Agronomy Guide

Purdue University Cooperative Extension Service

SOILS (TILLAGE) AY-285

Vegetated Filter Strips for Improved Water Quality

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Filter strips are areas of vegetation bordering a body of surface water. Seeded with close-growing plants, such as grasses or legumes, filter strips protect surface water from eroded soil, nutrients, chemicals, and organic materials. Plants in the filter strip slow water runoff, which reduces the water's ability to carry pollutants. Potential pollutants, especially those associated with sediment, are deposited before they reach surface water. Filter strips also preserve highly erodible ground often found near moving surface water.

Filter strips are a "best management practice" (BMP) near field boundaries or within fields near water sources or inlets. They are often used along with practices such as conservation tillage, pest scouting, crop rotations, strip cropping, soil testing, contour tillage, riparian zones, and proper nutrient and pest management to improve water quality. Many state and federal agencies recommend filter strips as an agricultural and urban best management practice because of their potential environmental benefits.

Vegetated filter strip, Gibson Co., Indiana

Benefits

Filter strips often provide unrealized economic benefits; possibly returning more than traditional field crop production. Filter strips planted to marketable hay or forest species, or used for very limited grazing, can easily recover much of the construction and maintenance expenses. Where good markets exist for alternative products, such as timber or hay, filter strips may prove more profitable than a corn-soybean rotation. Property taxes may be waived for filter strips located along legal drainage ways, although the filter strip can not be used for profit and must fall within a county's legal right-of-way (consult your local assessor's office for full details). Federal and state programs, such as the USDA Conservation Reserve Program, may increase the economic feasibility of filter strips in more environmentally sensitive locations.

Additional benefits of filter strips:

- year-round access to land for farming operations
- improved drainage through access to ditches and tile outlets
- increased safety through more stable stream banks and ditches
- wildlife and hunting areas
- natural beauty

The established plant species in filter strips improve soil structure and internal drainage and increase soil organic matter. Since many filter strips are located near ditches, dug ponds, legal drains or other waterways that may have experienced dredging or other disturbances in the past, filter strips may actually prove a wiser choice than row-crop production.

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For additional information on the economics of vegetated filter strips refer to the Ohio State University Extension Service Fact Sheet *Vegetated Filter Strips: Economics* (AEX-468).

Effectiveness

A vegetated filter strip's effectiveness at protecting surface waters depends on several things. The most important factors can be grouped into five categories. These factors include:

1.) *The amount of sediment reaching the filter strip from surrounding fields*, which is affected by field slope, field slope length, rainfall intensity, length of rainfall, and types of tillage above the filter strip.

2.) *The period of time that the water is held by the filter strip*, which can be affected by the filter strip width, type of cover, and the condition of stand. In general, wider, more uniformly shaped filter strips consisting of dense, healthy, and deep-rooted plant species are the most effective at slowing run-off and trapping sediments. (Figure 1).

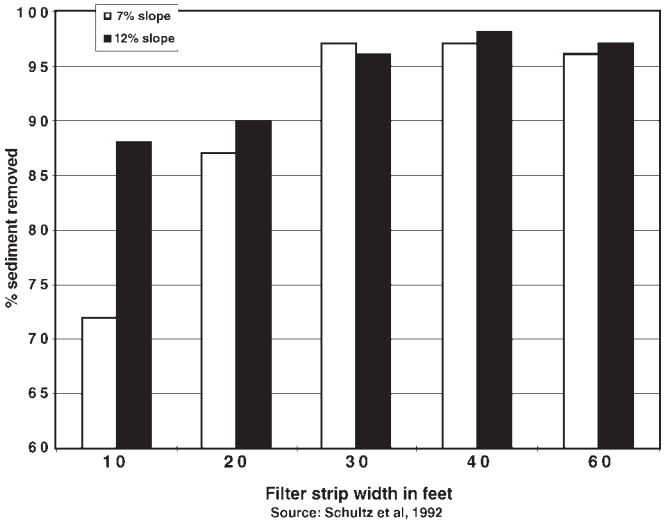


Figure 1: Sediment % Deposited in vegetated filter strips. 1991 demonstration, Allamakee County, IA

3.) *The soil's infiltration rate*, with higher infiltration rates trapping and holding more dissolved pesticides and nutrients than soils with lower infiltration rates.

4.) *Surface uniformity, or "levelness", of the filter strip*, since small rolls, depressions, and rills may concentrate flow and reduce strip effectiveness. Research at the University of Kentucky found that with incorrect installation, wider (>30'), improperly installed filter strips actually performed worse than narrower (<30'), properly installed strips under the same conditions. Small rivulets or channels would form in improperly prepared wider strips due to swags or natural humps, which decreased filtration effectiveness and carried sediments and chemicals through the buffers too fast for proper removal.

5.) *Maintenance of the filter strip*, including upkeep of vegetation stands and removal of previously trapped sediments and debris. Vegetated filter strips function best when designed as a component of a farm-wide water quality plan. Sedimentation is often the leading cause for reduced filter strip effectiveness and eventual failure. Sedimentation can be reduced, however, through the adoption of conservation tillage and other practices designed to lower sediment loads and prolong vegetated filter strip life.

The largest concern for maintaining existing filter strips is preserving the uniform, level design needed to reduce channelization and concentrated flow across the filter strip. Sediments and debris trapped in working filter strips often result in miniature levees which, if left unchecked, can result in overall filter strip failure as well as the short term ponding in adjacent crop, grass, and legume species.

Filter Strip Establishment

In general, a wider, uniformly shaped strip is more effective at stopping or slowing pollutants than a narrow strip. As a field's slope and/or watershed size increases, wider strips are required for effective filtering (Table 1).

Table 1: Suggested Vegetated Filter Strip Widths Based on Percent Slope*

Land Slope, %	Strip Width, Feet
0 - 5	20
5 - 6	30
6 - 9	40
9 -13	50
13 -18	60

* Widths are for grass and legume species only and are not intended for shrub and tree species

Adapted from the USDA-Soil Conservation Service (Indiana) Field Office Technical Guide, 1990

Plant selection is also important to the overall success of filter strip design. In general, plants with fibrous root systems that form a dense living mat (as opposed to "clump" type species) are preferred to better insure that soil and pollutants will be slowed and/or held in place. As with any planting, give consideration to soil fertility and pH, soil drainage, time of seeding, and species type(s) to aid in establishment and eventual stand (Tables 2 through 5). When seeding filter strips all rates should be according to pure live seed (PLS) rates. Bulk seed rates should be adjusted to meet PLS requirements for a successful establishment.

Prior to seeding the filter strip, the land should be carefully shaped to allow water to pass over the area

in a steady, uniform manner. Avoid low places where rivulets or concentrated flow may occur. Areas immediately adjacent to streams, sinkholes, ponds, or other areas, where increased erosion may be a problem, should be shaped to reduce future problems such as sloughing or caving in of the banks.

If extensive earth work is done, fertilizers and other soil amendments, such as lime, should be incorporated according to soil test results and plant species being planted. Tilled soil should be loose but firm prior to seeding. Ensure good seed-to-soil contact for adequate seedling establishment. For species requiring longer periods of establishment, the use of "companion" crops, such as spring oats, wheat, or rye, should be considered if erosion or weed pressure are concerns.

Related conservation practices:

Buffer Zones

Similar to vegetated filter strips, buffer zones provide a physical separation between adjacent areas, such as between a city and a wildlife refuge or between a crop field and a body of water. Unlike filter strips, buffer zones may not necessarily be designed to filter water that flows through them.

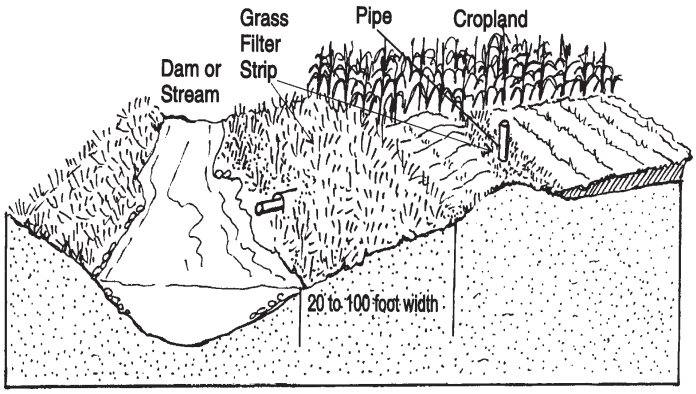
Corridors

A corridor is any combination of grasses, legumes, shrubs, and trees used to link separate wildlife habitats and provide cover for wildlife to travel between habitats. Corridors, like vegetated filter strips, may provide some filtering of pollutants from nearby croplands, but primarily provide benefits for wildlife and divert wildlife from adjacent fields.

Riparian Zones

A riparian zone consists of the land adjacent to and including a stream, river, or other area that is at least periodically influenced by flooding in a natural state. Similar to vegetated filter strips, plants in riparian areas effectively prevent sediment, chemicals, and organic matter from entering bodies of water. Unlike filter strips, riparian zones use plants that are of a higher order, such as trees or shrubs, as well as grasses or legumes. Vegetated filter strips are often utilized in riparian areas as an initial filtering component next to crop field borders.

For additional information on the use and design of riparian zones in cropland areas refer to the USDA Forest Service Agroforestry Notes *Riparian Buffers For Agricultural Land* (AF Note - 3), *How To Design A Riparian Buffer For Agricultural Land* (AF Note - 4), and *A Riparian Buffer Design For Cropland* (AF Note - 5).



References:

A Riparian Buffer Design For Cropland. 1997. M. Dosskey, D. Schultz, and T. Isenhart. AF Note-5. USDA Forest Service, Rocky Mountain Station/ USDA - Natural Resources Conservation Service, East Campus - UNL, Lincoln, Nebraska.

Forage Selection and Seeding Guide for Indiana. 1994. K. D. Johnson, C. L. Rhykerd, and J. O. Trott. AY-253. Purdue University Cooperative Extension Service, West Lafayette, Indiana.

How To Design A Riparian Buffer For Agricultural Land. 1997. M. Dosskey, D. Schultz, and T. Isenhart. AF Note-4. USDA Forest Service, Rocky Mountain Station/USDA - Natural Resources Conservation Service, East Campus - UNL, Lincoln, Nebraska.

Riparian Buffers For Agricultural Land. 1997. M. Dosskey, D. Schultz, and T. Isenhart. AF Note-3. USDA Forest Service, Rocky Mountain Station/ USDA - Natural Resources Conservation Service, East Campus - UNL, Lincoln, Nebraska.

Vegetated Filter Strips: Applications, Installation and Maintenance. 1993. R.P. Leads, L.C. Brown, M. Sulc, and L. Van Lieshout. AEX 467. Ohio State University Extension, Columbus, Ohio.

Vegetated Filter Strips: Economics. 1993. R.P. Leed, D.L. Forster, and L.C. Brown. AEX 468. Ohio State University Extension, Columbus, Ohio.

Vegetative Filter Strips for Improved Water Quality. 1992. M. Smith. Pm-1507. Iowa State University Extension, Ames, Iowa.

Table 2. Recommended Seeding Mixtures and Rates for Vegetated Filter Strips in Indiana - Pure Species Stands

Seeding Mixture Species	Soil Fertility[1,2]	Soil pH	Soil Moisture[3] WD	MWD	SPD	PD	Optimum Seeding Dates	Pure Live Seed (PLS) Rate[4] (lbs./acre)
Reed canarygrass	M - H	5.8-6.2	X	X	X	X	Mar.1-May 1 Aug.1-Sept.1	8
Tall fescue[5]	M	5.4-6.2	X	X	X	X	Mar.1-May 1 Aug.1-Sept.1	20
Redtop	L	5.4-6.2	X	X	X	X	Feb.1-May 1	6
Orchardgrass	M	5.5-6.2	X	X	X		Mar.1-May 1 Aug.1-Sept.1	12
Timothy	M	5.4-6.2	X	X	X		Feb.1-May 1 Aug.1-Nov.1	6-8
Smooth bromegrass	H	5.8-6.5	X	X	X		Feb.1-May 1 Aug.1-Sept.1	20
Switchgrass	L - M	5.4-6.2	X	X	X		May 1 - June 1	5-8

Table 3. Recommended Seeding Mixtures and Rates for Vegetated Filter Strips in Indiana - Mixed Species Stands

Seeding Mixture Species	Soil Fertility[1,2]	Soil pH	Soil Moisture[3] WD	MWD	SPD	PD	Optimum Seeding Dates	Pure Live Seed (PLS) Rate[4] (lbs./acre)
Smooth bromegrass & alfalfa	H	5.8-6.5	X	X			Mar.1-May 1 Aug.1-Sept.1	10 8
Smooth bromegrass & crownvetch	M - H	6.0-6.5	X	X	X		Mar.1-May 1 Aug.1-Sept.1	8 6
Smooth bromegrass & tall fescue[5]	M - H	5.8-6.5	X	X	X	X	Mar.1-May 1 Aug.1-Sept.1	8 10
Tall fescue[5] & alfalfa	M - H	6.0-6.5	X	X			Mar.1-May 1 Aug.1-Sept.1	10 8
Tall fescue[5] & crownvetch	M	5.4-6.2	X	X	X		Mar.1-May 1 Aug.1-Sept.1	10 5
Tall fescue[5] & sericea lespedeza	L - M	5.4-6.2	X	X	X		Mar.1-May 1 Aug.1-Sept.1	10 18
Redtop & sericea lespedeza	L	5.4-6.2	X	X	X		Feb.1-May 1	4 18
Reed canarygrass & smooth bromegrass & ladino clover (opt.)	M - H	5.8-6.5	X	X	X	X	Mar.1-May 1 Aug.1-Sept.1	4 10 1
Reed canarygrass & tall fescue[5] & ladino clover (opt.)	M - H	5.8-6.5	X	X	X	X	Mar.1-May 1 Aug.1-Sept.1	4 10 1
Reed canarygrass & tall fescue[5] & redtop	M	5.6-6.2	X	X	X	X	Mar.1-May 1 Aug.1-Sept.1	4 8 3
Big bluestem & switchgrass & Indiangras	L - M	5.4-6.2	X	X			Apr.15-Jun.5	5 1/2 5
Big bluestem & little bluestem & switchgrass & Indiangrass & Side oats grama	L - M	5.4-6.2	X	X			Apr.15-Jun.5	1.5 1.0 1/2 1.5 4.0

1 Minimum adequate level for species

2 Soil fertility levels: L = Low, M = Medium, H = High

3 Soil moisture characteristics: WD = Well drained, MWD = Moderately well drained, SPD = Somewhat poorly drained, PD = Poorly drained

4 Pure Live Seed: To calculate Pure Live Seed (%PLS) rates, multiply the percent purity by the percent germination. Divide the seeding rate by the %PLS to find the amount of bulk seed needed per acre. Example: 98% Purity X 60% Germination = .588

$$\frac{\text{10 pounds seed per acre rate}}{\text{.588 percent pure live seed}} = \text{17 pounds of bulk seed per acre}$$

5 Only low-endophyte varieties should be used to avoid adverse affects on livestock and wildlife

Table 4. Recommended Seeding Mixtures and Rates for Vegetated Filter Strips in Indiana - Native Species and Wildlife Mixtures

Seeding Mixture Species	Soil Fertility[1,2]	Soil pH	Soil Moisture[3] WD	MWD	SPD	PD	Optimum Seeding Dates	Pure Live Seed (PLS) Rate[4] (lbs./acre)
Orchardgrass & redtop & timothy & ladino clover	M	5.5-6.2	X	X	X		Mar.1-May 1 Aug.1-Sept.15	10 4 4 1
Orchardgrass & timothy & ladino clover	M	5.5-6.2	X	X	X		Mar.1-May 1 Aug.1-Sept.15	10 4 1
Orchardgrass & sericea lespedeza	L-M	5.5-6.2	X	X	X		Mar.1-May 1 Aug.1-Sept.15	10 8
Switchgrass oats or wheat & partridge pea (opt.) &/or Ill. Bundleflower (opt.)	L-M	5.4-6.2	X	X	X		Apr.15-Jun.5	8 32 30 1/2-2 1/2-2
Big bluestem & Indiangrass & switchgrass & oats or wheat & partridge pea (opt.) &/or Ill. Bundleflower (opt.)	L-M	5.4-6.2	X	X			May 1- Jun.1	4 4 1/2 32 30 1/2-2 1/2-2
Big bluestem & switchgrass & oats or wheat & partridge pea (opt.) &/or Ill. Bundleflower (opt.)	L-M	5.4-6.2	X	X			May 1-Jun.1	8 1/2 32 30 1/2-2 1/2-2
Indiangrass & switchgrass & oats or wheat & partridge pea (opt.) &/or Ill. Bundleflower (opt.)	L-M	5.4-6.2	X	X			May 1-Jun.1	8 1/2 32 30 1/2-2 1/2-2

Table 5. Recommended Seeding Mixtures and Rates for Vegetated Filter Strips in Indiana - Short-term Companion Crops for Mixtures

Seeding Mixture Species	Soil Fertility[1,2]	Soil pH	Soil Moisture[3] WD	MWD	SPD	PD	Optimum Seeding Dates	Pure Live Seed (PLS) Rate[4] (lbs./acre)
Spring oats	M	6.9-6.5	X	X			Mar.15-Jun.1 Aug.1-Oct.1	32
Rye	L-M	5.8-6.2	X	X	X		Aug.1-Oct.30	30
Wheat	M	6.0-6.5	X	X	X		Aug.1-Oct.30	30
Barley	L-M	6.2-6.8	X	X	X		Aug.1-Oct.15	30

1 Minimum adequate level for species

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$$\frac{\text{10 pounds seed per acre rate}}{\text{.588 percent pure live seed}} = \text{17 pounds of bulk seed per acre}$$

5 Only low-endophyte varieties should be used to avoid adverse affects on livestock and wildlife

Tables 2 through 5 adapted from Purdue University Cooperative Extension Service Forage Selection and Seeding Guide for Indiana (AY-253), 1994; USDA - Soil Conservation Service (Missouri) Field Office Technical Guide, 1990; and Quail Unlimited, Inc. - Great Plains Reg. Riparian/ Lowland Application Seeding Guide, 1996.

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