NEWS & VIEWS

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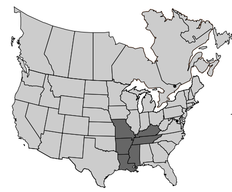

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Vegetative Filter Strips Reduce Runoff Losses and Help Protect Water Quality

What is a vegetative filter strip and why should I be interested?

Potential contamination (pollution) of surface waters with sediment, nutrients, and pesticides in agricultural runoff is an important water quality issue. Conservation tillage has been promoted and adopted by many row crop farmers because of its effectiveness in decreasing exposure to rainfall and reducing runoff and sediment loss. **Vegetative filter strips (VFS),** also known as buffer strips or buffer zones, increase infiltration, slow runoff, and allow more time for sediment, nutrients, and pesticides to deposit. They are installed down-slope of managed crop or forage areas which have been treated with fertilizer, manures, and/or pesticides. The purpose of VFS is to filter and purify runoff as it flows across the filter, before discharge to receiving waters. They can be established and maintained at field edges, adjacent to water flow paths that discharge to surface waters and can reduce non-point agricultural pollution to acceptable limits. Combining the advantages of conservation tillage with VFS should lead to the maximum deposition of contaminants and reduction in potential runoff losses to help preserve and protect water resources.

In areas where there is a history of high concentrations of poultry or livestock, there has been an increasing concern about the potential for off-site movement of field-applied nutrients, sediment, and animal waste as non-point discharges to surface waters. Row crop farmers have similar stewardship concerns about the potential runoff losses of sediment, nutrients, and pesticides from their fields. Vegetative filter strips are another best management practice (BMP) that can be used in conjunction with, 1) nutrient management plans based on realistic yield goals, and 2) appropriate timing of nutrient and pesticide applications, to improve crop production, preserve the farm resources, and protect water quality.

Excessive loading of nitrogen (N) and phosphorus (P) to surface waters, when there is an available supply of carbon as an energy source, can lead to algae blooms and profuse growth of aquatic vegetation. This process is called eutrophication. In shallow waters with excessive nutrient levels, particularly in warm weather, algae and other microscopic organisms can grow quite rapidly and significantly reduce the oxygen content of the waters upon death and decomposition. Loss of water quality can result, as well as reductions in the total number of aquatic organisms and biodiversity, and possibly fish kills in the worst cases. Sediment loading can shorten the effective life of ponds and lakes, restrict the ability of streams to transport water, and can lead to more frequent flooding. Sedimentation can also interfere with fish reproduction by covering spawning beds.

Prevention and reduction of runoff losses of these contaminants can benefit farmers and ranchers as well as their livestock, and those who use the waters downstream. Vegetative filter strips are one of the excellent BMP tools available to protect water quality and to enhance the farm resources.

What type of plants work best as vegetative filters?

Vegetative filter strips are most commonly grass. Perennial grasses are often considered the most desirable vegetation, and can be used alone or with riparian forest and shrub vegetation to buffer streams, ponds, lakes, and rivers from contaminants. Cool season grasses in the Midsouth, such as fescue, orchardgrass, bromegrass, and/ or bluegrass, actively grow in the fall through the spring

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when rainfall events and runoff potential are usually greatest. They do not creep into fields as bermudagrass can and will usually not interfere with crop production practices as invading weeds. Perennial cool season grass filters can also serve as cover and food for wildlife, especially when preferred food species are also planted. Trees and shrubs can also be used as VFS, but usually involve more expense if not already present at field edges and can prove costly to establish.

How should vegetative filters be managed?

To be most effective, grass VFS should be managed for maximum ground coverage to prevent erosion. Lime and fertilizer should be applied according to soil tests to permit robust growth and to increase the potential life of the stand. Grass height should be managed to prevent lodging, to slow runoff water velocity, and to provide for diffuse or even flow of runoff water instead of permitting channelization of flow. Some suggest a dense stand of grass, maintained at a height of 4 to 6 inches, as optimal. Grazing of vegetative filters should be avoided because of the risk of over-grazing, build up of manure, and channelization of water flow along traffic paths.

Work in Virginia by T.A. Dillaha and others evaluated the long-term effectiveness of VFS and resulted in conclusions that VFS are effective for water quality improvement only if:

1) flow across the surface is shallow and the VFS is not submerged
2) they are installed in areas that are down-slope of (not higher than) fields they are intended to protect
3) they are located in areas characterized by sheet flow which are up-slope of natural or man-made channels
4) they are installed on both sides of internal field drainageways or grassed waterways in large fields, and
5) they are a minimum of 20 ft. wide at the time of establishment, except where steep slopes dictate greater widths based on design equations.

Their recommendations for VFS maintenance were:

1) VFS should be mowed (to help control weeds) and the residue harvested a minimum of 2 or 3 times per year to promote thick vegetation.
2) VFS should be limed and fertilized annually with the rest of the field according to soil test recommendations. (Note: Some believe that VFS should be fertilized out of phase with the remainder of the field so they will be relatively “clean” when field runoff occurs.)
3) When herbicides are applied to fields, sprayers should be turned off before crossing VFS or using them for turn rows.
4) VFS should not be used for roadways, but if the VFS must be used for some equipment traffic, it should be 8 to 10 ft. wider than normal on the down-slope side to permit filtration of waters received from the disturbed area.
5) Cattle should be excluded from VFS at all times, but especially when soils are moist and susceptible to animal hoof damage.
6) VFS should be inspected after establishment and then regularly for any damage associated with tillage operations. Damaged areas should be re-fertilized and reseeded.
7) VFS areas that have accumulated sediment that causes them to be higher than the field they are to protect should be plowed, disked and graded as necessary before reseeding to establish favorable conditions for optimum filtration
8) Gully formation next to the VFS can be avoided where moldboard plowing is practiced by turning the soil towards the VFS with the last plow pass.

The greatest problem discovered in a survey of 33 farms in the Chesapeake Bay and Chowan River Basins in Virginia (Dillaha et al.) was channelization of flow, especially from drainageways in fields which caused water to cross the VFS only at a few narrow points. Wildlife habitat filter strips were judged to be ineffective due to an inability to retard surface flow because of their sparse ground cover and bunching growth habit. Even where filter strips were found to be ineffective for filtering sediment and nutrients from runoff, they did provide localized erosion control in border areas and along streambanks where erosion was often most critical. Most of the farmers who were interviewed in the survey indicated that they would not install new VFS without cost-sharing of some kind from soil and water conservation districts and the Farm Service Agency. However, nearly all were positive about their VFS and said they would maintain them even after existing cost-sharing ended.

How effective are vegetative filters in reducing runoff losses of common water contaminants?

Research at the University of Kentucky has investigated the effectiveness of different tillage systems and different widths of VFS **(Table 1)**. The most effective combination of tillage system and VFS was no-till with a 45-ft. vegetative filter. Thirty-foot grass filter strips were more consistent, however, than 15-ft. or 45-ft. strips in reducing runoff water volume and mass losses of sediment, nitrate-N, and atrazine. With wider VFS, on soils with a high erosion potential, there is considerable risk for rill erosion and a reduction in infiltration and contaminant filtering. In separate studies with poultry litter (7.5 tons/A) lightly incorporated with a chisel plow and disk before simulated rainfall, 30-ft. strips were slightly more effective in trapping fecal coliform bacteria than were 15-ft. filter strips. Though total fecal bacteria were reduced by up to 95 percent with VFS, runoff water contained bacterial concentrations well in excess of primary and recreational contact standards.

Table 1. Mean trapping efficiency of vegetative filters for four components lost from cropped plots in Kentucky (mean of conventional-till and no-till plots on a 9 percent slope).

Filter width, ft.	Sediment	Water	Nitrate-N	Atrazine
	- - - - - - - - - - - -% trapped- - - - - - - - - - - -			
15	96	96	94	93
30	99	97	98	99
45	99	91	97	98

Applied 150 lb/A of N as ammonium nitrate and atrazine at 2 lb/A of active ingredient one day before runoff-producing rainfall.

Research in Arkansas comparing poultry litter and swine manure applications to fescue showed that total P losses were reduced with an increase in VFS width to about 30 ft. **(Figure 1)**. The VFS removed more P from swine manure than from poultry litter applied to the areas above the VFS, even though the swine manure rate resulted in a higher P_2O_5 load to the plots. Fescue VFS as narrow as 10 ft. can apparently reduce runoff losses of many contaminants by about 40 percent **(Table 2)**, while widths of 70 ft. were required to reduce losses to approximately 90 percent. While total N and total P losses were not statistically increased with an increase in VFS width beyond 30 ft., ammonium-N and orthophosphate-P (soluble-P) losses were reduced further by increasing the VFS width to 50 ft.

Table 2. Vegetative filter width affects mass transport of several potential contaminants from fescue plots with a 3 percent slope, treated with 2.25 T/A of poultry litter in northwest Arkansas.

Filter width, ft.	Total N	Ammonium-N	Total P	Orthophosphate-P
	- - - - - - - - - - - - % reduction in loss - - - - - - - - - - - -			
10	39	47	40	39
20	54	70	58	55
30	67	78	74	71
50	76	94	87	85
70	81	98	91	90
	Mass loss with no filter, lb/A/year			
	16	4	4	3

The greatest potential for runoff loss usually occurs with the first storm event after fertilizer or animal manure application. The runoff loss is dramatically less in subsequent runoff-producing rains **(Figure 2)**. Timing the application of fertilizers and animal manures to avoid intense rainfall that results in significant runoff can greatly reduce runoff losses of N, P and other nutrients.

Work with grain sorghum in eastern Kansas (but pertinent to the row crop area in the Midsouth) compared P placement methods and tillage systems on a somewhat poorly drained silt loam soil with a 1 to 1.5 percent slope. In two of the three years of the study, rainfall during the sampling period was 20 percent higher than the historic average. The lowest soluble P and total P losses were observed when P was knifed beneath the surface in the no-till system **(Figures 3 and 4)**. An important point to recognize from this work is that the highest 3-year average total P loss (1.2 lb/A of P) still amounted to less than one percent of the total P applied (66 lb/A of P, or 150 lb/A of P_2O_5,) for the 3 years combined. Soluble P losses ranged from 3 to 16 percent of the total annual P loss, among the three tillage systems studied. These results are consistent with research in Kentucky which showed that less than one percent of the total applied P was lost in runoff.

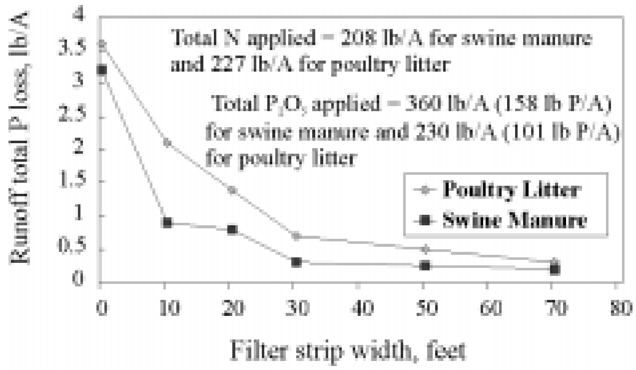

Figure 1. Effect of grassed filter strip width on runoff P loss for swine manure and poultry litter.
(Edwards and others. 1996. Arkansas)

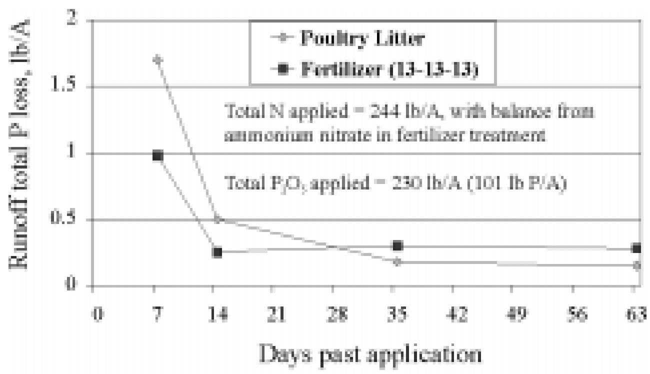

Figure 2. Relationship between time past application and runoff P loss for fertilizer and poultry litter on fescue plots.
(Edwards and others. 1996. Arkansas)

In perennial forage and turfgrass systems, and probably also with turfgrasses, soluble P losses often represent a larger fraction of the total P lost compared to cultivated crop systems. Research has shown that for perennial grass systems, soluble P can represent as much as 80 percent of the total P losses. With cultivated crops, or where ground cover is sparse in perennial grass systems, sediment-bound P may constitute the majority of the runoff P losses. Efforts to reduce both sediment-bound P and soluble P will result in the greatest reduction in potential surface water eutrophication.

Reductions in runoff volume and sediment load with VFS are paralleled by reductions in pesticide concentrations according to work in Mississippi with cotton **(Table 3)** and soybeans **(Table 4)**. These results indicate that VFS which are effective in reducing runoff volume and sediment loss are also likely to be effective in decreasing pesticide and nutrient losses.

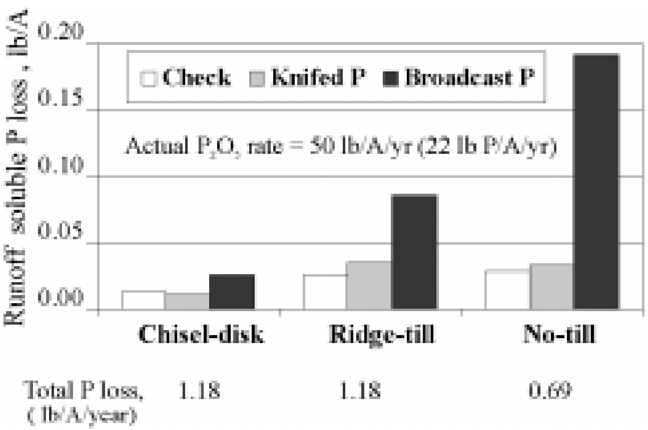

Figure 3. Three-year average soluble P losses from tillage systems and P placement methods. (Janssen and others. 1996. Kansas)

Table 3. Effect of fescue filter strip width on total runoff, sediment, and herbicide loss in Mississippi from a Brooksville silty clay soil, with a 3 percent slope, planted to cotton.

Filter width, ft.	Runoff volume acre-inches	Sediment loss, lb/A	Herbicide Loss Fluometuron[1]	Herbicide Loss Norflurazon[2]
			- - - - - - % of applied	- - - - - -
none	4.6	1482	9.8	8.6
1.6	3.0	857	4.5	4.2
3.3	4.3	884	5.6	4.4

[1]Common name example: Cotoran. Applied at 1.5 lb/A of active ingredient.
[2]Common name example: Zorial. Applied at 1.5 lb/A of active ingredient.

Table 4. Average percentage of applied herbicide lost in runoff, with and without a 20-foot fescue filter strip, from 1991-1993 in Mississippi on a Brooksville silty clay soil with a 3 percent slope planted to soybeans.

No-till Monocrop Without	No-till Monocrop with	Conventional-till monocrop without	Conventional-till monocrop with	No-till doublecrop with wheat without	No-till doublecrop with wheat with
- - - - - - - - - - - - - - -		Herbicide loss, % of applied		- - - - - - - - - - - - - - - -	
		Metalachlor[1]			
2.4	0.8	1.1	0.7	2.7	1.1
		Metribuzin[2]			
3.7	1.1	1.3	0.7	6.7	2.6

[1]Common name example: Dual. Applied at 3.0 lb/A of active ingredient.
[2]Common name example: Sencor. Applied at 0.4 lb/A of active ingredient.

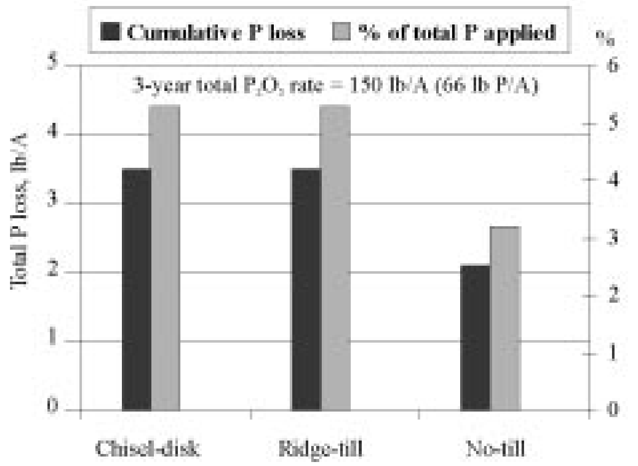

Figure 4. Three-year cumulative total P loss from different tillage systems, as percentage of P applied. **(Janssen and others. 1996. Kansas)**

Conclusion

Significant reductions in the potential for runoff losses of nutrients, pesticides, animal wastes, and fecal bacteria during intense storm events can be accomplished with VFS. The VFS width will need to be designed for the length of treated area above the filter strip as well as the slope of the field. Vegetative filter strips will add to pollutant removal by conservation tillage on croplands. While some believe that there is no need for VFS for pasture and hay meadows, the edges of fields adjacent to streams and water discharge paths should probably be managed better in many fields. Efforts to exclude grazing animals, and to maintain dense vegetation to a height of about 4 to 6 inches, in water discharge areas along field edges would help reduce non-point pollution risks considerably. Temporary fencing (e.g. electric fencing) is a practical, low-cost tool that can improve vegetation management at pasture and hay meadow edges, adjacent to streams.

One of the most practical and inexpensive things farmers and land managers can do, besides establishing and maintaining filter strips, is to time fertilizer, manure, and/or pesticide applications when rainfall intensity is unlikely to produce runoff. In other words, applications should be timed to avoid storm events that may occur within several days after application of these production inputs. ■

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