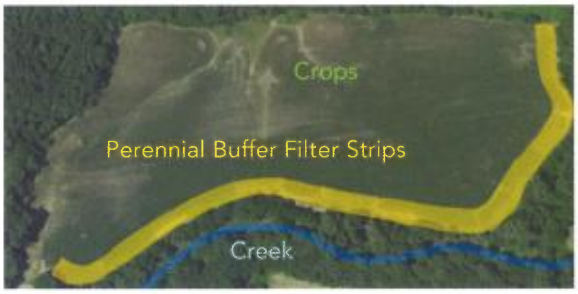
Multifunctional Perennial Filter Strips

An effective way to reduce nutrient loss

This field management guide demonstrates the potential of a multifunctional perennial mixed grass filter strip for mitigating nutrient leaching and runoff from a row-crop field and provides establishment and management guidelines.

Nutrient loss reduction at the edge-of-field

The Gulf of Mexico Task Force has obligated the development of action plans by the 12 contributing states in the Mississippi River Basin to reduce the loss of nutrients (nitrogen and phosphorous) to the Gulf by 45%. With this, Illinois published the "Illinois Nutrient Loss Reduction Strategy" in 2015 (State of Illinois, 2015). This strategy identified priority watersheds for nutrient loss reduction efforts and outlined the alternative scenarios necessary to achieve the target reduction from both point and nonpoint (agricultural) sources. The agricultural practices include nutrient management, cover crops, reduced tillage, and edge-of-field practices. Perennial based filter strips installed at the edge of fields (see figure) are highly effective at reducing nutrient losses. Also, a perennial grass-based (bioenergy and/or forage crops) filter strip can be designed for multifunctionality to offer opportunities to bridge crop production (alternative revenue generation) and ecosystem services (reducing greenhouse gas emission and improving soil carbon sequestration and biodiversity) in agricultural watersheds.



A 3-year study of a filter strip established with perennial warm-season grasses and cool-season forage mixtures at MWRD's Fulton County Site (IL).

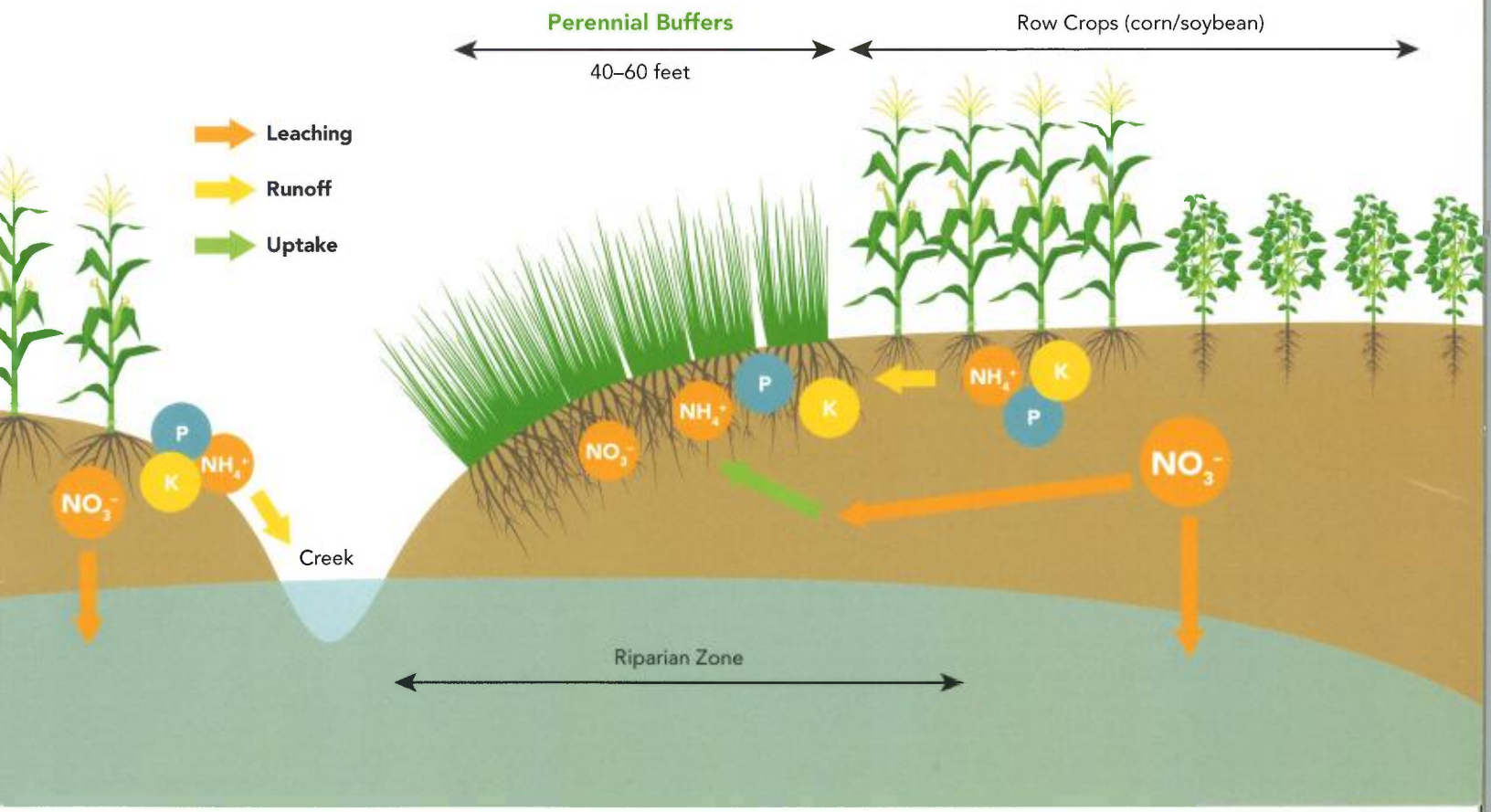
Perennial Buffers

Bioenergy crops

- Switchgrass
- Big bluestem
- Indiangrass
- Prairie cordgrass

Forage crops

- Alfalfa
- Smooth bromegrass
- Tall forage fescue
- Orchardgrass
- Perennial ryegrass
- Timothy
- Meadow fescue



Establishment is the key

Establishment is critical for perennial cropping systems. Successful establishment optimizes biomass yield, promotes productive long-term stands, reduces weed pressure, and contributes to effective nutrient capture from runoff water.

Species and Cultivar Selection

- Perennial grass filter strips compliment crop production by providing multiple services in agricultural watersheds.
- A filter strip can be designed to carry out many functions with various monocultures and mixtures of perennial grasses and forbs can be used.
- Selecting the right species and cultivars is the first step for effective filter strip establishment. Contact local NRCS, extension, or other experts to select the best species and cultivars to meet your management objectives.
- Warm-season grasses in monocultures or mixtures typically produce more biomass and provide more options for wildlife and pollinator habitat.
- Cool-season mixtures provide high-quality forage and are often less expensive and easier to establish than warm-season grasses.

Vegetation 1: Native warm-season grasses

Species	Purpose
Switchgrass Big bluestem Indiangrass	Bioenergy feedstock Summer forage Wildlife habitat
Prairie cordgrass*	Bioenergy feedstock
Mixtures	Bioenergy feedstock Summer forage Wildlife habitat**

Vegetation 2: Cool-season grasses and legumes mixture

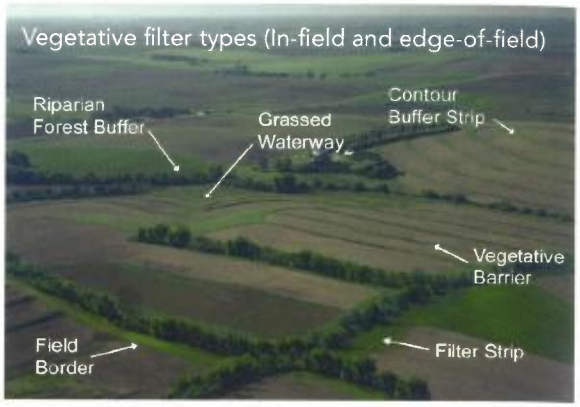
Species	Purpose
Smooth bromegrass Meadow fescue, Orchardgrass Tall fescue, Ryegrass, Alfalfa	Spring and fall forage

Vegetation 3: Warm- and cool-season grasses mixtures

Species	Purpose
Mixtures	Spring forage Fall bioenergy feedstock

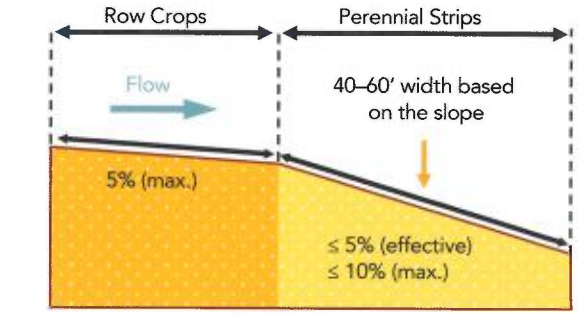
**Ideal for bottomland and poorly drained sites*
***Wildlife and pollinator benefits can be enhanced by including native forbs*

Design and Implementation

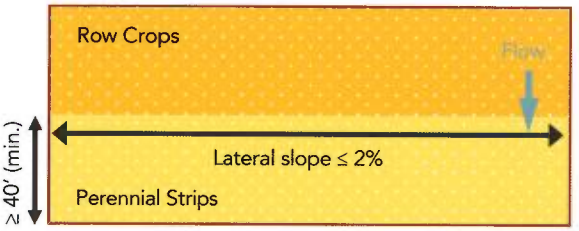


(Photo courtesy of USDA-NRCS)

Technical Notes



Section View



Overhead View

Maintenance

- Rills/small channels need to be repaired to avoid concentrated flow through the strip.
- Control grazing to prevent access by livestock.
- Control weeds to maintain quality stands.
- Repair gullies, remove deposited sediment, and reseed after storm events, if necessary.

Establishment Guidelines

1. Develop a firm seedbed
2. Plant high quality seed
3. Use a well calibrated drill
4. Plant seed ¼–½ inch deep
5. Plant 2–3 weeks before or after corn
6. Control weeds early
7. Monitor weather conditions to plant before predicted rain

Land Preparation

CONCEPTS: Prepare a firm seedbed to provide good soil-to-seed contact to maximize seed germination and minimize soil erosion and stand failure (no-till is ideal).

KEYS: Avoid tillage in sensitive areas (e.g. high erosion risks, see picture). In areas with heavy residues (e.g. after corn or sorghum harvest), graze or shred the residue, incorporate the residue with tillage, then pack soil surface using a cultipacker or roller (Note: seedbed preparation is similar to Alfalfa).

Planting

SEED QUALITY

- Grass-seed quality affects seedling vigor and establishment speed. Quality test is based on percent Pure Live Seed (PLS):

$$PLS(\%) = \frac{seed\ purity(\%) \times viable\ seed(\%)}{100}$$

where

$$Viable\ seed(\%) = dormant\ seed(\%) + germination(\%)$$

SEEDING RATE (30 PLS FT^{-2})

- Approximately 3–10 lbs ac^{-1} based on seed weight and quality. This will vary by seed lot.

SEEDING

- Drills (shallow seeding depth of ¼–½"): Small seed box drills, native grass-seed drills (see picture), no-till drills, conventional drills
- Broadcast: needs to followed by cultipacker (Not typically needed in no-till fields, killed pasture sod, or surfaces with heavy residues).

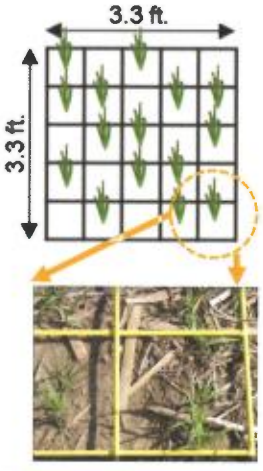
TIMING

- 2–3 weeks before or after the recommended corn planting date in your area (late April to early June)
- Germination is maximized at soil temperature of 68–86 °F
- Gemination usually begins 3–5 days after planting in optimum soil conditions but complete emergence can take more than a month.

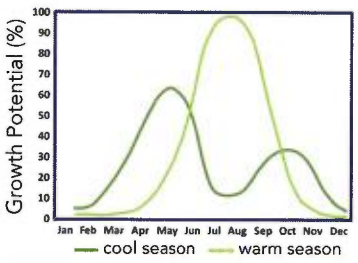
Erosion sabotages the seed planting and establishment

Good stand with no-till

1 Small seed box
2 Grass box
3 Grain box
4 Spacing: 7–10 inches row



Stand density



Growth potentials of cool-season and warm-season perennial grasses

- Cool-season grasses in late summer (early September) to minimize weed pressure and optimize ground cover in spring management.

Weed Control

PRE-EMERGENCE APPLICATION

- Existing weeds should be controlled using burn-down herbicides before planting.
- Pre-emergence herbicides can be sprayed before or immediately after planting.

POST-EMERGENCE APPLICATION

- Selective herbicides to control weeds can be applied after planting but wait until perennial grasses reach the four- or five leaf stage.
- Mowing during the establishment year above perennial grass canopy can suppress weed competition and seed production.

Stand Density

Evaluate stand establishment with a frequency grid (see picture) 4 to 6 weeks after planting to decide if overseeding or replanting is necessary.

CRITERIA FOR RATING STANDS

- Successful: ≥ 50% (≥ 2 plants ft^{-2})
- Marginal/Adequate: 25-50%
- Poor: < 25 % (needs to be overseeded or replanted)

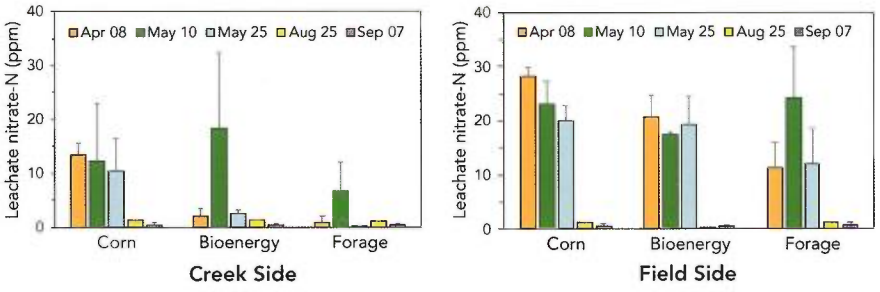
Managing Established Stands

- Control weed species in a timely manner.
- First aboveground biomass harvest should not be done until the completion of ground cover.
- For cool-season grasses or mixtures, biomass can be harvested more than once depending on stand health. Healthy stands can be harvested two times per year in spring and fall to optimize forage yield and quality.
- For warm-season grasses or mixtures, one annual harvest after a killing frost is recommended for bioenergy feedstock production to ensure stand longevity. Warm-season grasses can be harvested for summer forage at peak standing crop, usually early August. Annual harvests during summer can reduce stand health if fertility is not maintained.
- If the filter strip is enrolled in CRP, follow the CRP harvest management requirements

How does a perennial-based filter perform at Fulton County?

Nitrate-N leaching from row crop fields was measured with high concentrations of soil leachate nitrate-N near the field side of the filter strips. The uptake of leached-N by perennial crops (filter strip) resulted in lower nitrate-N concentrations in soil water at the creek site of the filter strips, showing that the perennial-based filters significantly reduced nutrient leaching compared with the row crop systems (i.e. corn in this study), especially for nitrate-N (see graph).

Soil nitrate concentrations from the field- and creek-side



Why Perennial Cropping Systems for Filter Strips?

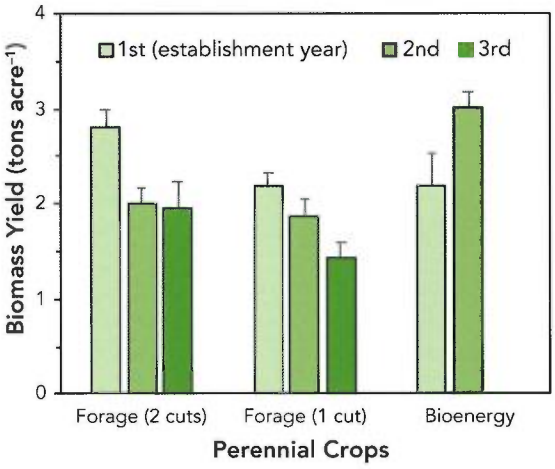
Perennial-based cropping systems can be used for feedstock bioenergy and/or forage, which can be considered as alternative income sources on marginal lands. The research demonstrated that a three-year rotation of forage crops with conventional row crop rotation improved net income compared with the traditional soybean-corn rotation system. The deep rooting system of perennial crops and extended growing seasons increase nutrient removal, greatly contributing to nutrient loss reduction. This on-farm field trial demonstrates that the potential of multifunctional filter strips for reducing nutrient loss from field to surface waters.

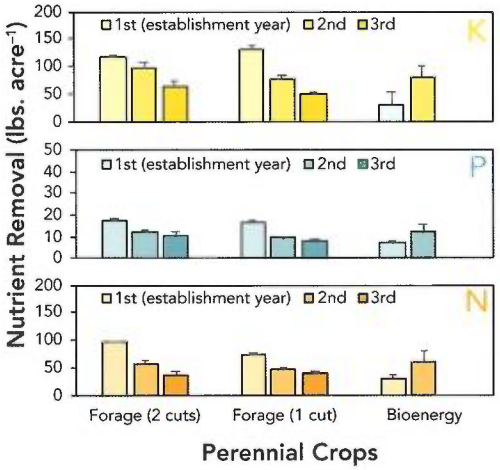
This specific filter strip research was jointly conducted by the University of Illinois and Metropolitan Water Reclamation District of Greater Chicago (MWRD)

For more information, contact Dr. D.K. Lee, University of Illinois, Urbana-Champaign (leedk@illinois.edu) or Dr. Guanglong Tian at MWRD (TianG@MWRD.Org)

What affects how much nutrient a filter strip can remove?

Nutrient removal by perennial crops is based on nutrient concentrations in plant tissues and aboveground biomass yields, which were substantially influenced by the harvest frequency (one or two annual harvests) and timing (at anthesis in spring and fall for cool season grasses and after a killing frost for warm-season grasses). For forage crops (cool-season mixture), the two-cut system produced higher biomass yields than the one-cut system during the three years (see graph). The yields potential of coolseason forage decreased over the years, most likely due to insufficient nutrient in the filter strips. However, warm-season bioenergy crops showed higher yield potential in 'marginal' (low fertility) areas. The increased biomass from both the two-cut systems and bioenergy crop also increased nutrient (N, P, K) removal (see graph).





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