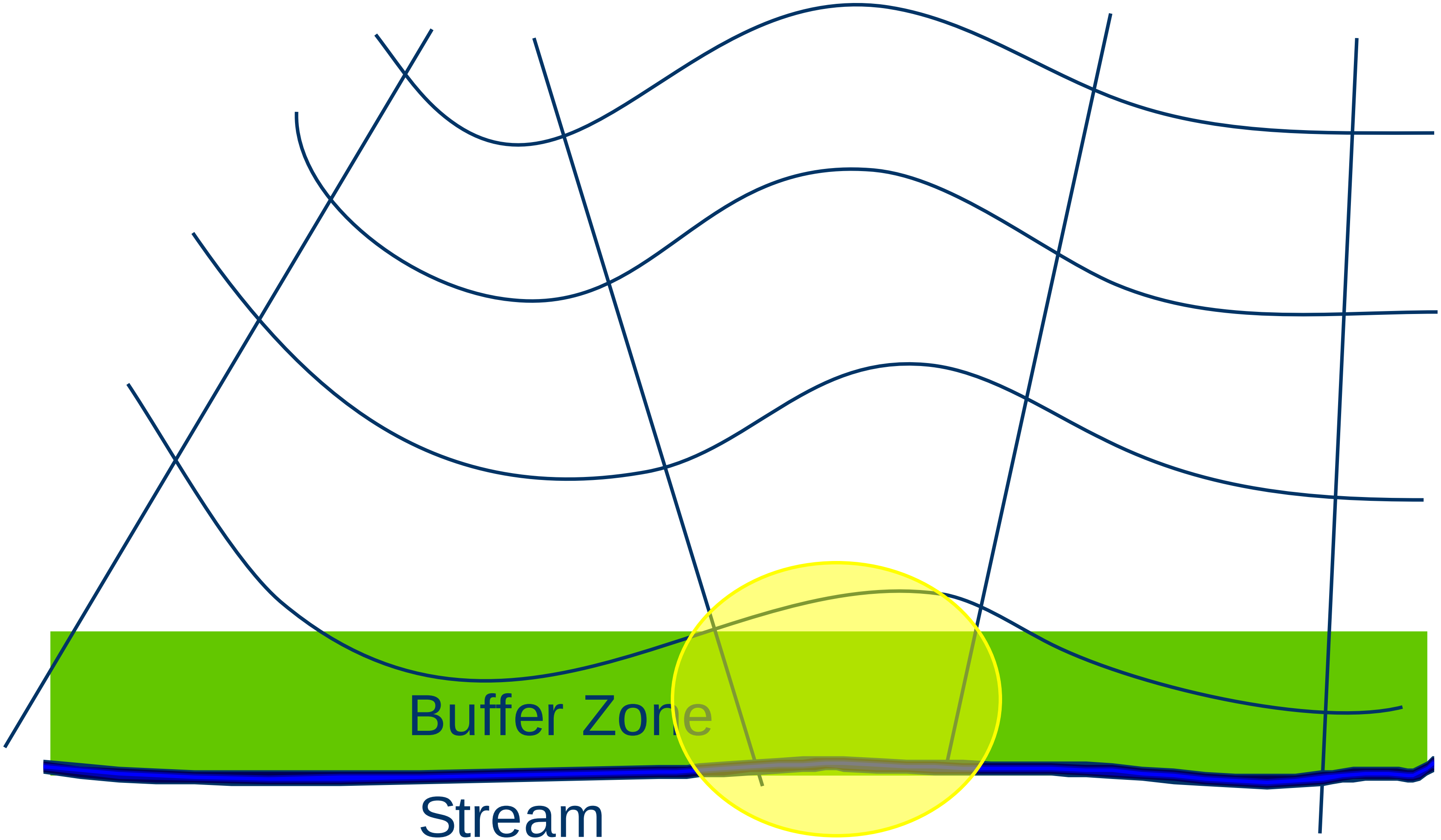

By Lynn Betts

Assumed Flow to Buffer



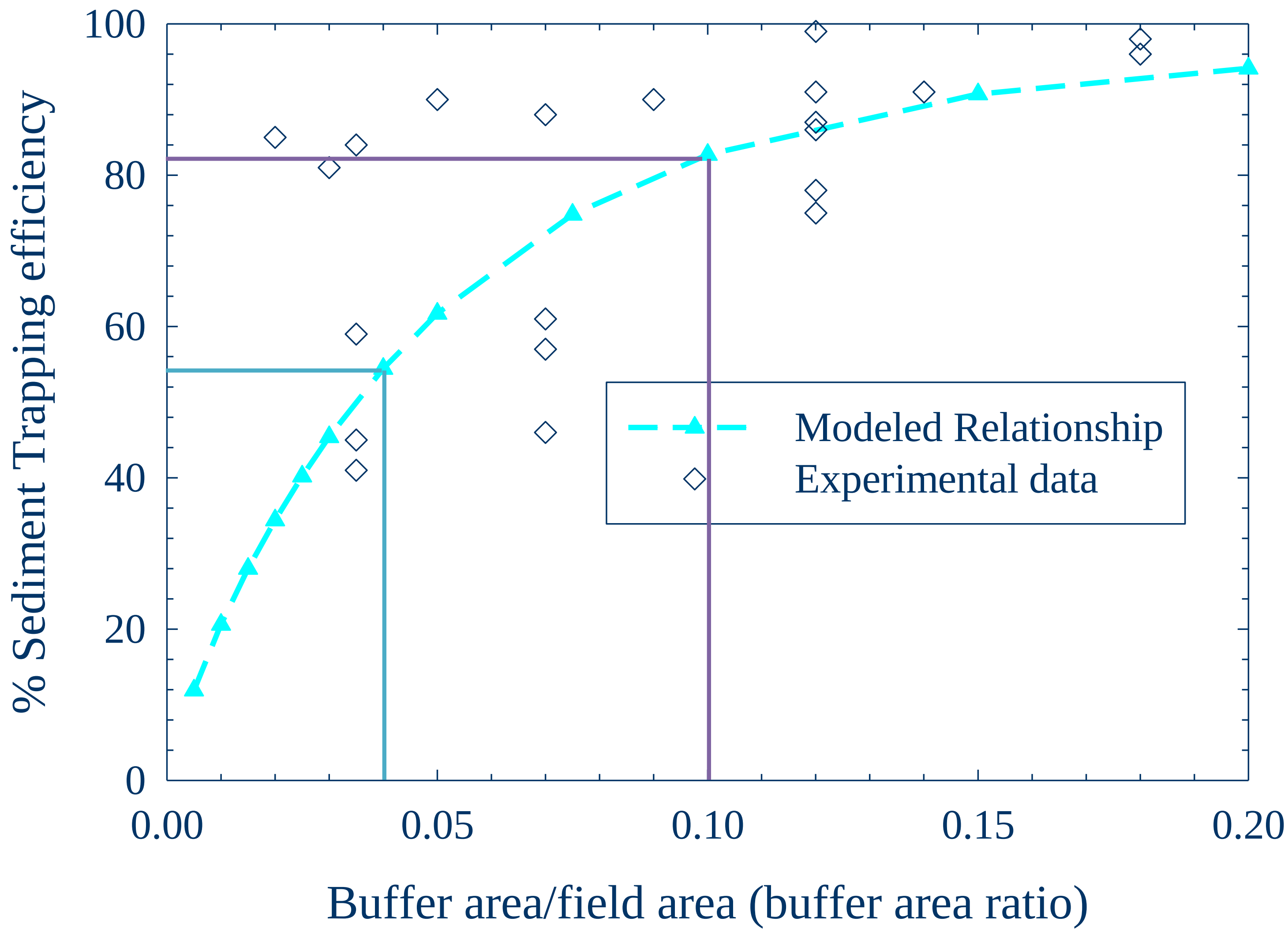
Actual Flow to Buffer



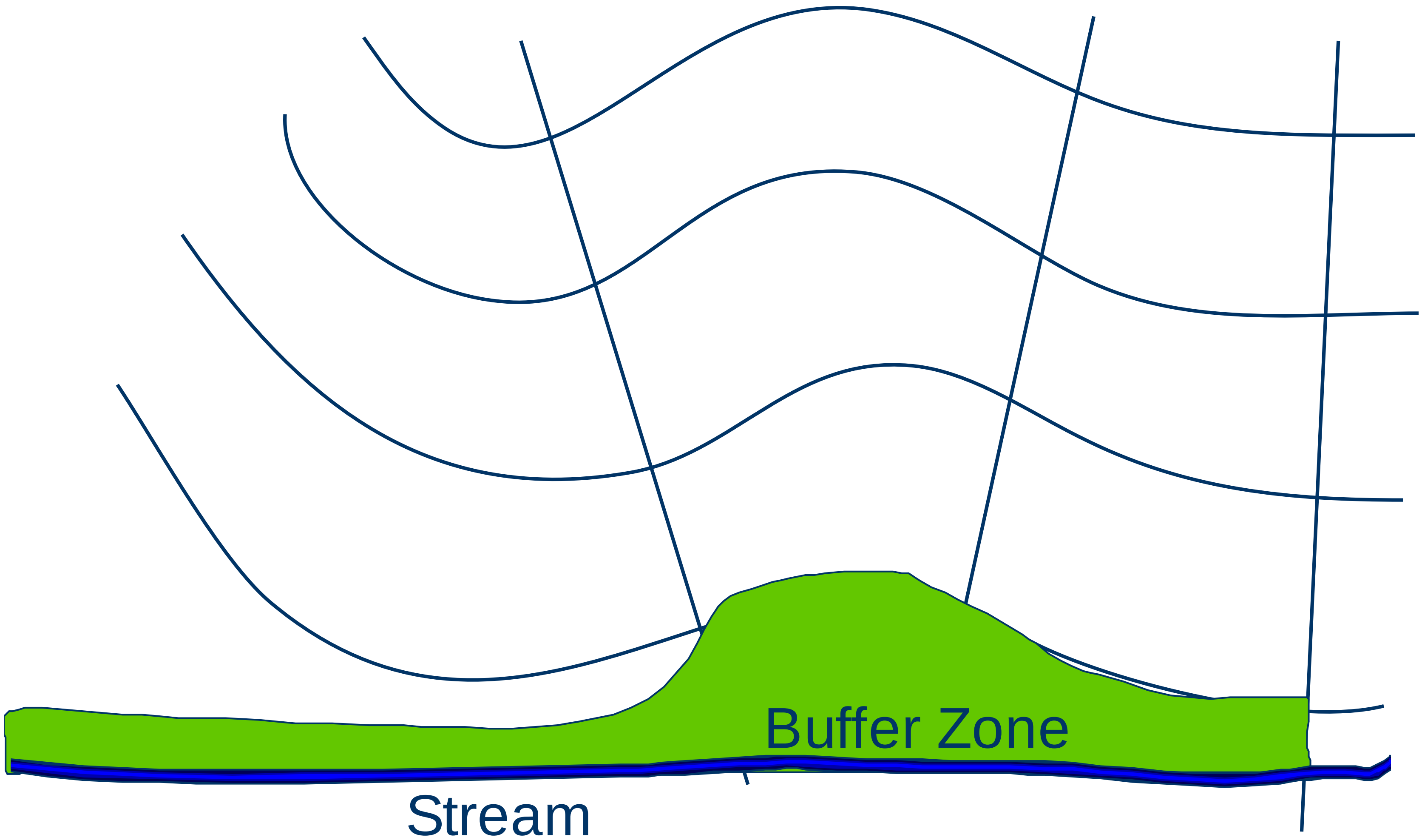


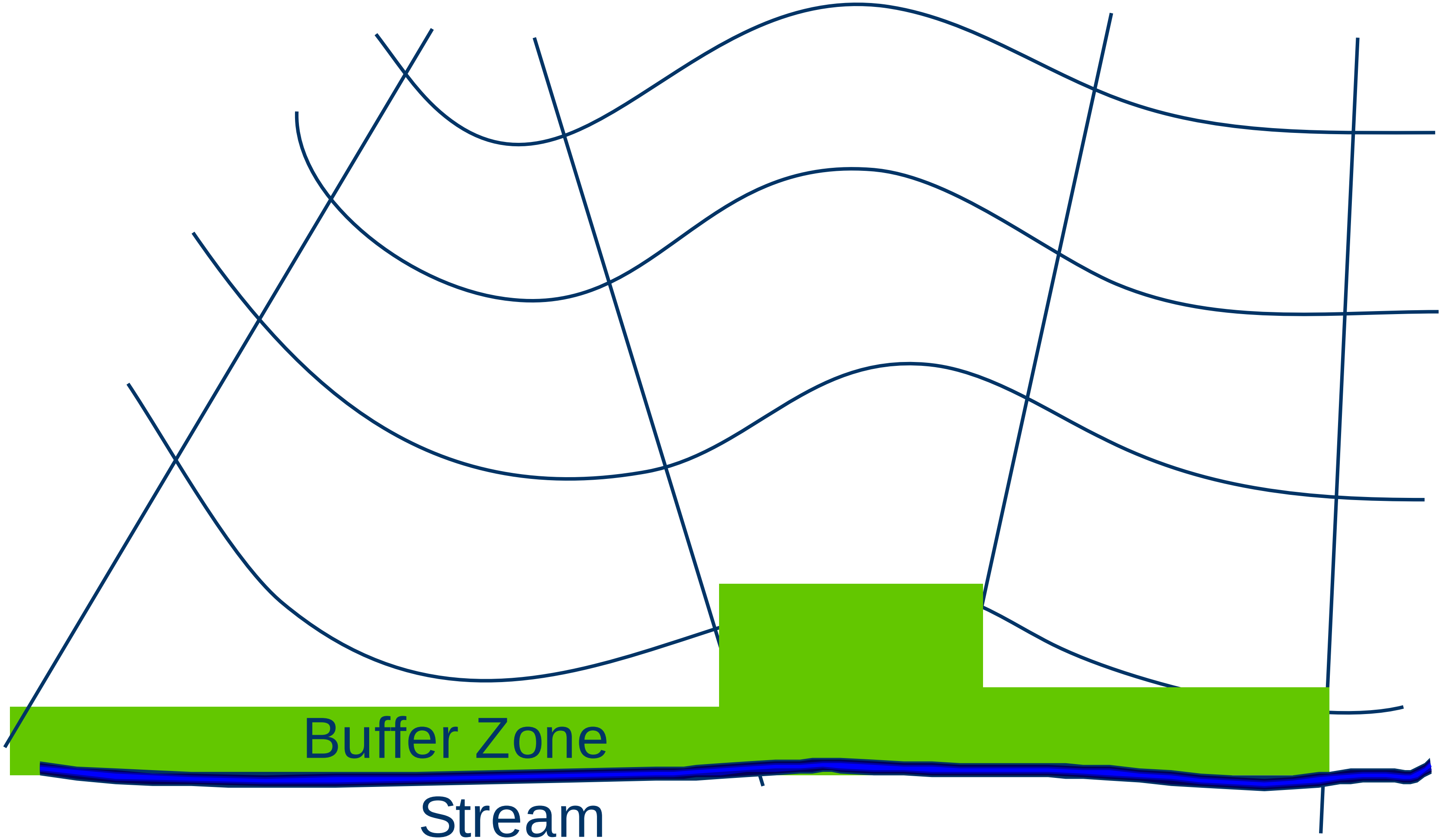
Example:
Overall BAR ~ 0.1

Actual BAR
~0.04



Trapping Efficiency as a Function of
Buffer Area Ratio with Experimental Data from Literature


Buffer Zone
Stream

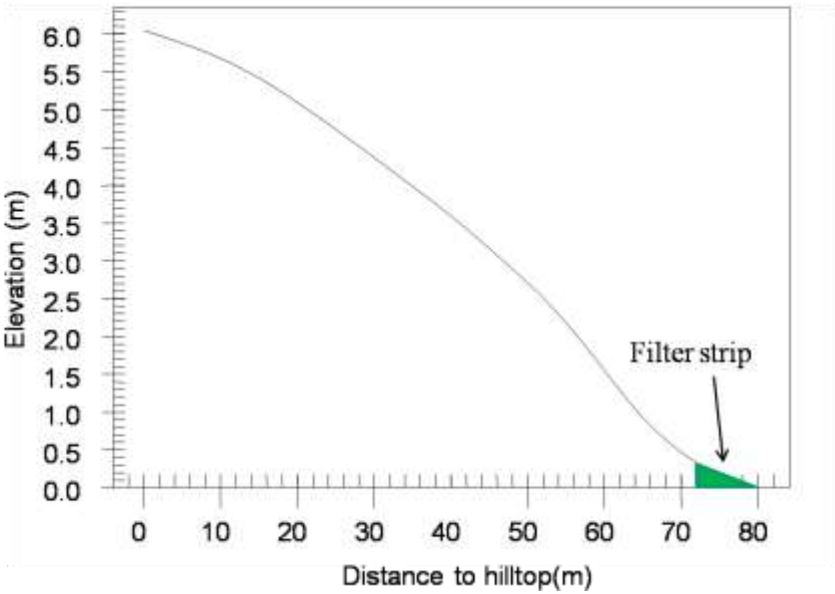

Buffer Zone
Stream

Buffer Width Design

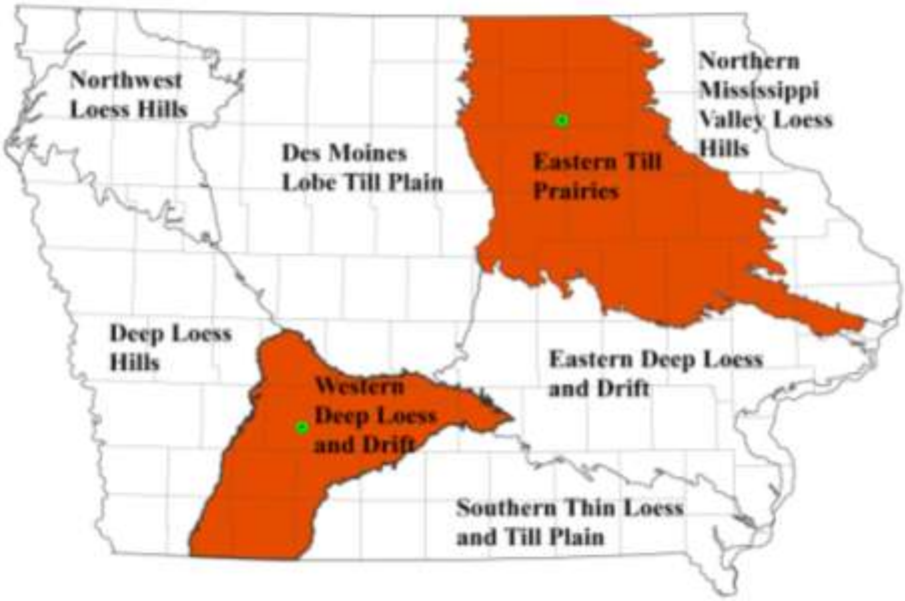
- Uniform width for all field-margin segments;
- Varying buffer width for different field-margin segments so that the ratio of buffer area to its runoff contributing area stays the same;
- There is a need to design buffer width based on the actual sediment load entering buffers.

Buffer Width Methods

- Uniform buffer width: dividing the buffer area (10% of the total farm size) by the total length of field margins;
- Constant buffer-area ratio: for each hillslope, converting 10% of cropland to vegetative buffer at the bottom of the hillslope;
- Constant buffer-sediment ratio: the buffer area of each hillslope was in proportional to the total sediment load from that hillslope.



Study Sites



Site	Area (Acre)	Mean Slope (%)	Primary Soil
Western Deep Loess and Drift	88.7	7.1	Sharpsburg silty clay loam
Eastern Till Prairie	196.6	3.2	Kenyon loam

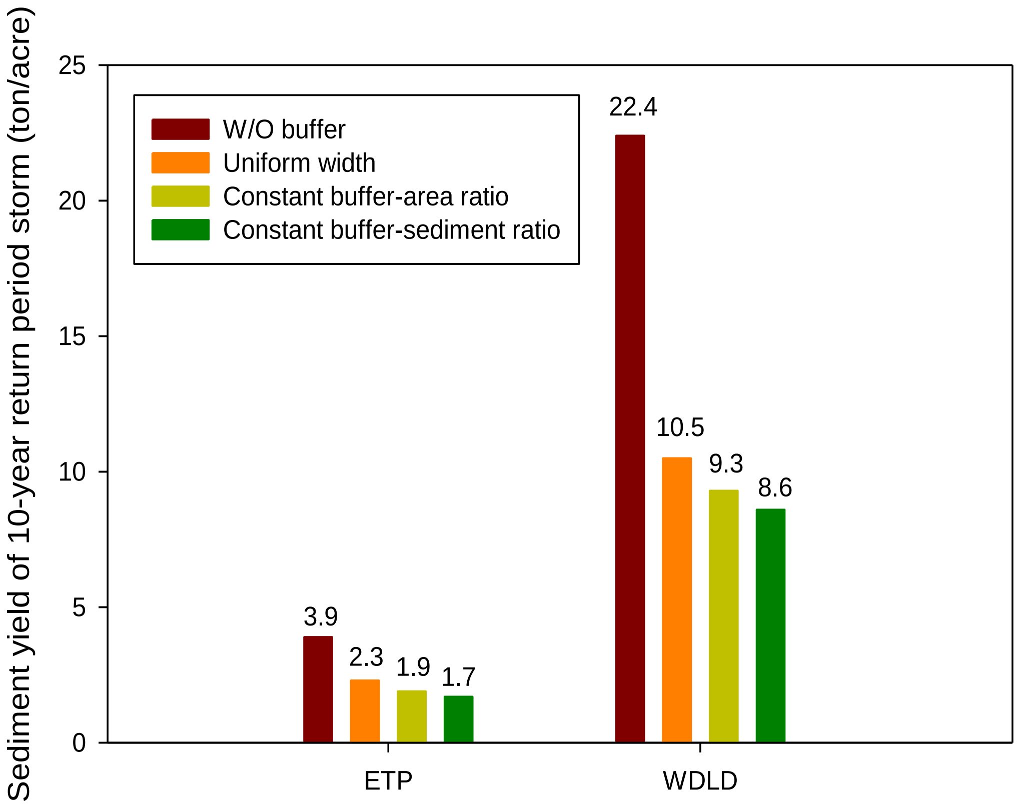
WEPP Simulation (ETP Farm)

- WEPP-estimated sediment yield and surface runoff during the 10-year return period storm;
- Some areas of the farm had a more serious soil erosion problem than the other areas, ranging between 1.1 and 8.4 ton/acre;
- Estimated runoff per unit area showed little spatial variation, suggesting runoff contributing area could be used as a surrogate for surface runoff in buffer design.

Subarea	Area (acre)	Sediment yield (ton/acre)	Surface runoff (inch)
H1	6.7	5.0	2.5
H2	1.6	5.8	2.4
H3	3.8	6.3	2.3
H4	3.8	5.8	2.2
H5	3.6	3.5	2.4
H6	14.0	4.3	2.4
H7	9.5	1.3	2.4
H8	18.2	8.4	2.4
H9	8.2	6.6	2.2
H10	7.0	7.4	2.4
H11	13.4	4.7	2.4
H12	0.6	2.8	2.3
H13	1.8	4.8	2.4
H14	13.5	1.3	2.4
H15	1.4	2.7	2.4
H16	1.8	1.2	2.4
H17	14.3	1.1	2.4
H18	39.6	2.7	2.4
H19	10.3	3.5	2.4
H20	4.7	2.9	2.4
H21	3.5	2.6	2.1

Overall Performance of Buffers

- Use of buffers reduced sediment yield compared to the 100% row-crop scenario;
- Buffers with variable width were more effective in sediment reduction than those with uniform width;
- Buffers with a constant buffer-sediment ratio had the best overall performance.



STRIPs AT Neal Smith National Wildlife Refuge

www.nrem.iastate.edu/research/STRIPs

Science-based Trials of Rowcrops Integrated with Prairies

Welcome to the homepage of the STRIPs research team! We are an interdisciplinary team of researchers, educators, and extension specialists studying the impacts of strategically integrated strips of prairie within row-cropped agricultural landscapes. We encourage you to visit the links above to learn more about our project, current findings, and upcoming opportunities. We also thank the U.S. Fish and Wildlife Service and the Neal Smith National Wildlife Refuge for their leading role in supporting this project.

U.S. FISH & WILDLIFE SERVICE

NATIONAL WILDLIFE REFUGE SYSTEM

Perennial vegetation can be placed into annual cropland to provide conservation benefits that are disproportionately greater than the land area occupied.

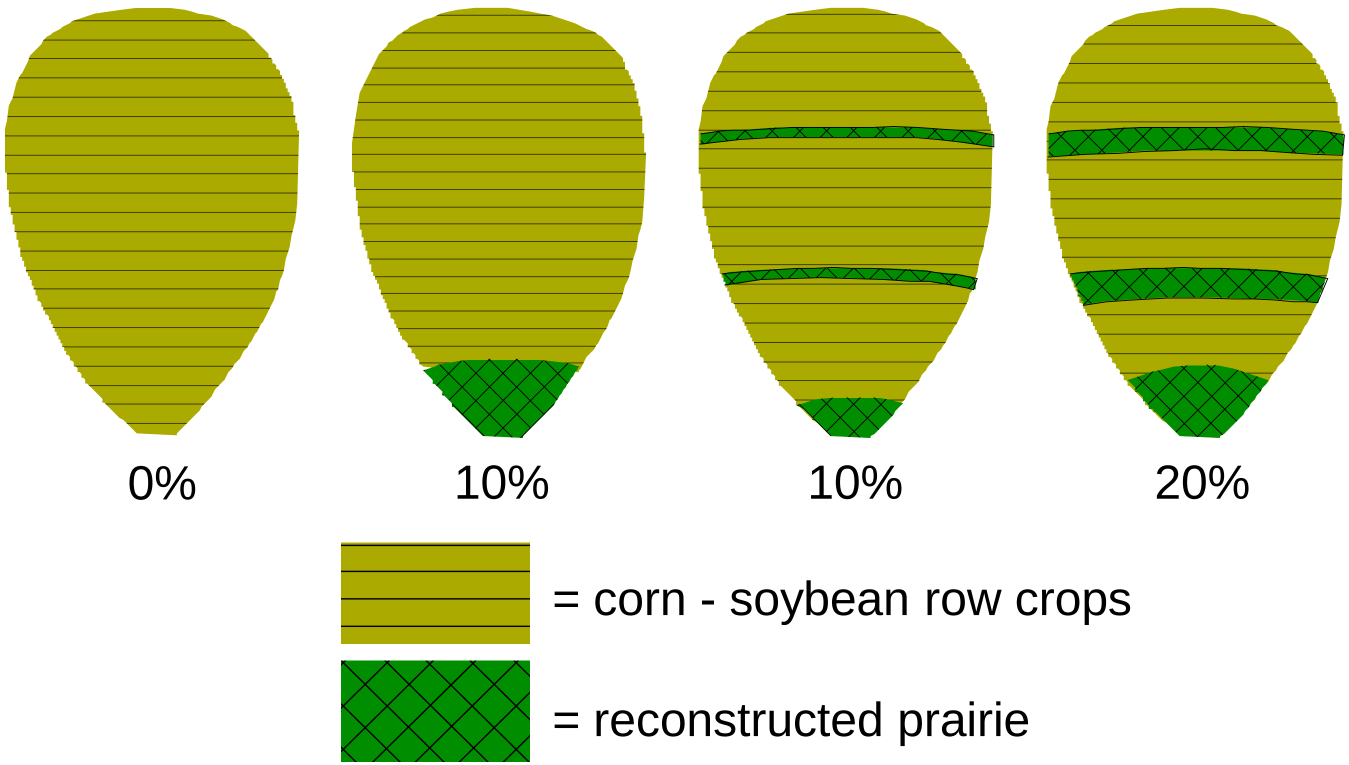
Current Funding

- Leopold Center for Sustainable Agriculture
- Iowa Department of Agriculture and Land Stewardship, Division of Soil Conservation
- U.S. Forest Service Northern Research Station
- Iowa State University College of Agriculture and Life Sciences
- USDA-NCR-SARE
- USDA-NIFA-AFRI-Managed Ecosystems

LEOPOLD CENTER · IOWA STATE UNIVERSITY OF SCIENCE AND TECHNOLOGY · FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE · IOWA DEPARTMENT OF AGRICULTURE AND LAND STEWARDSHIP · NSF · USDA

Experimental Watershed Treatments

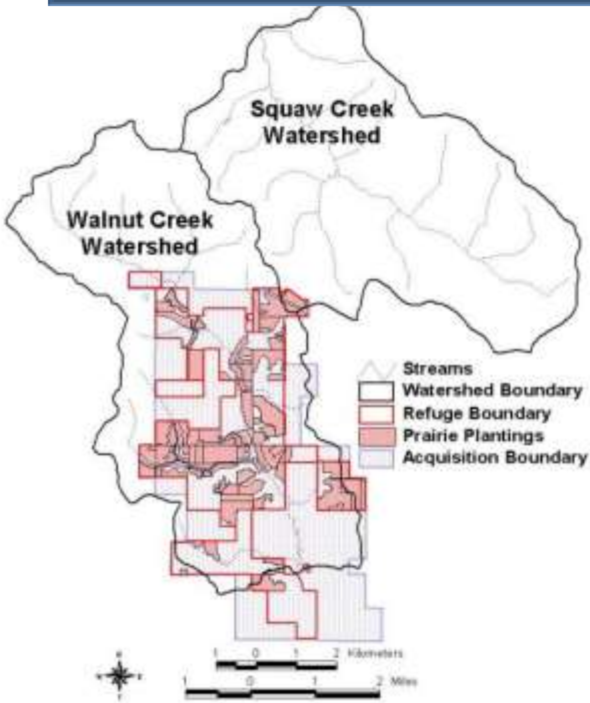
12 watersheds:
Random Incomplete Block Design:
3 reps X 4 treatments X 3 blocks

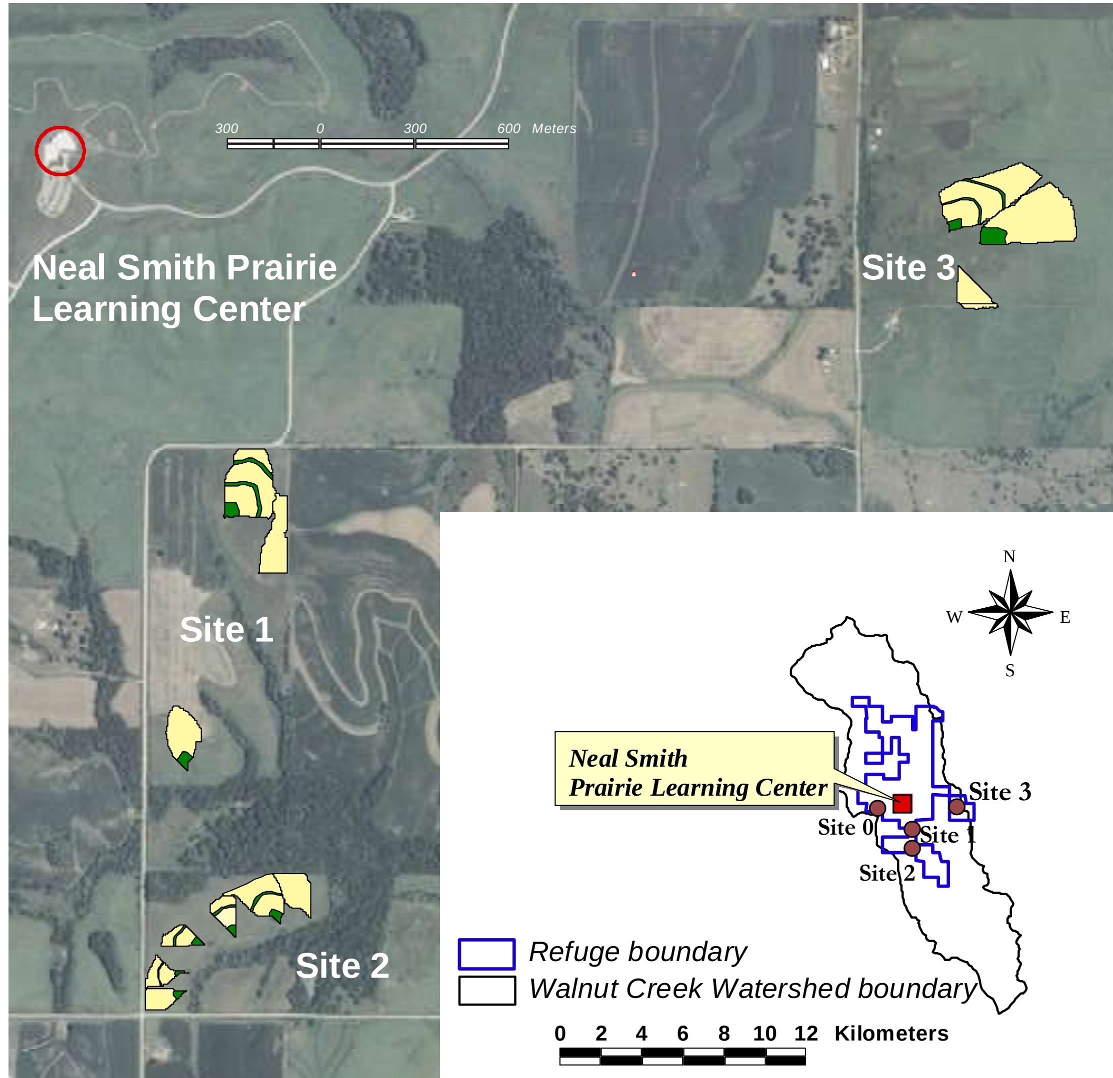


12 experimental watersheds, 1 to 8 acres each, Neal Smith National Wildlife Refuge, Prairie City, IA

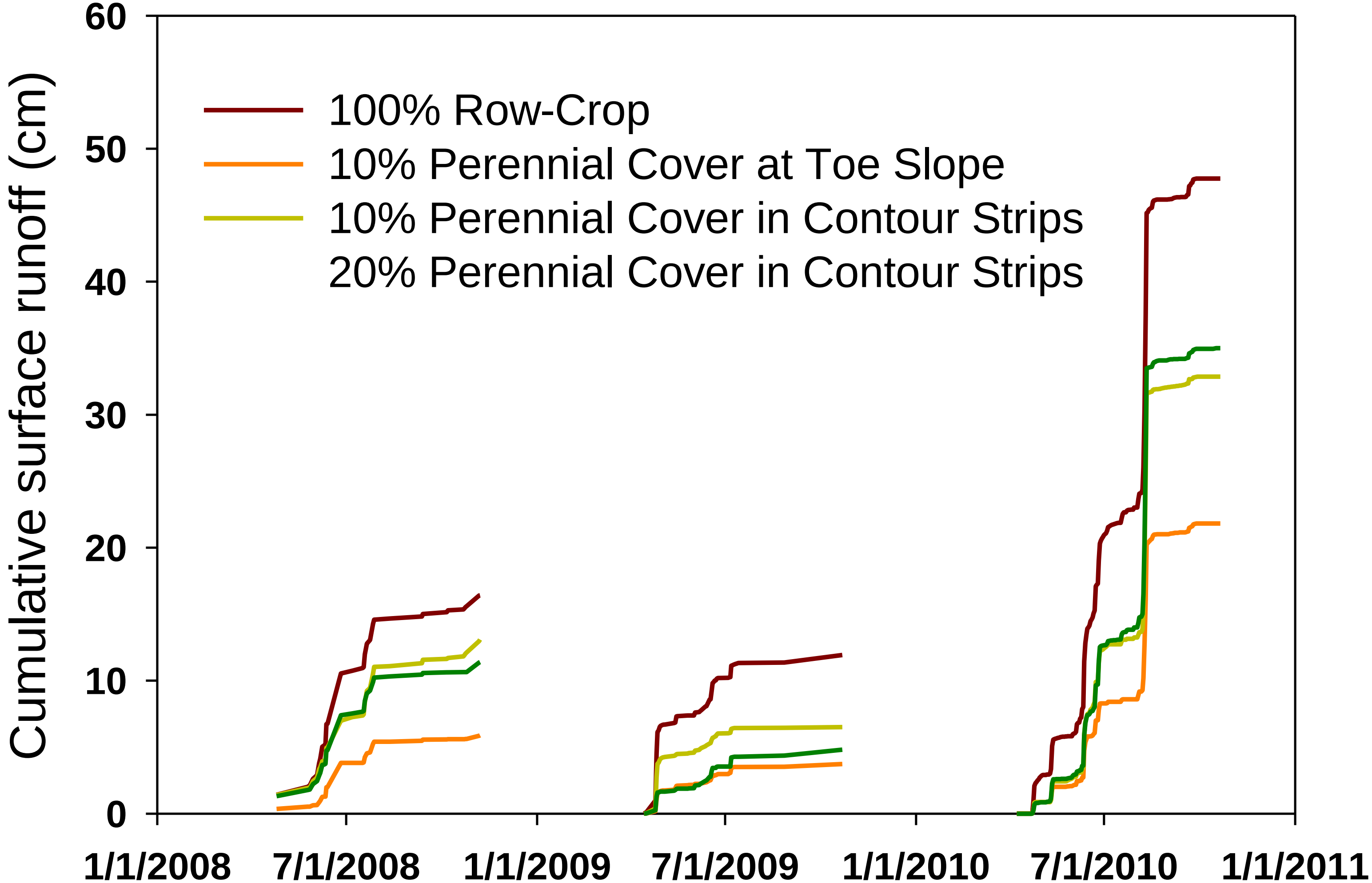
Four treatments:
100% crop (no-till)
10% buffer, toe slope
10% buffer, contour strips
20% buffer, contour strips

Watershed Experiment: NSNWR



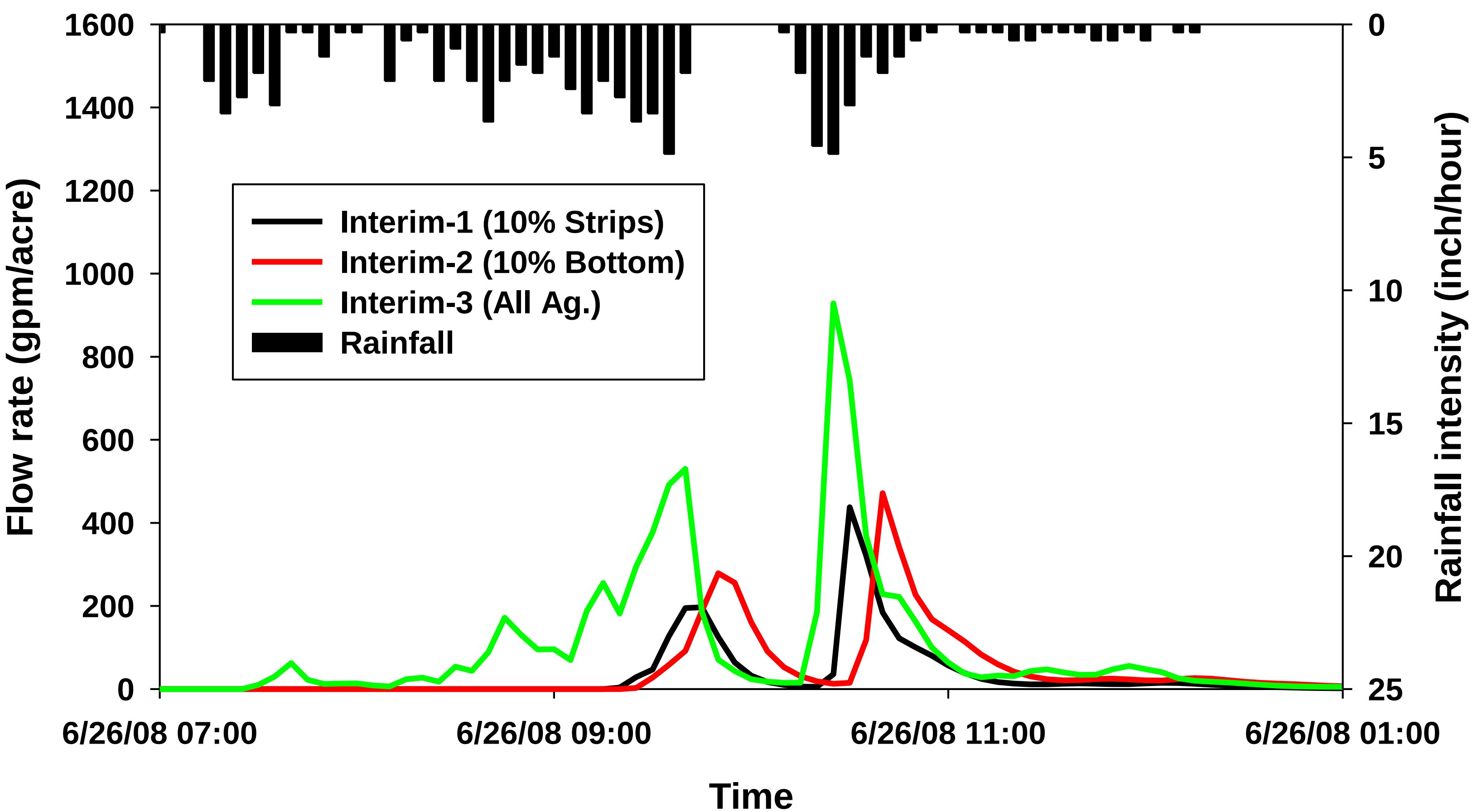


Surface Runoff 2008-2010



Helmers et al., unpublished data

Example Runoff Hydrographs



Helmers et al., unpublished data

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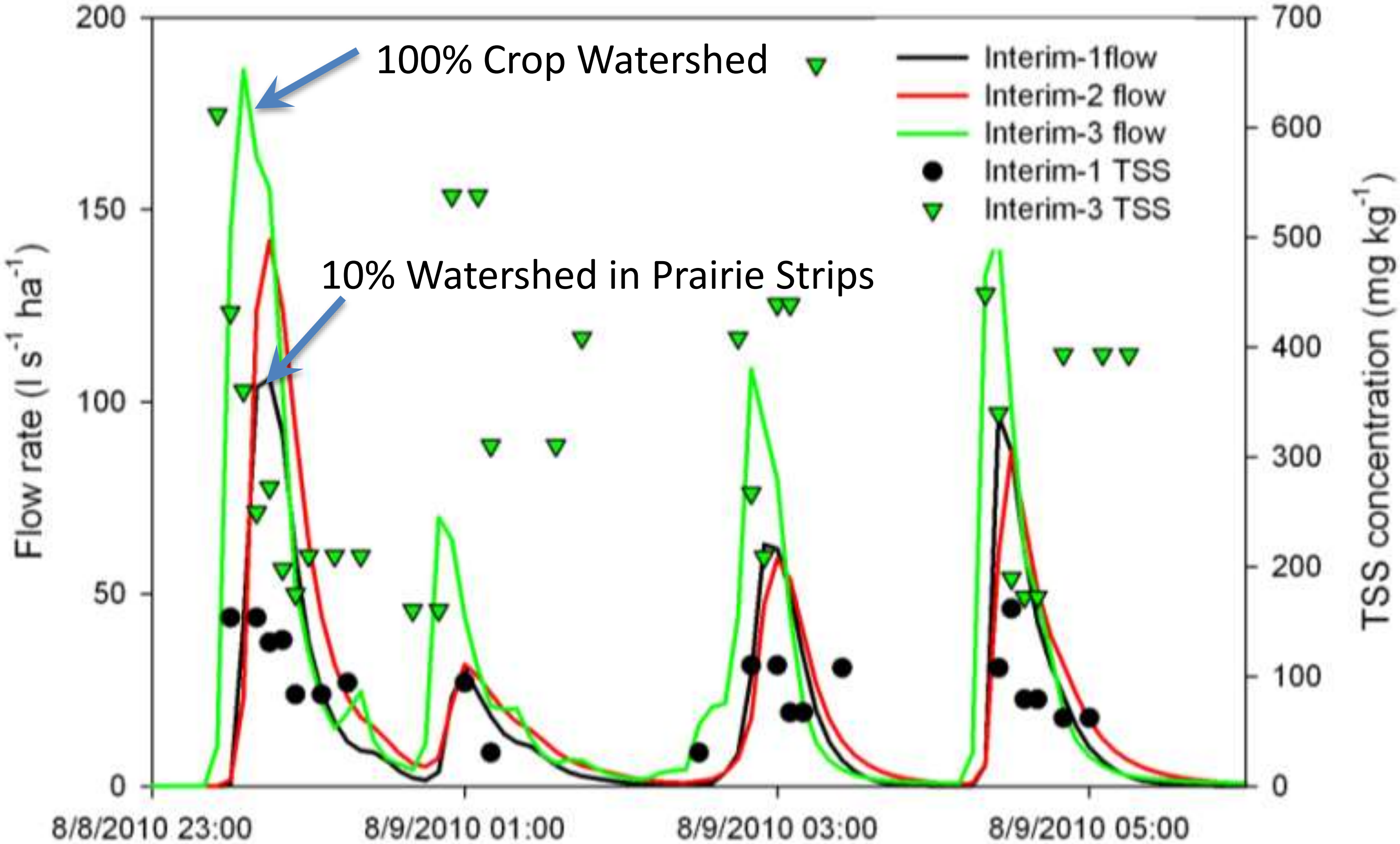
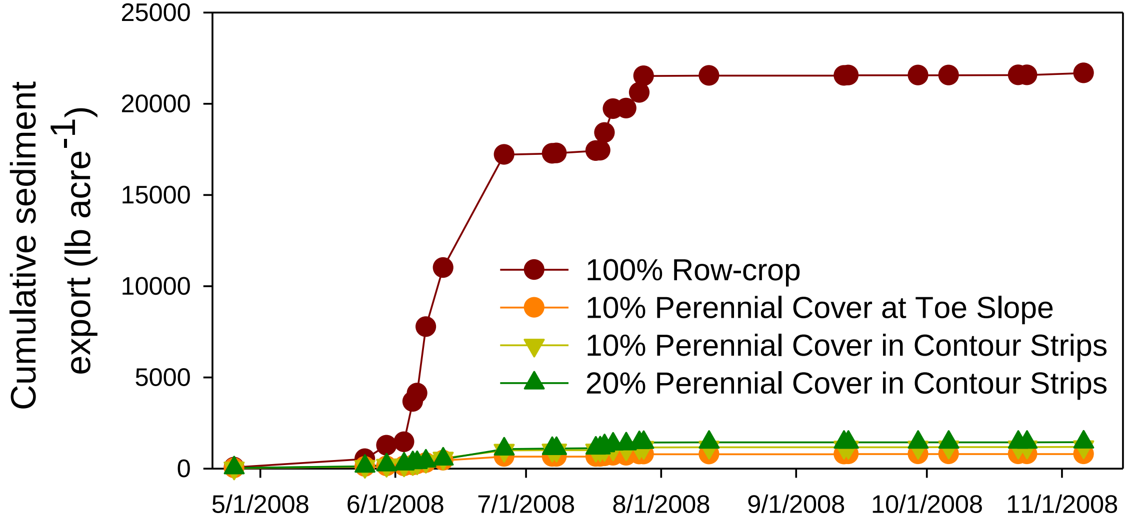
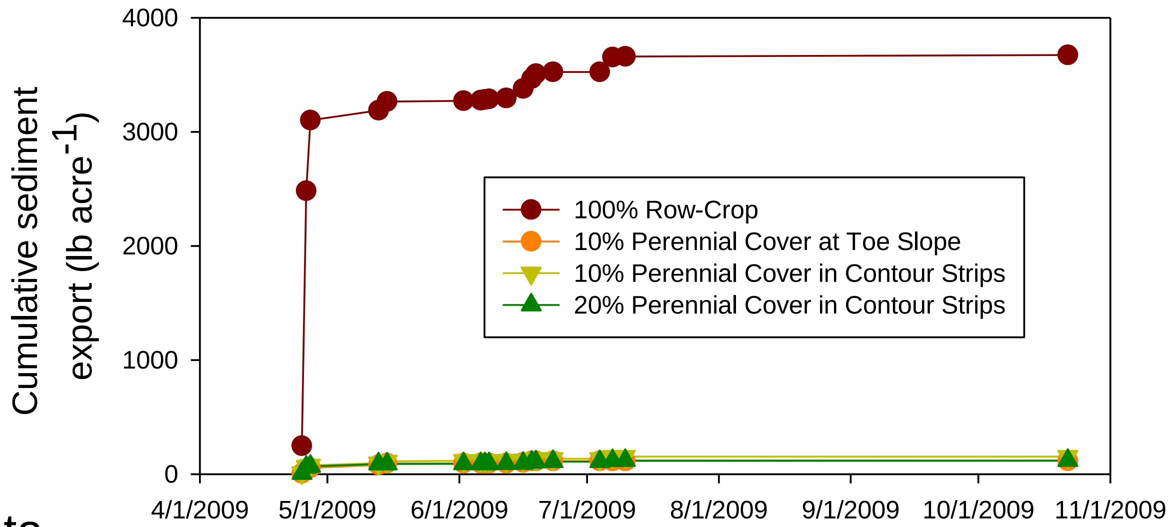


Helmers et al., unpublished data

Sediment Loss in 2008 and 2009

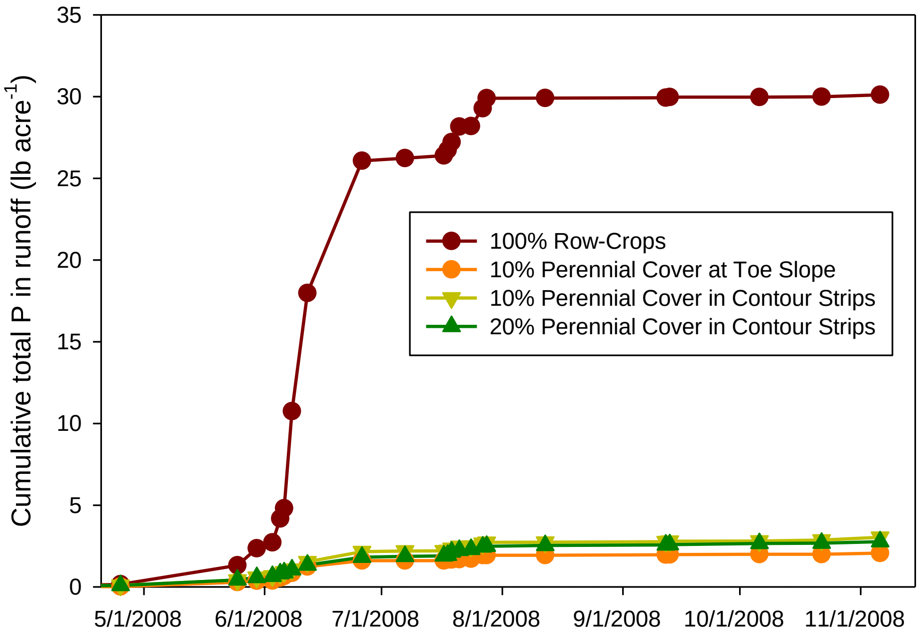


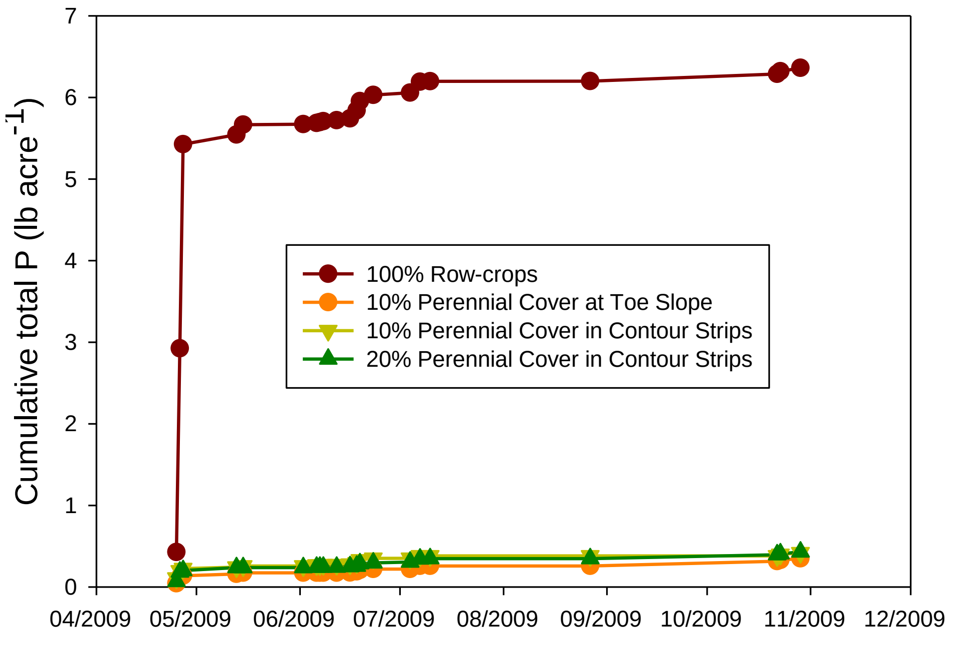
Sediment loss 20 times greater in watersheds with 100% cropland compared to those with perennial strips



Helmers et al., unpublished data

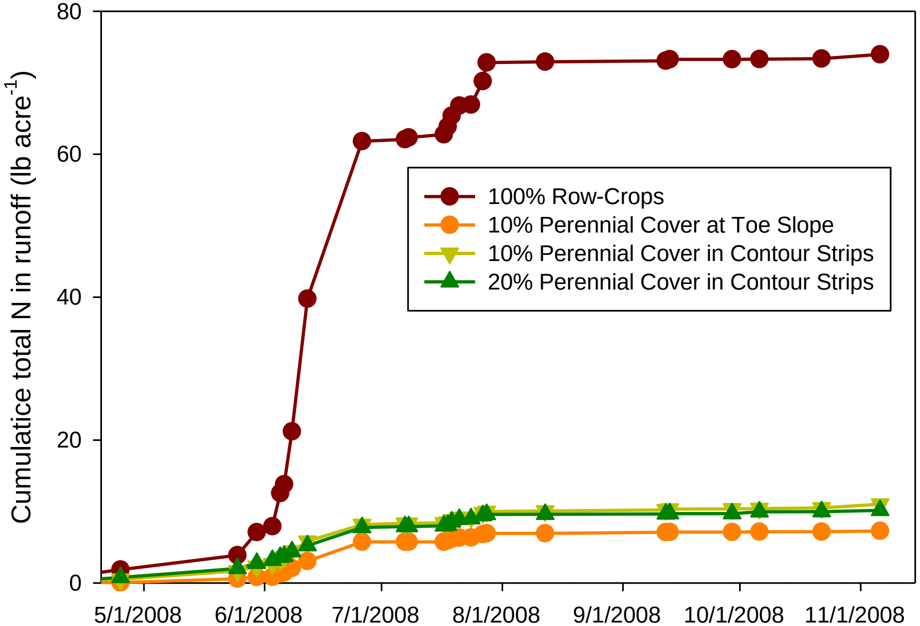
Phosphorus Loss in Runoff in 2008 and 2009



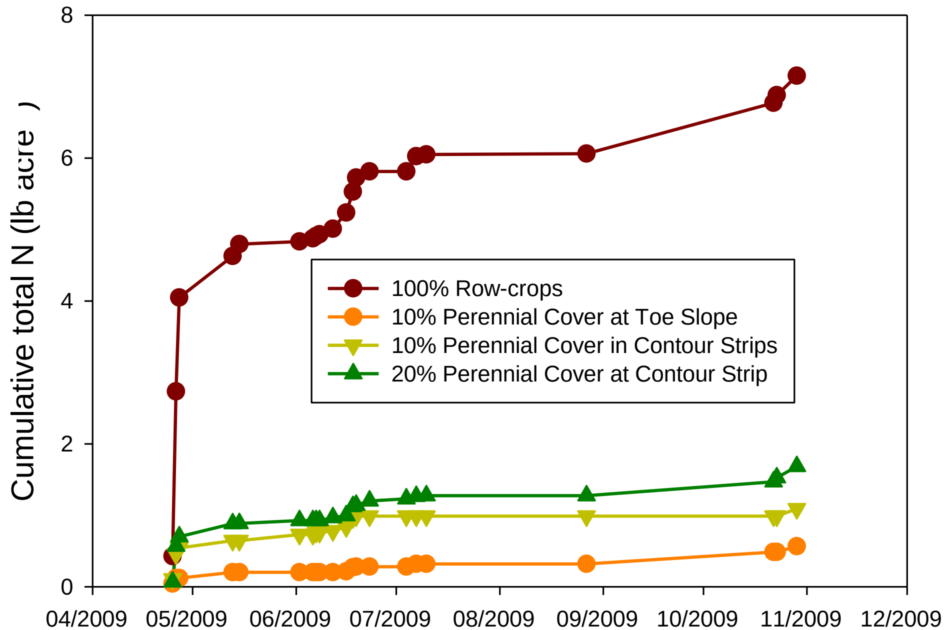


Phosphorous loss 8.5 times greater in watersheds with 100% cropland compared to those with perennial strips

Nitrogen Loss in Runoff in 2008 and 2009



Nitrogen loss 8.5 times greater in watersheds with 100% cropland compared to those with perennial strips



Visual Examples (4 inch rain in June 2008)

100% Crop

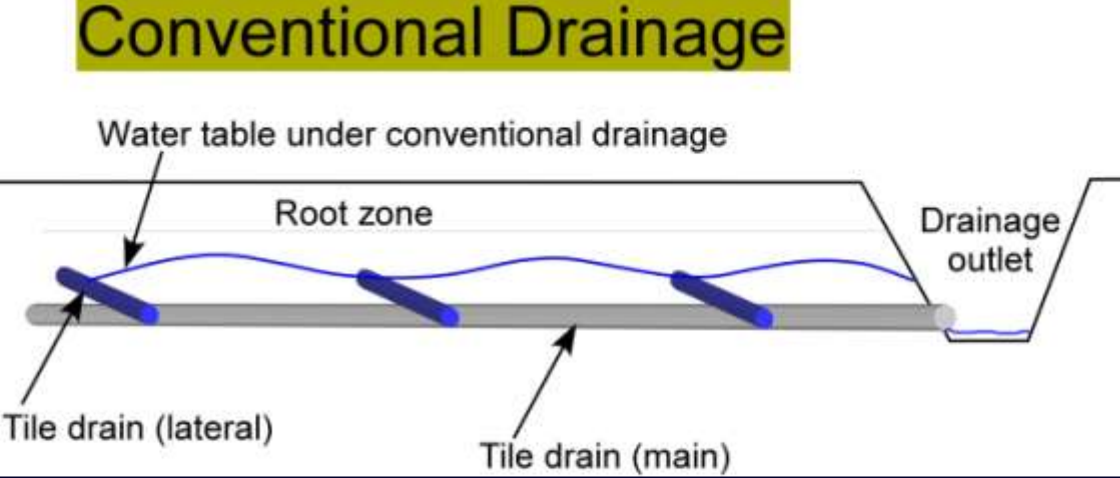
10% Perennial
90% Crop

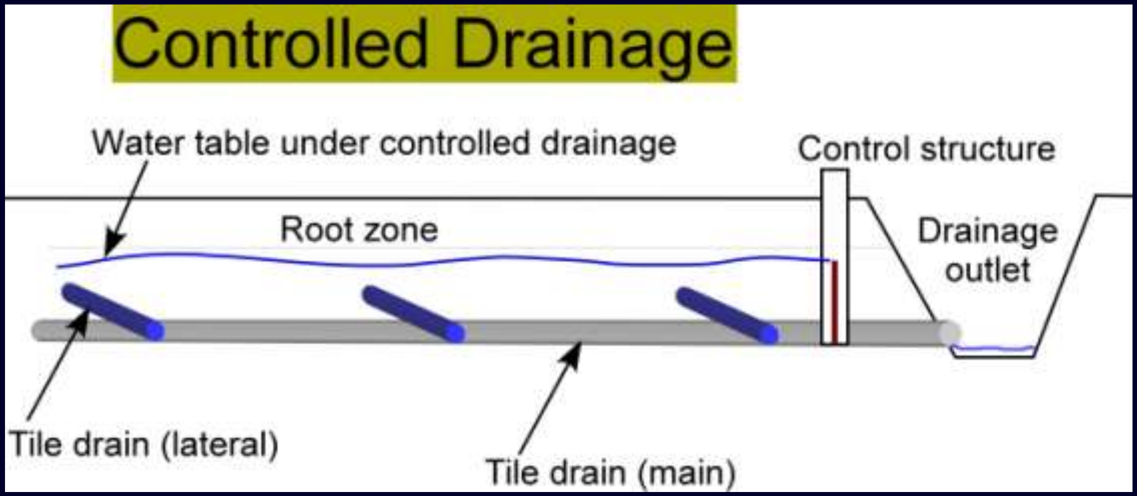
100% Perennial

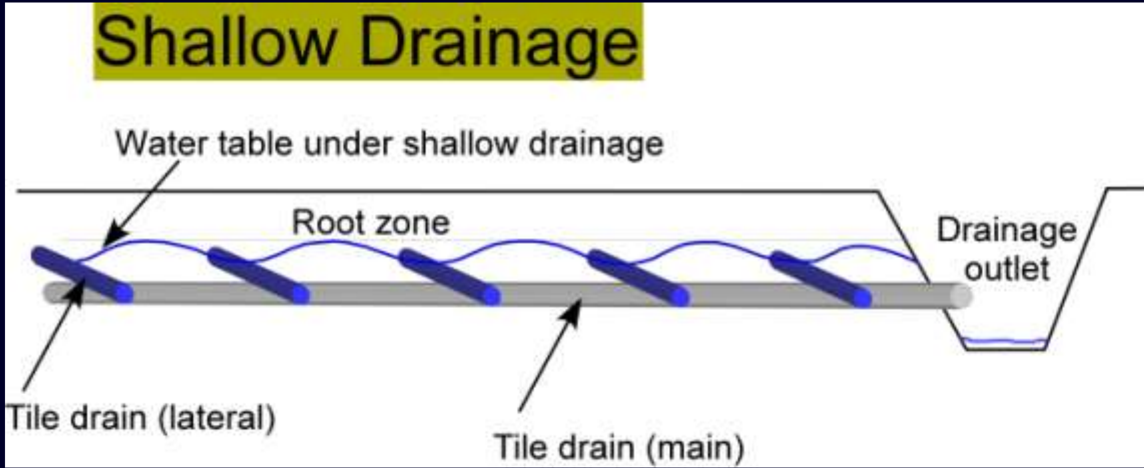
Perennial vegetation can be placed into annual cropland to provide conservation benefits that are disproportionately greater than the land area occupied.

Drainage Design

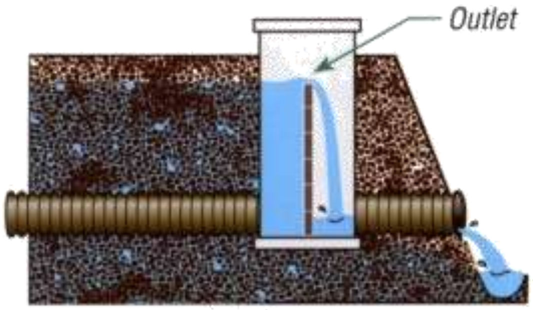
Drainage Design and Management



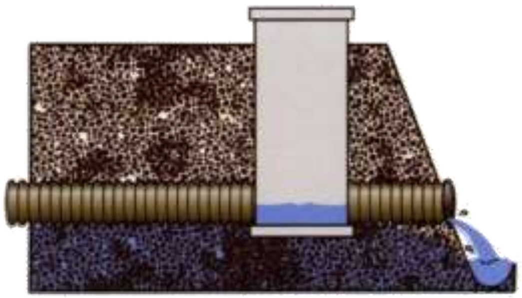




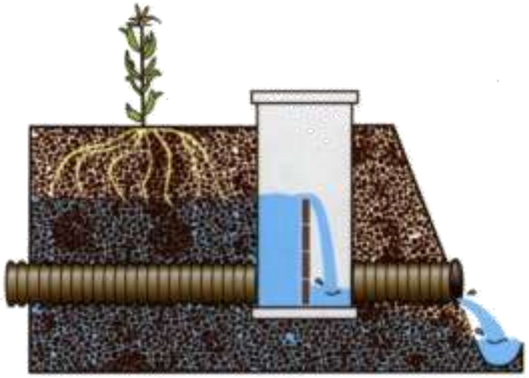
Drainage Water Management (DWM)



The outlet is raised after harvest to reduce nitrate delivery during winter.

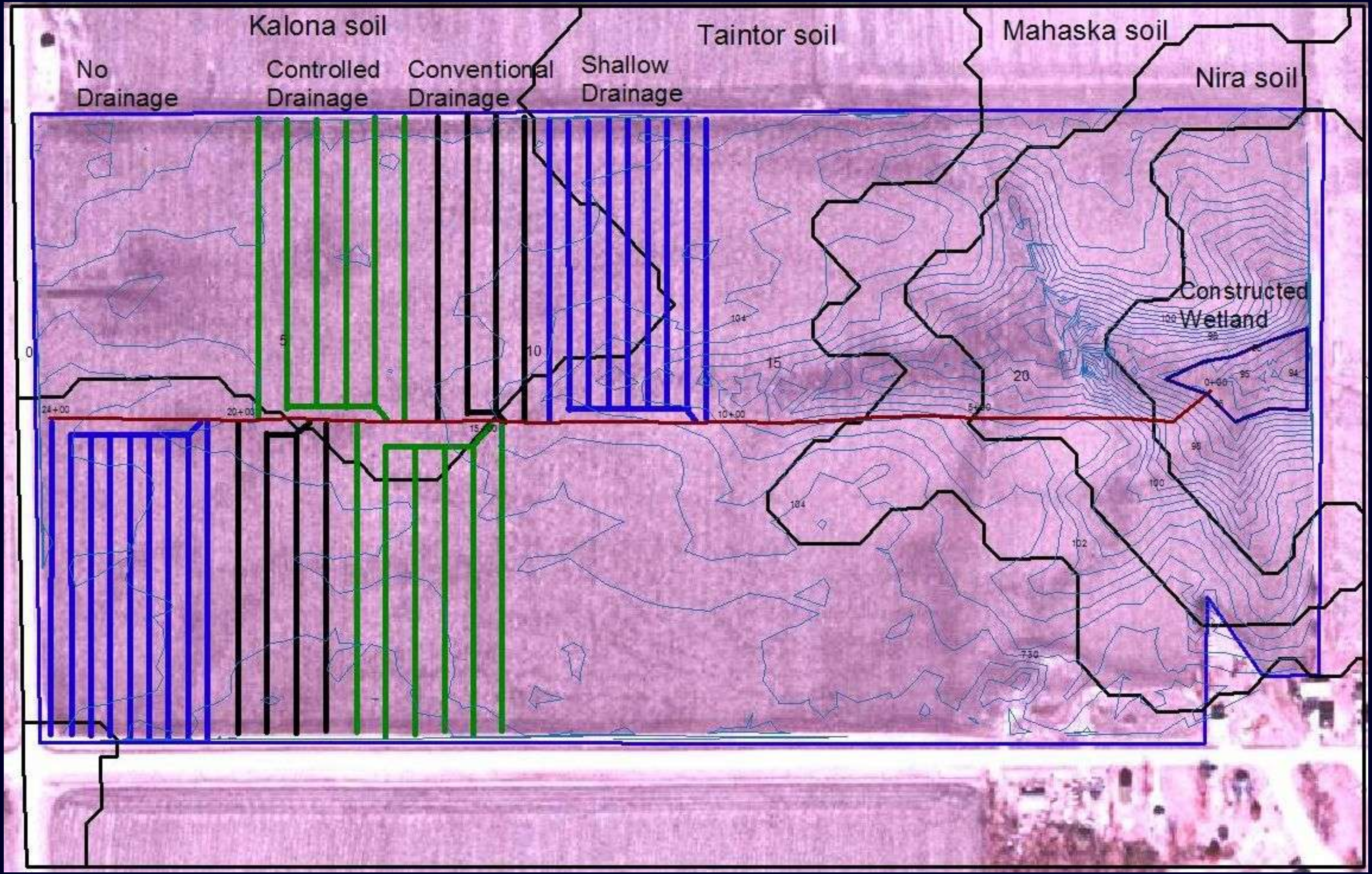


The outlet is lowered a few weeks before planting and harvest to allow the field to drain more fully.



The outlet is raised after planting to potentially store water for crops.

Crawfordsville



Treatments

- Conventional drainage – 4 ft. tile depth with 60 ft. spacing
- Shallow drainage – 2.5 ft. tile depth with 40 ft. spacing
- Drainage water management – 4 ft. tile depth with 60 ft. spacing
- Undrained

Annual Drainage

	Drainage (in)			
Treatment	2007	2008	2009	3-Yr Avg.
Conventional	10.12a	12.1a	15.0a	12.4a
Drainage Water Management	7.05a	9.13ab	9.72a	8.66b
Shallow	7.16a	5.63b	9.13a	7.28b
% Reduction Conv vs. DWM	30	24	35	30
% Reduction Conv vs. Shallow	29	53	39	41

Means within years or for the 3-yr average with a different letter are significantly different (p=0.05).

Summary

- Reduced tillage systems were effective in reducing soil loss by nearly 90% in highly erodible areas
- When cost of eroded soil was included the conservation practices had an economic benefit
- Site-specific buffer design may maximize or increase performance relative to surface runoff protection
- Drainage design should consider conservation drainage principles.

Conservation Station

IOWA
Learning Farms

2010

50 events
4000+ attendees
9848 miles on the road

Conservation Station

Rainfall Simulator

Conservation Station
Learning Lab

- Interactive, multimedia learning center
- Discussion/dialogue led by ILF personnel
- Completely interchangeable educational modules

Discussion

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