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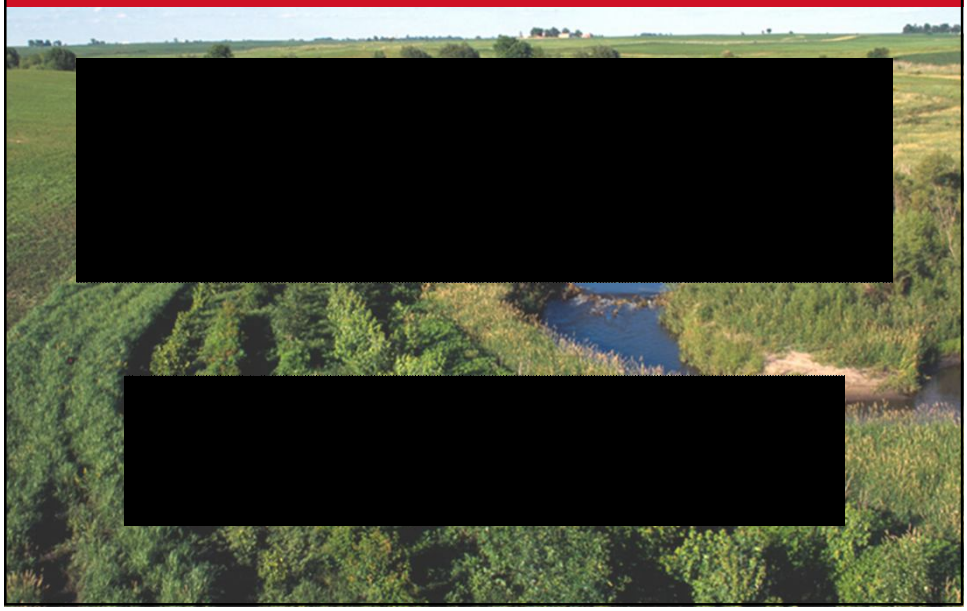
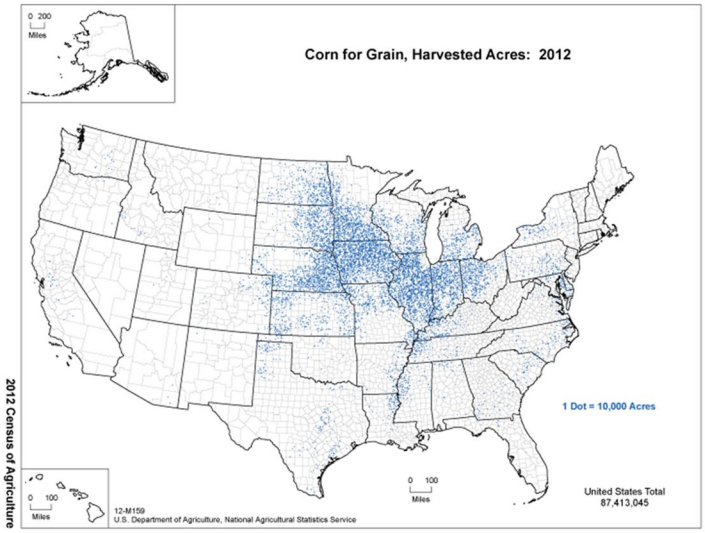
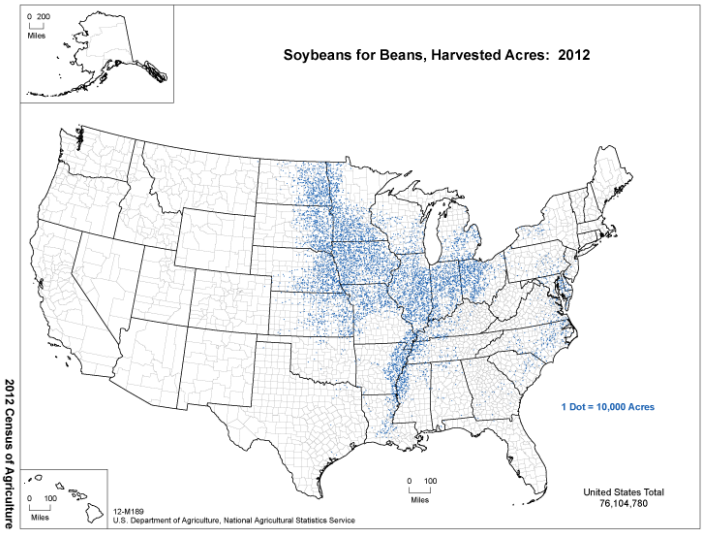
Iowa Nutrient Research Center



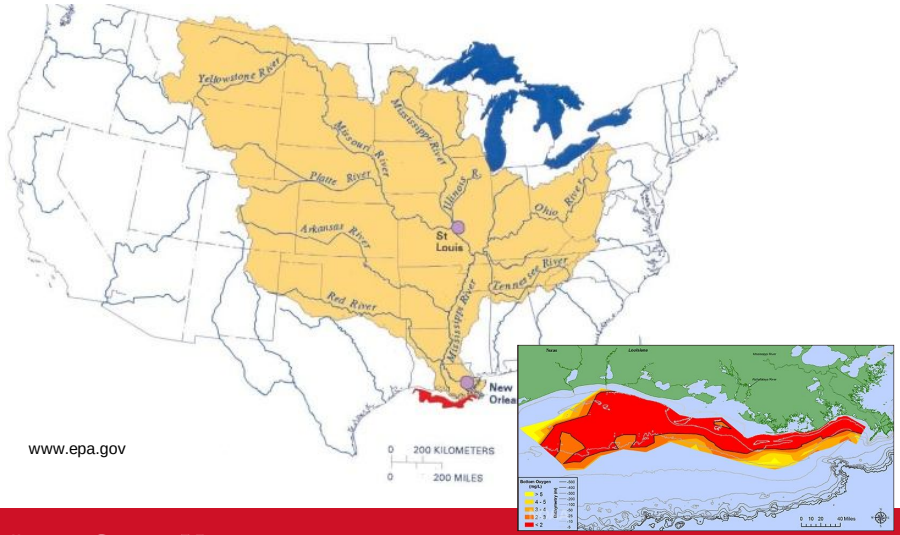
Scale of Agriculture



Scale of Agriculture



Why Does Nutrient Loss Matter?

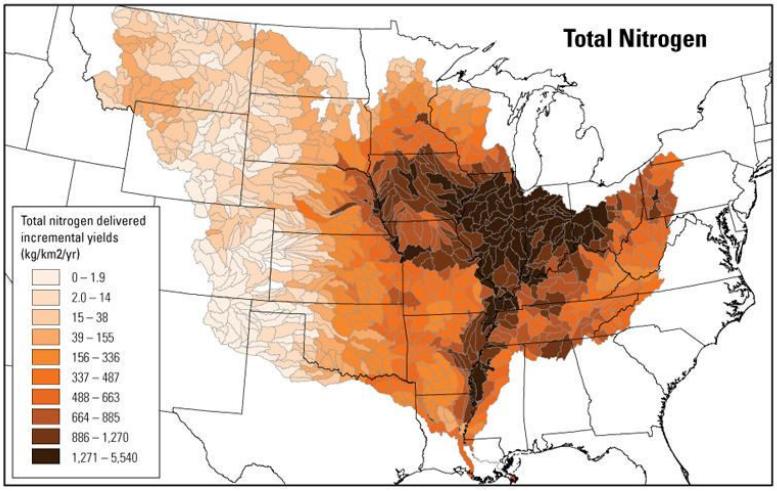


www.epa.gov

Nutrient Loss – Why is this a Problem?

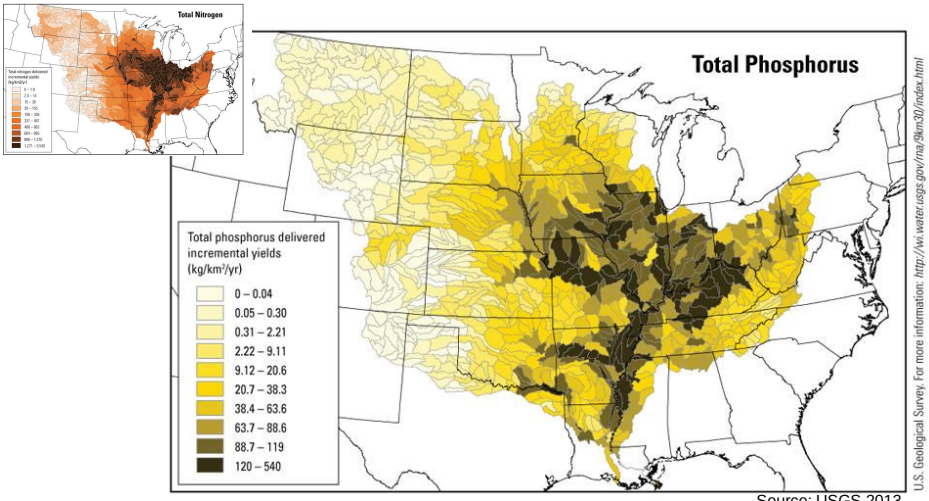
- Local drinking water – high nitrate-N levels
- Harmful algae blooms
- Gulf of Mexico Hypoxia
- Local waterbody impairments

Nitrogen Contributions from Midwest



Source: USGS 2013

Phosphorus Contributions from Midwest



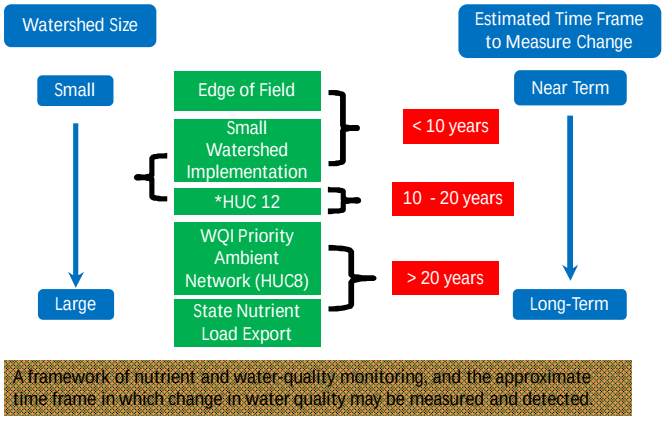
Source: USGS 2013

State Level Nutrient Reduction Strategies

- Mississippi River/Gulf of Mexico Watershed Nutrient Task Force
  - 2008 Gulf Hypoxia Action Plan
- 12 states
  - Developed and is implementing own strategies for nutrient reduction
- Detailed science assessments
  - Agricultural management practices
  - Scale needed to reach reduction goals

The Iowa Nutrient Reduction Strategy

- 45% reduction in total nitrogen and total phosphorus loads.



Source: Iowa Department of Agriculture and Land Stewardship et. el. , 2016

http://www.nutrientstrategy.iastate.edu/

Practice Categories

- 4Rs of nutrient management
  - Source
  - Rate
  - Time
  - Place

- Cover crops
- Pasture/hay
- Extended crop rotations
- Land retirement

- Buffers
- Saturated buffers
- Bioreactors
- Wetlands
- Drainage water recycling
- Sediment basins
- Terraces

Practices – Nutrient Management

- 4Rs of nutrient management
  - Source
  - Rate
  - Time
  - Place

- Opportunities for improved water quality and profitability in some areas with better nutrient management especially in areas with livestock manure

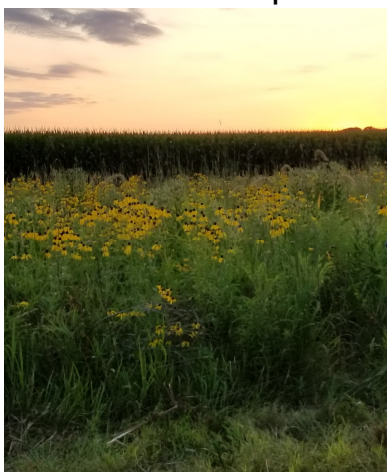
Practices – Land Use

- Cover crops
- Pasture/hay
- Extended crop rotations
- Land retirement
- Terraces

Practices – Land Use

- Cover crops
- Pasture/hay
- Extended crop rotations
- Land retirement
- Terraces

Prairie Strips

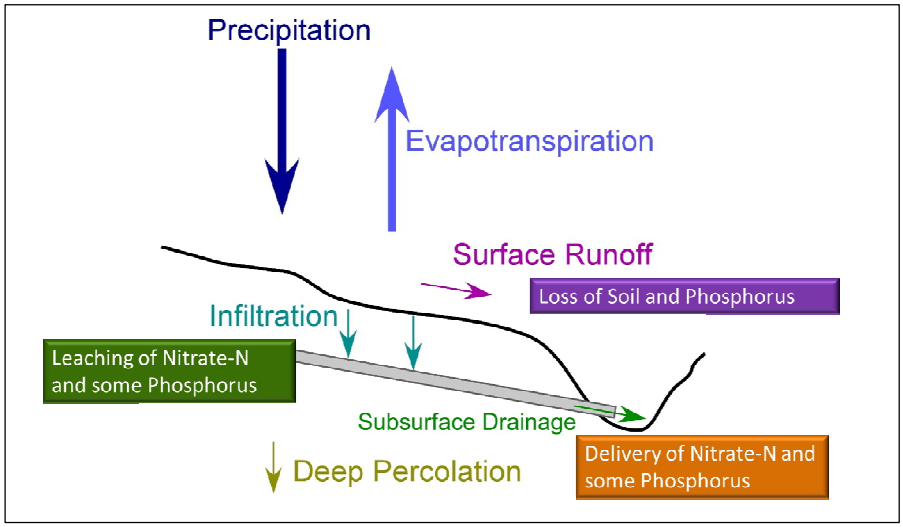


Practices – Edge-of-Field

- Buffers
- Saturated buffers
- Bioreactors
- Wetlands
- Drainage water recycling
- Sediment basins
- Terraces

- Many Edge-of-Field practices focused on nitrate removal
- New and developing technology resulting from call to reduce nutrients in waterways
- Unlike many Edge-of-Field practices, Nutrient Management and Land Use practice implementation began prior to nutrient reduction strategy

Nitrogen and Phosphorus Flow Pathways through Much of Midwest



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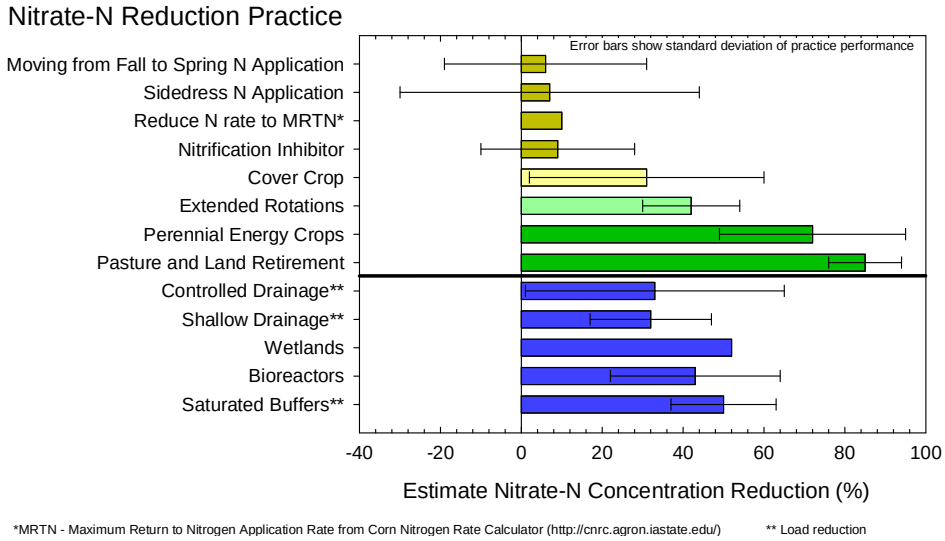
Nitrate-N Practice Performance



*MRTN - Maximum Return to Nitrogen Application Rate from Corn Nitrogen Rate Calculator (http://cnrc.agron.iastate.edu/) ** Load reduction

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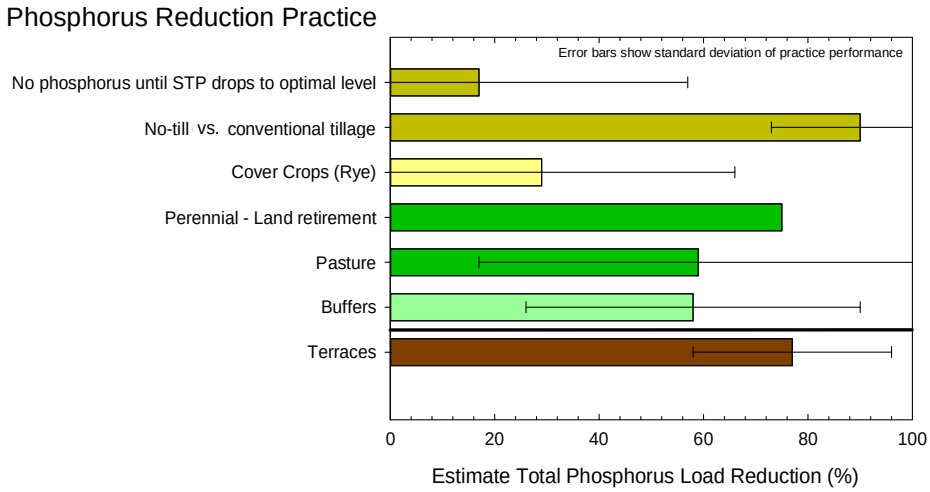
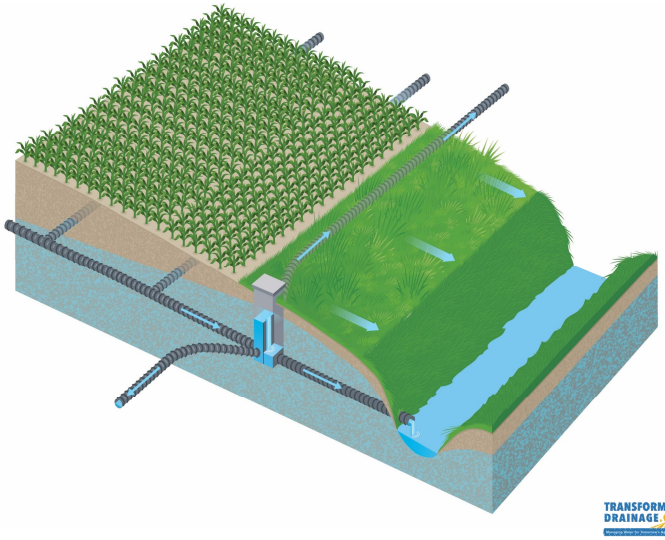
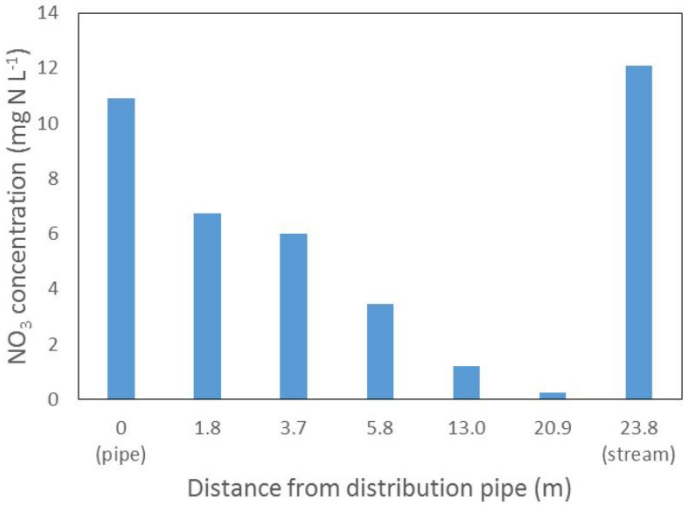
Phosphorus Practice Performance



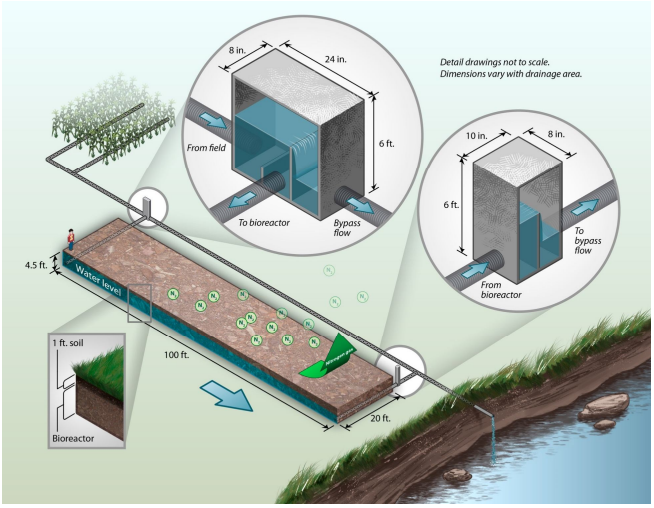
Saturated Buffers



Saturated Buffer Performance – Jaynes and Isenhart, 2019

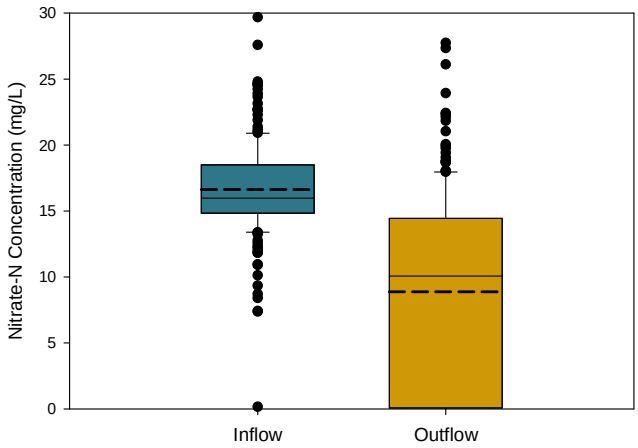


Subsurface Drainage Bioreactor



From Christianson and Helmers, 2011
Illustration by John Petersen (www.petersenart.com)

Example Bioreactor Performance – Nitrate-N



Subsurface Drainage Bioreactor – What about P?

- Steel byproducts have been shown to reduce P levels in effluent
- Mixed-media systems (activated alumina/gravel mixture) have been shown to reduce P levels in effluent
- Still need for research on long-term effectiveness and development of design standards

Nitrate Removal Wetland

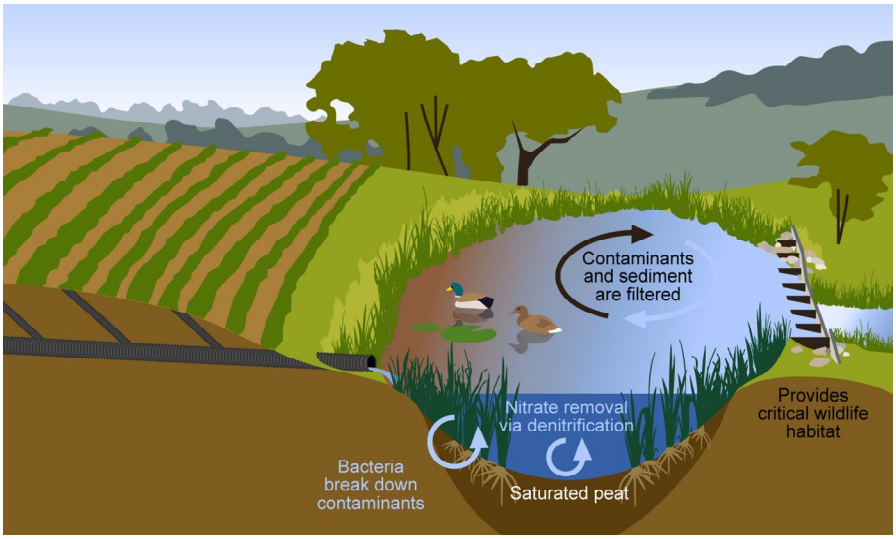
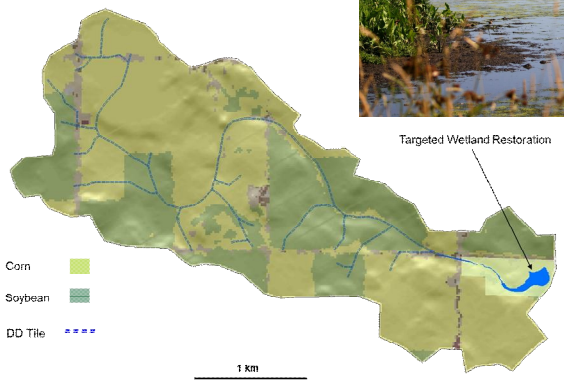


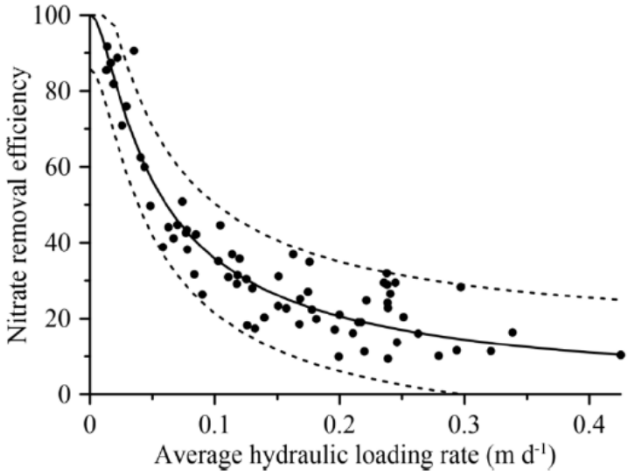
Image source: Iowa Learning Farms

Nitrate Removal Wetland

- There is considerable interest in using wetlands to intercept and reduce nitrogen loads in tile drained landscapes



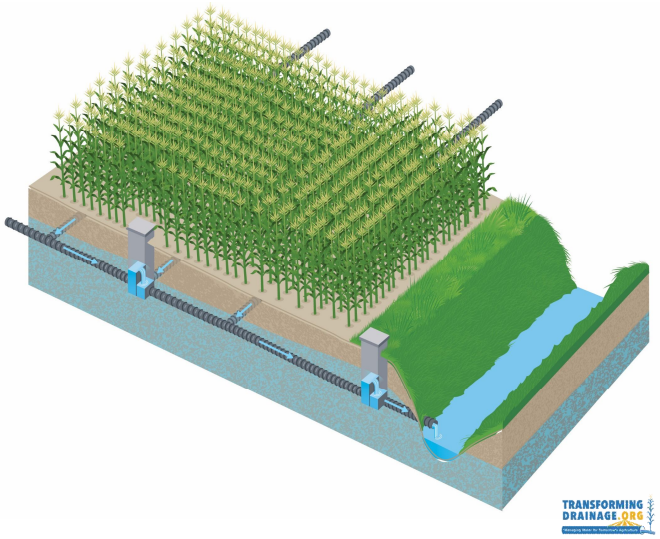
Nitrate Removal Wetland – Performance (Crumpton et al., 2020)



What about wetlands for P?

- Review by Land et al. (2016) in Environmental Evidence indicated Median TP removal was 46%
  - However, this study indicated that restored wetlands on former farmland were significantly less efficient than other wetlands at TP removal

Drainage Water Management



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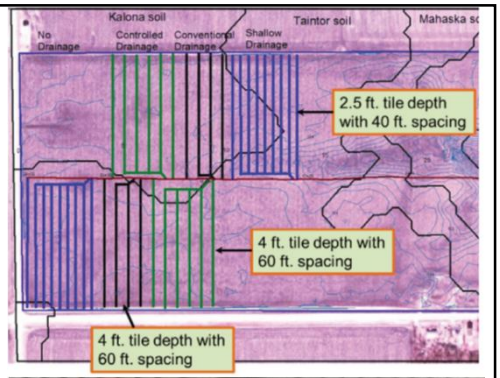
Southeast Research and Demonstration Farm (SERF)

- Shallow drainage has tiles at 2.5 feet depth and 40 foot spacing where as the conventional drainage has tiles at 4 feet depth and 60 foot spacing
- Control boards are set at 2.5 feet below the ground surface and are removed two weeks before planting.
- Grab samples for nitrate-nitrogen (nitrate-N) and total phosphorus (P) analysis are taken weekly when tiles are flowing.



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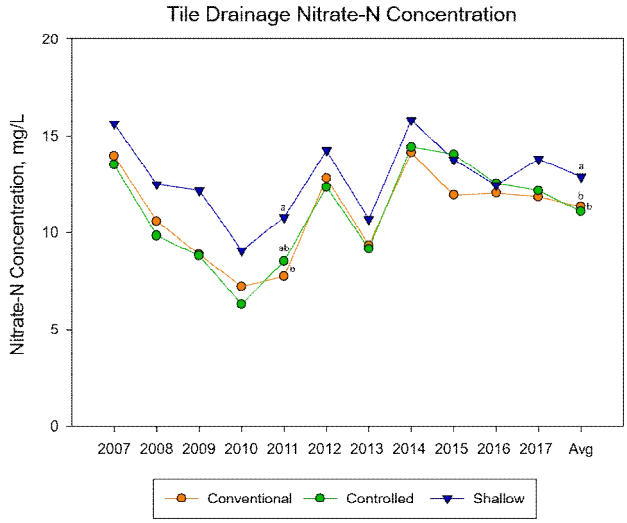
Extension and Outreach

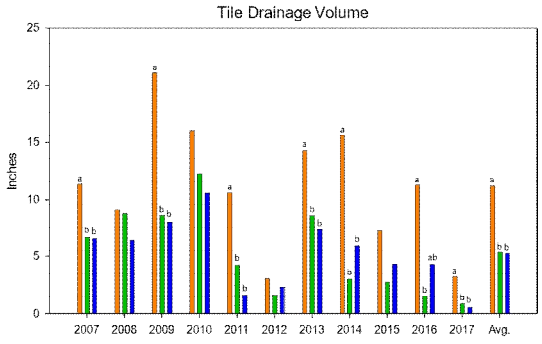


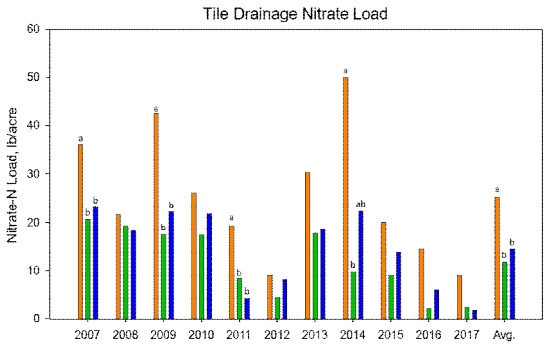
Annual flow-weighted nitrate-N concentrations for three drainage systems

Points with the same letter (or no letters) for the same year are not significantly different at the P=0.05 level.

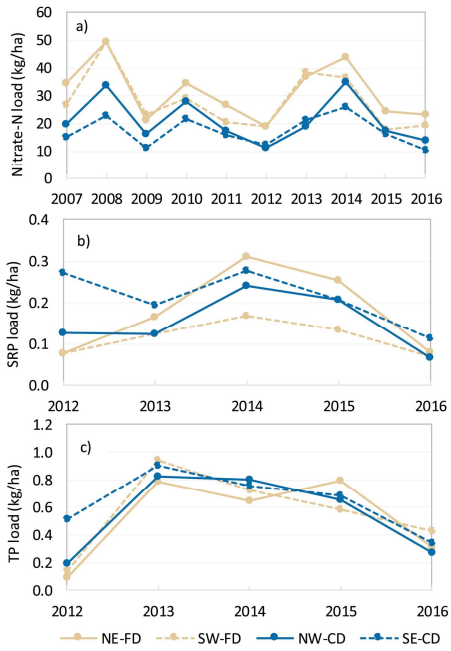
Annual drainage volume and nitrate-N load for three drainage systems

Bars with the same letter (or no letters) for the same year are not significantly different at the P=0.05 level.

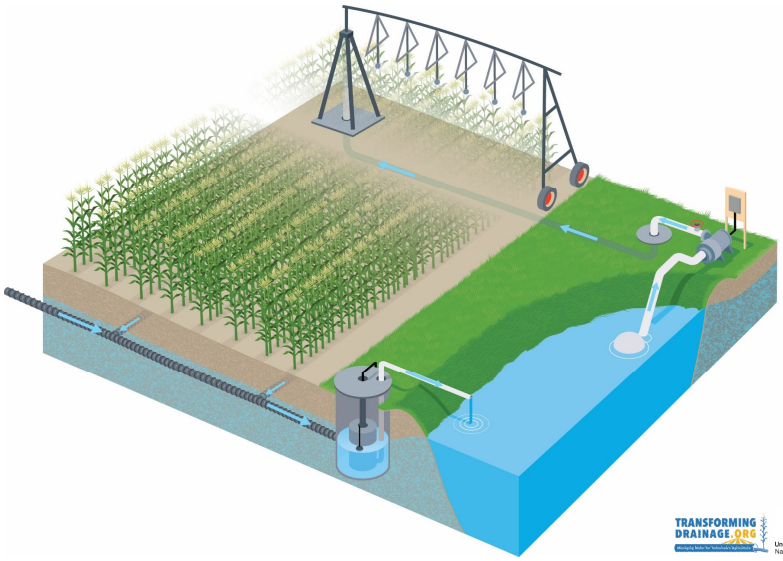




Nitrate and Phosphorus Load – Purdue Study (Saadat et al. 2018)



Drainage Water Recycling



TRANSFORMING DRAINAGE.ORG

USDA United States Department of Agriculture National Institute of Food and Agriculture

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Estimated N and P Reduction – Reinhart et al. 2019

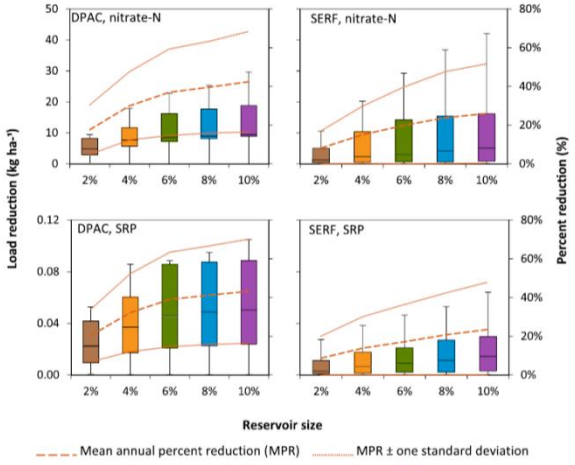


Fig. 12. Variation in the annual nitrate-N (top) and SRP (bottom) load reduction (boxplots) and percent load reduction (lines) at DPAC (left) and SRF (right) between 2007 to 2016 given reservoir sizes of 2%, 4%, 6%, 8%, and 10%.

Science-based Trials of Row-crops Integrated with Prairie Strips

www.prairiestrips.org

- **Watershed-based scientific monitoring**
- **Comparing prairie strip treatments to 100% corn-soy crop control**

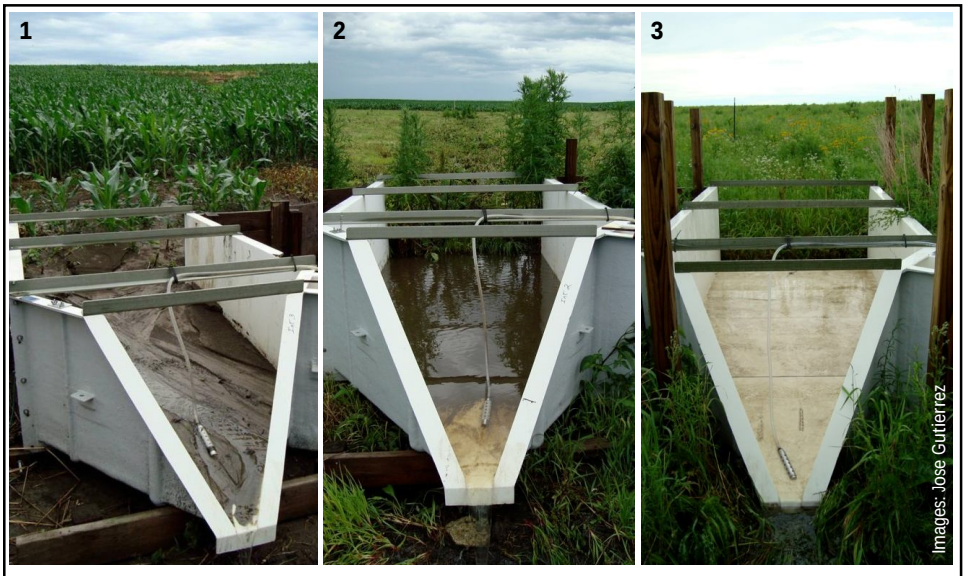
Science-based Trials of Row-crops Integrated with Prairie Strips

www.prairiestrips.org

Strategically adding ~10% prairie to crop fields:

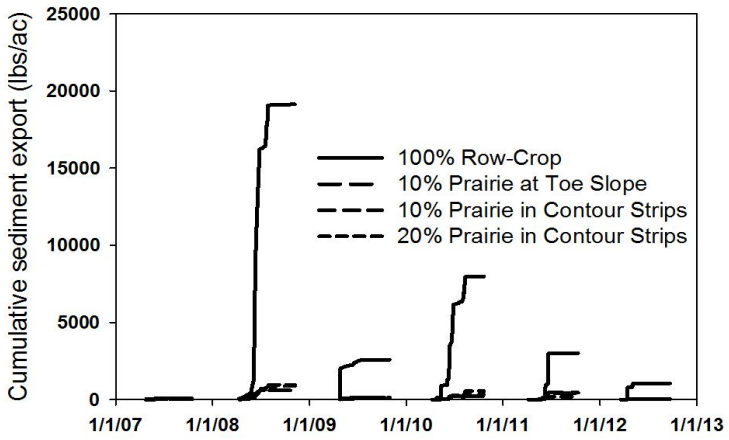
- **44% reduction in water runoff**
- **95% reduction in soil loss**
- **90% reduction in P runoff**
- **84% reduction in N runoff**
- **70% reduction in subsurface NO_3-N concentrations (not tiled)**
- **Potentially improves beneficial insects and wildlife**
- **Doesn't reduce per acre yields**
- **Doesn't create a weed problem**
- **Cheaper than installing terraces; cost comparable to cover crops**

Source: Data collected between 2007-2014 at Neal Smith National Wildlife Refuge



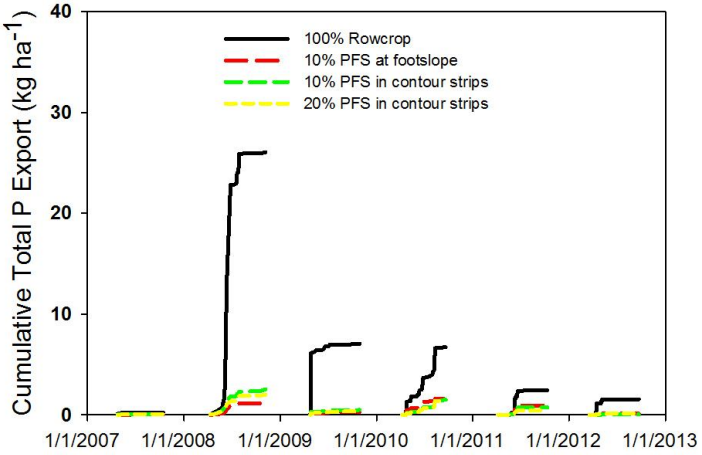
These flumes measure surface water movement and soil, nitrogen and phosphorus export from the STRIPS experiment sites at the Neal Smith National Wildlife Refuge. Compare the transport of these resources from: 1) a 100% no-till, corn crop field, 2) a 90% corn crop field treated with a 10% prairie strip, and 3) a 100% prairie. These pictures were all taken after the same 4" rain event in June, 2008.

Sediment Loss in Runoff (2007-2012)



>95% Reduction in sediment export from watersheds with prairie filter strips

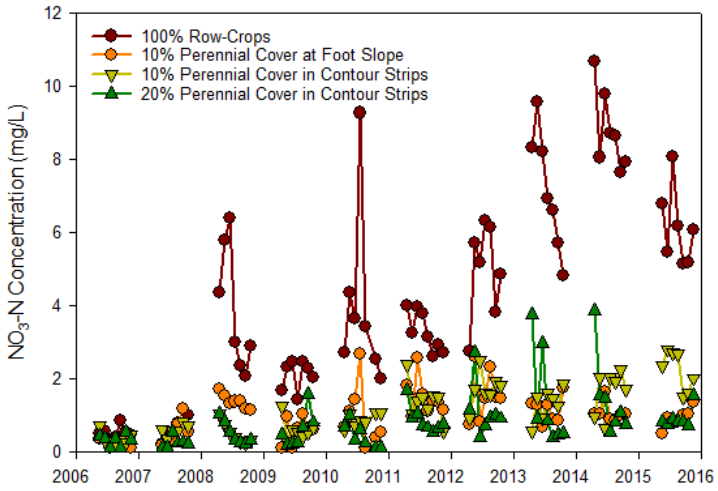
Phosphorus Loss in Runoff (2007-2012)



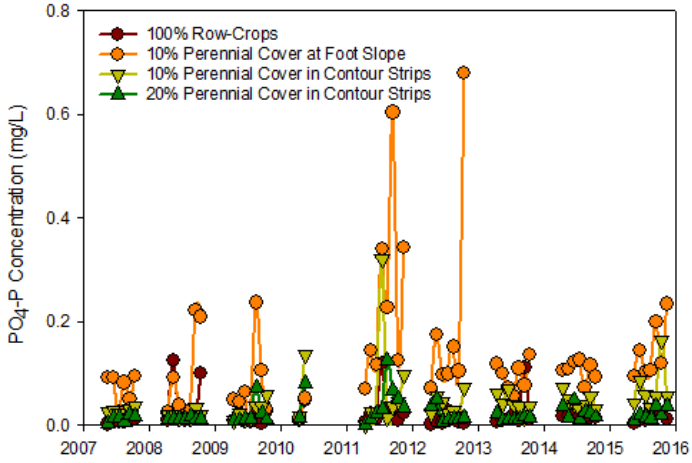
>90% Reduction in TP export from watersheds with prairie filter strips

Zhou et al., 2014

Nitrate-N Concentrations in Groundwater at the Footslope of Each Watershed



Dissolved Phosphorus Concentrations in Groundwater at the Footslope of Each Watershed



Using Practices to Reach Reduction Goals

- No one cure-all
- Multi-practice approach necessary to reach reduction goals

What is the Payoff?

- Improved local water
- Protection of our soil resources
- Employment opportunities to implement these practices
- More diverse landscape

Summary

- Agriculture is a large and an important part of the regional economy
- There are significant and growing concerns related to soil and water resources
- There are approaches to mitigate impacts on these resources – Edge-of-Field practices can be effective but maybe more effective for N loss in tile drained landscapes where significant nutrient loss with drains
- To reach the goals for improvement will take substantial change and there is a need for accelerating adoption
- Local economic benefits in pursuing these water quality goals

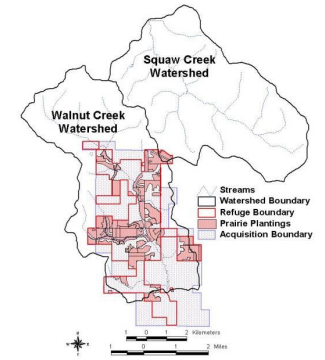
Integrating Prairie Strips with other BMPs for Greater Impact on Water Quality

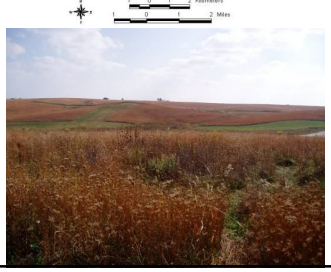
prairiestrips.org

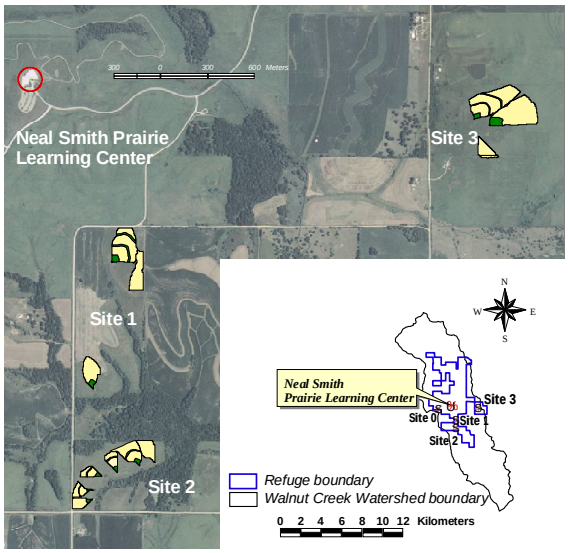
Prairie Strips

- How well do they perform at the field scale relative to water quality?
- Should they be integrated with other practices?

Watershed Experiment: NSNWR





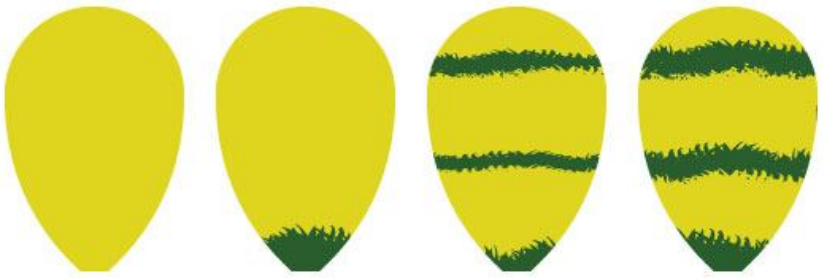


What is unique?

Natural Flow Conditions

Experimental Watershed Treatments

12 watersheds:



0% 10% 10% 20%

corn - soybean row crops, ZERO TILLAGE

reconstructed prairie

Surface Runoff Monitoring

H-flumes monitor movement of water, sediment, and nutrients

What is Happening in Field?

2013 – No-till Since 2007

Opportunity for Grassed Waterway?

What is Happening in Field?

Prairie Strips Reduce Sediment Loss but What about In-field Soil Movement

Depositional Wedge

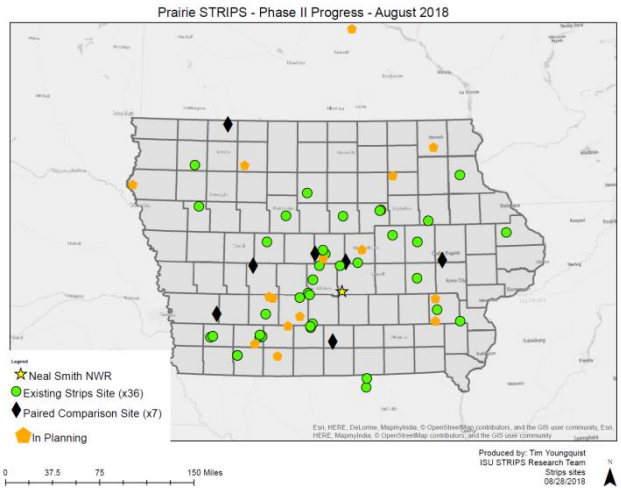
Can this Soil Movement Impact the Prairie Strip?

Can this Soil Movement Impact the Prairie Strip?

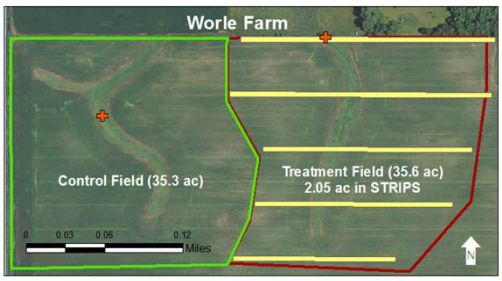
Can this Soil Movement Impact the Prairie Strip?

Phase II

- Started in 2013
- Work with landowners to implement prairie strips
- Farmer liaison that works with farmers and landowners
- Implementing an intensively monitored paired network of sites

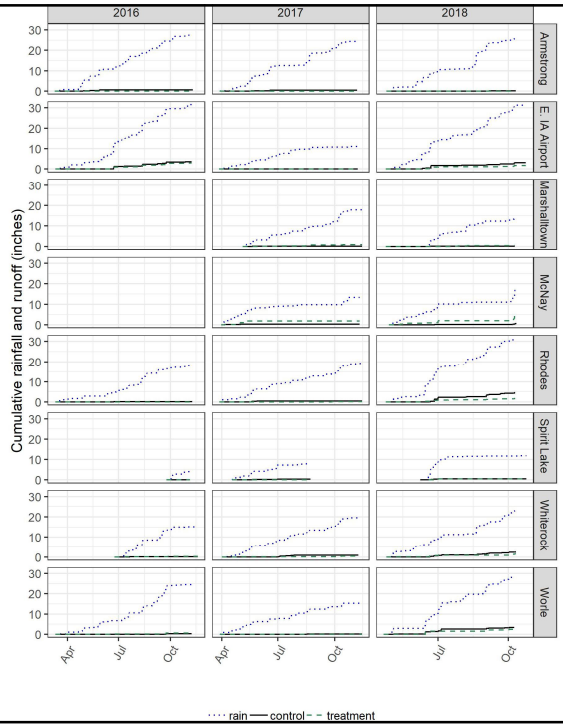


Paired Comparison Sites

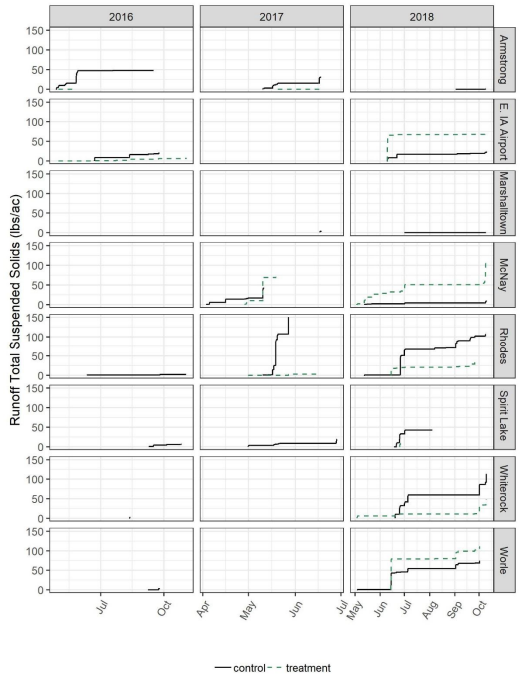


H-flume location

Rainfall and Runoff



Sediment Loss



Benefits of Decreased Loading to Prairie Strips

- Less maintenance
- Less disturbance at upstream edge of prairie strip
- Less chance of short circuiting

Prairie Strips

- How well do they perform at the field scale relative to water quality? Reduce sediment and nutrient loss from the field
- Should they be integrated with other practices? Yes

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