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

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

Annual average soil loss (T ha⁻¹)

- Chisel plow tillage
- No-till

Northwest Iowa
Loess Hills
Des Moines Lobe
Western Deep Loess and Drift
Eastern Deep Loess and Drift
Eastern Till Prairie
Northeast Iowa
Southern Thin Loess and Till Plain
Crop Revenue

- Northwest Iowa
- Loess Hills
- Des Moines Lobe
- Western Deep Loess and Drift
- Eastern Deep Loess and Drift
- Eastern Till Prairie
- Northeast Iowa
- Southern Thin Loess and Till Plain

Crop revenue ($ ha\(^{-1}\) yr\(^{-1}\))

Chisel plow tillage
No-till
Impact of Conservation Practices

Deep Loess Hills (10.8% slope)

Eastern Till Prairie (3.2% slope)
Estimated Net Benefit – compared to chisel till system

Deep Loess Hills (10.8% slope)

Net benefit ($ha^{-1} yr^{-1})

Net benefit ($ha^{-1} yr^{-1})

Eastern Till Prairie (3.2% slope)

Net benefit ($ha^{-1} yr^{-1})
Complete Landuse Change

Grass

No Till

Strip Till

Chisel Till
Buffers

- 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

Buffer Zone

Stream
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

% Sediment Trapping efficiency

Buffer area/field area (buffer area ratio)

Modeled Relationship
Experimental data

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

<table>
<thead>
<tr>
<th>Site</th>
<th>Area (Acre)</th>
<th>Mean Slope (%)</th>
<th>Primary Soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Deep Loess and Drift</td>
<td>88.7</td>
<td>7.1</td>
<td>Sharpsburg silty clay loam</td>
</tr>
<tr>
<td>Eastern Till Prairie</td>
<td>196.6</td>
<td>3.2</td>
<td>Kenyon loam</td>
</tr>
</tbody>
</table>
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.

<table>
<thead>
<tr>
<th>Subarea</th>
<th>Area (acre)</th>
<th>Sediment yield (ton/acre)</th>
<th>Surface runoff (inch)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>6.7</td>
<td>5.0</td>
<td>2.5</td>
</tr>
<tr>
<td>H2</td>
<td>1.6</td>
<td>5.8</td>
<td>2.4</td>
</tr>
<tr>
<td>H3</td>
<td>3.8</td>
<td>6.3</td>
<td>2.3</td>
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<td>H4</td>
<td>3.8</td>
<td>5.8</td>
<td>2.2</td>
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<tr>
<td>H5</td>
<td>3.6</td>
<td>3.5</td>
<td>2.4</td>
</tr>
<tr>
<td>H6</td>
<td>14.0</td>
<td>4.3</td>
<td>2.4</td>
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<tr>
<td>H7</td>
<td>9.5</td>
<td>1.3</td>
<td>2.4</td>
</tr>
<tr>
<td>H8</td>
<td>18.2</td>
<td>8.4</td>
<td>2.4</td>
</tr>
<tr>
<td>H9</td>
<td>8.2</td>
<td>6.6</td>
<td>2.2</td>
</tr>
<tr>
<td>H10</td>
<td>7.0</td>
<td>7.4</td>
<td>2.4</td>
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<tr>
<td>H11</td>
<td>13.4</td>
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<td>H12</td>
<td>0.6</td>
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<td>H13</td>
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<td>4.8</td>
<td>2.4</td>
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<td>H14</td>
<td>13.5</td>
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<td>H15</td>
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<td>H16</td>
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<td>H17</td>
<td>14.3</td>
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<td>H18</td>
<td>39.6</td>
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<td>2.4</td>
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<td>H20</td>
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<td>2.4</td>
</tr>
<tr>
<td>H21</td>
<td>3.5</td>
<td>2.6</td>
<td>2.1</td>
</tr>
</tbody>
</table>
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.

![Graph showing sediment yield of 10-year return period storm (ton/acre) for different buffer scenarios.](image)
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.
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
12 watersheds:
Random Incomplete Block Design:
3 reps X 4 treatments X 3 blocks

0% 10% 10% 20%

= corn - soybean row crops
= reconstructed prairie
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

Neal Smith Prairie Learning Center

Site 1
Site 2
Site 3

#S
#S#S
#S

Site 0

%U

Walnut Creek Watershed boundary
Refuge boundary
Example Runoff Hydrographs

Helmers et al., unpublished data
Example Runoff Hydrographs

Helmers et al., unpublished data
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 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

**Conventional Drainage**
- Water table under conventional drainage
- Root zone
- Drainage outlet
- Tile drain (lateral)
- Tile drain (main)

**Controlled Drainage**
- Water table under controlled drainage
- Root zone
- Control structure
- Drainage outlet
- Tile drain (lateral)
- Tile drain (main)

**Shallow Drainage**
- Water table under shallow drainage
- Root zone
- Drainage outlet
- Tile drain (lateral)
- Tile drain (main)
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

<table>
<thead>
<tr>
<th>Treatment</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>3-Yr Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional</td>
<td>10.12a</td>
<td>12.1a</td>
<td>15.0a</td>
<td>12.4a</td>
</tr>
<tr>
<td>Drainage Water Management</td>
<td>7.05a</td>
<td>9.13ab</td>
<td>9.72a</td>
<td>8.66b</td>
</tr>
<tr>
<td>Shallow</td>
<td>7.16a</td>
<td>5.63b</td>
<td>9.13a</td>
<td>7.28b</td>
</tr>
<tr>
<td>% Reduction Conv vs. DWM</td>
<td>30</td>
<td>24</td>
<td>35</td>
<td>30</td>
</tr>
<tr>
<td>% Reduction Conv vs. Shallow</td>
<td>29</td>
<td>53</td>
<td>39</td>
<td>41</td>
</tr>
</tbody>
</table>

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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