Integration of Perennials in Rowcrop Agriculture for Enhancing Water Quality in Central Iowa

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Introduction:

Perennial grassland have beneficial effects on maintaining ecosystem processes and functions that enhance ecosystem services. Many croplands planted to perennial grasses under the Conservation Reserve Program are being returned to crop production, and with potential consequences for water quality. Among the most prominent and promising strategies to mitigate negative effects of rowcrop production on water quality is the incorporation of relatively small amounts of perennial cover in strategic locations within agricultural landscapes. The objective of this study was to quantify the impact of perennial filter strips (PFS), specifically diverse native prairie, on surface runoff, sediment loss, and nutrient export in row-cropped agricultural land in Central Iowa (Figure 1).

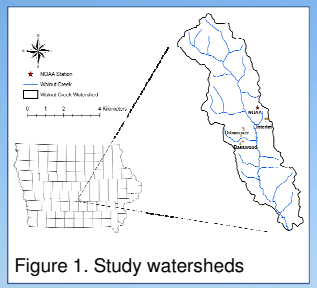

Figure 1. Study watersheds

Watershed treatments:

The study is being conducted at the Neal Smith National Wildlife Refuge, located in the Walnut Creek watershed in Jasper County, Iowa (Figure 1). A balanced incomplete block design was implemented with 12 small watersheds distributed across four blocks. Each watershed received one of 4 treatments (3 replicates per treatment): 100% rowcrop, 10% PFS at the toeslope position, 10% PFS distributed at the toeslope position and in contour strips further up in the watershed, and 20% PFS distributed at the toeslope position and in contour strips (Table 1). Prior to treatment, all the watersheds were in bromegrass for at least 10 years without fertilizer application. Starting in spring 2007, a two-year no-till corn-soybean rotation was implemented in areas receiving the rowcrop treatment. Areas receiving PFS treatment were seeded with a diverse mixture of native prairie forbs and grasses on July 7, 2007. No fertilizer was applied in the PFS areas.

Table 1. Watershed description and experimental design

	Size (ha)	Slope (%)	Location and percentage of grass filters
Basswood-1	0.53	7.5	10% at toeslope
Basswood-2	0.48	6.6	5% at toeslope and 5% at upslope
Basswood-3	0.47	6.4	10% at toeslope and 10% upslope
Basswood-4	0.55	8.2	10% at toeslope and 10% upslope
Basswood-5	1.24	8.9	5% at toeslope and 5% upslope
Basswood-6	0.84	10.5	All rowcrops
Interim-1	3.00	7.7	3.3% at toeslope, 3.3% at sideslope, and 3.3% at upslope
Interim-2	3.19	6.1	10% at toeslope
Interim-3	0.73	9.3	All rowcrops
Orbweaver-1	1.18	10.3	10% at toeslope
Orbweaver-2	2.40	6.7	6.7% at toeslope, 6.7% at sideslope, and 6.7% at upslope
Orbweaver-3	1.24	6.6	All rowcrops

Field monitoring:

Surface runoff was monitored using an H-flume at the outlet of each watershed during the growing season in 2008–2010 (Figure 2). Water samples were collected using an ISCO flow sampler in each watershed for determining total suspended solid, total nitrogen, and total phosphorus concentrations in samples.

Figure 2. Surface flow monitoring

Results:

- Incorporation of PFS in corn-soybean fields greatly reduced overall amounts of runoff in the watersheds, and were most effective for small and medium storms (Figure 3). The watersheds having10% perennial cover at toe slope had the lowest runoff among the perennial treatments.

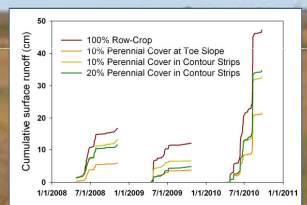

Figure 3. Surface runoff

- Most of the soil loss occurred during a few large storms each year. Perennial strips planted among corn-soybean fields, regardless of the size and position of the strips, reduced the sediment yield exported out of the fields by >90% when compared to 100% row-crop watersheds (Figure 4). A visual example of sediment export after a large storm in 2008 is shown below.

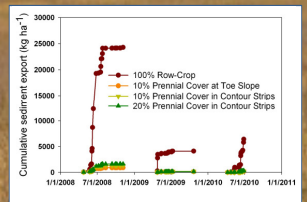

Figure 4. Sediment export

100% Crop | Crop with PFS | 100% Prairie

- The total nitrogen and phosphorus concentrations in surface runoff as well as the total nutrient export were also significantly reduced by the incorporation of PFS (Figures 5 and 6). The different size and positions of PFS had a similar effect on nutrient reduction. Similar to sediment export, most of the nutrient loss occurred during a small number of large storms. In 2009, a year with normal precipitation, only a small amount of nutrients were transported out of the fields receiving PFS treatment.

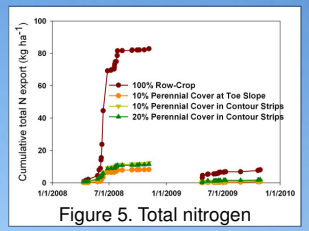

Figure 5. Total nitrogen

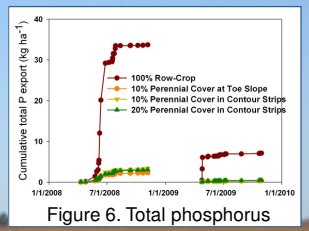

Figure 6. Total phosphorus

Conclusion:

- In general, placing some perennial vegetation among corn-soybean fields is beneficial in mitigating agricultural impacts on water quality with less runoff and lower sediment and nutrient export.

- Most of contaminants were transported out of the field with runoff after large storms and perennial strips were effective in reducing the contaminant export.

- While placing some perennials at toe slope is most effective in reducing runoff, the size and various positions of PFS investigated in this study had a similar effect on contaminant reduction.

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