VEGETATIVE FILTER STRIPS AS A BEST MANAGEMENT PRACTICE ON RILL-IRRIGATED ROW FIELDS

By
Dr. Brian W. Bodah, Pierce County Director, Washington State University Extension, **Dr. Jeffrey L. Ullman**, University of Florida, Department of Agricultural and Biological Engineering, **Mark Stannard**, USDA-NRCS Pullman Plant Materials Center, **Dr. R. Troy Peters**, P.E., Washington State University Extension Irrigation Specialist, Department of Biological Systems Engineering, **Dr. William Pan**, Professor, Washington State University, Department of Crop and Soil Sciences

WSU PEER REVIEWED
TB17

Vegetative Filter Strips as a Best Management Practice on Rill-Irrigated Row Fields

What is a vegetative filter strip?

Vegetative filter strips (VFSs) are one of many best management practices (BMPs) that farmers can use to help limit the amount of pollution that comes off of their farms. VFSs are areas of land that have been planted with vegetation in order to intercept overland flow, decrease flow velocity, and increase localized surface water infiltration. VFSs are incredibly versatile. They can come in nearly any width and can be planted with a variety of grass or forage species.

As surface irrigation water flows through a VFS, the plant stems physically slow the water down. This reduction in velocity allows for suspended sediments to settle out in the VFS. Reduced flows also increase the amount of time the water spends within the VFS, known as residence time. An increased residence time allows for more of the surface water and dissolved nutrients to infiltrate the soil, allowing plant roots and soil microbes to utilize nutrients and promote degradation of pesticides (Schachtman et al. 1998).

Problems targeted by VFSs

VFSs can be used to address several water quality issues. In addition to other pollutants, VFSs have been shown to be effective in reducing water quality impairments associated with nutrients and sediments (Osborne and Kovacic 1993). A number of studies have reported removal rates of soluble nitrogen (N) and phosphorous (P) compounds in surface flows exceeding 95% through the use of VFSs (Carballas et al. 1990; Dias-Fierros et al. 1990; Nunez et al. 1991; Fajardo et al. 2001).

Eutrophication, or the excess growth of aquatic plants due to high levels of dissolved nutrients, is a widespread and significant problem in surface water bodies in intensively farmed areas of the United States. Productive modern farmland is typically fertilized with water soluble fertilizers. Some water soluble nutrients inevitably enter local waterbodies, transported by irrigation return flows or surface runoff following precipitation events.

Sediments represent another common problem in agricultural areas. Loose top soil on working farms can easily be picked up by water moving over the surface of the field. As long as that water's path is uninterrupted as it flows through furrows and into return ditches, it will carry a certain amount of suspended sediment along with it. Suspended sediment that ends up in local waterways can be highly detrimental to aquatic ecosystems. The initial 3 m of a VFS is where primary sediment deposition takes place (Dillaha et al. 1988; Line 1991; Chaubey et al. 1995; Robinson et al. 1996).

Utilizing VFSs on rill-irrigated fields as a BMP

VFSs are often planted along streams and rivers (referred to as riparian zones) to intercept storm runoff coming off of croplands before entering surface waterbodies. One novel approach we explored was to implement VFSs at the ends of rill-irrigated (also known as furrow-irrigated) row-crop fields in an effort to treat the irrigation return flows coming off the individual field (Bodah et al. 2012). This approach serves as an attempt to retain eroded soil and accompanying nutrients and prevent the off-farm transport of these contaminants. The sediment can later be redistributed and incorporated back into the same field from which it was lost. While much work has been done testing the use of VFSs to treat overland flow generated by storm events, this is the first time that we know of that VFS were critically examined as a potential treatment of irrigation return flows.

Experiments using VFSs on rill-irrigated fields

Understanding that farmers do not want to take land out of production, we aimed to learn the minimum size of land needed for a VFS to effectively remove nutrient and suspended sediment from irrigation return flows. Also, we examined whether VFSs could serve as productive farm land, wherein it could produce a hay or forage crop for use as livestock feed. Thus, we tested VFSs comprised of four different forage species and three differing widths on working, rill-irrigated, row-cropped farms in central Washington in the 2011 and 2012 growing seasons. Forage species (treatments) were chosen based on the climate and localized environmental conditions of the two sites in the Yakima River Basin.

Four different forage treatments were initially established on each of two different locations in 2011. Broadleaf weed pressure was significantly high at both sites, and the only two treatments that successfully established on Site A were alfalfa (*Medicago sativa* L.) and 'Baronesse' barley (*Hordeum vulgare* L.). On Site B, only the barley plots were successfully established. However, on Site B, nearly pure stands of barnyard grass (*Echinochloa crus-galli*) emerged on several plots, so we tested this volunteer treatment as well, referred to simply as grass plots. The grass plots consisted of approximately 70% barnyard grass and 30% lambsquarters (*Chenopodium album*).

This plot was retained and sampled to determine the effectiveness of a grass naturally present in the seed bank, in essence requiring no effort or cost for establishment. Each experimental plot was 10 ft across and was 10, 20, or 30 ft wide (the distance from the edge of the field to the irrigation return ditch).

At the inflow and outflow of each plot, we collected runoff samples and analyzed them for suspended sediment load and soluble nutrient content. Soluble nutrients included phosphorus in the form of phosphate and nitrogen in the form of nitrate, as these are the forms that are readily taken up by plants.

Findings

We found that a strip as narrow as 10 ft wide had removal efficiencies very close to 100% in both dissolved nutrient and suspended sediment output from a given field (Figures 1–3).

While we also examined strips comprised of 20 and 30 ft widths, the removal efficiencies of the larger strips were nearly identical to those of smaller strips, yielding no significant statistical difference among treatment effectiveness based on width. Sediment reduction rates agreed with the literature.

It is therefore evident that a local farmer can achieve very good results while taking as little as 10 ft of land out of row-crop production and planting a VFS. However, we found that significant maintenance issues can be involved with establishing and maintaining VFSs at the end of rill-irrigated fields, which will make it a difficult BMP to implement in many situations. For more information on these difficulties, see the WSU Extension publications on VFSs: FS214E, FS215E, and FS216E.

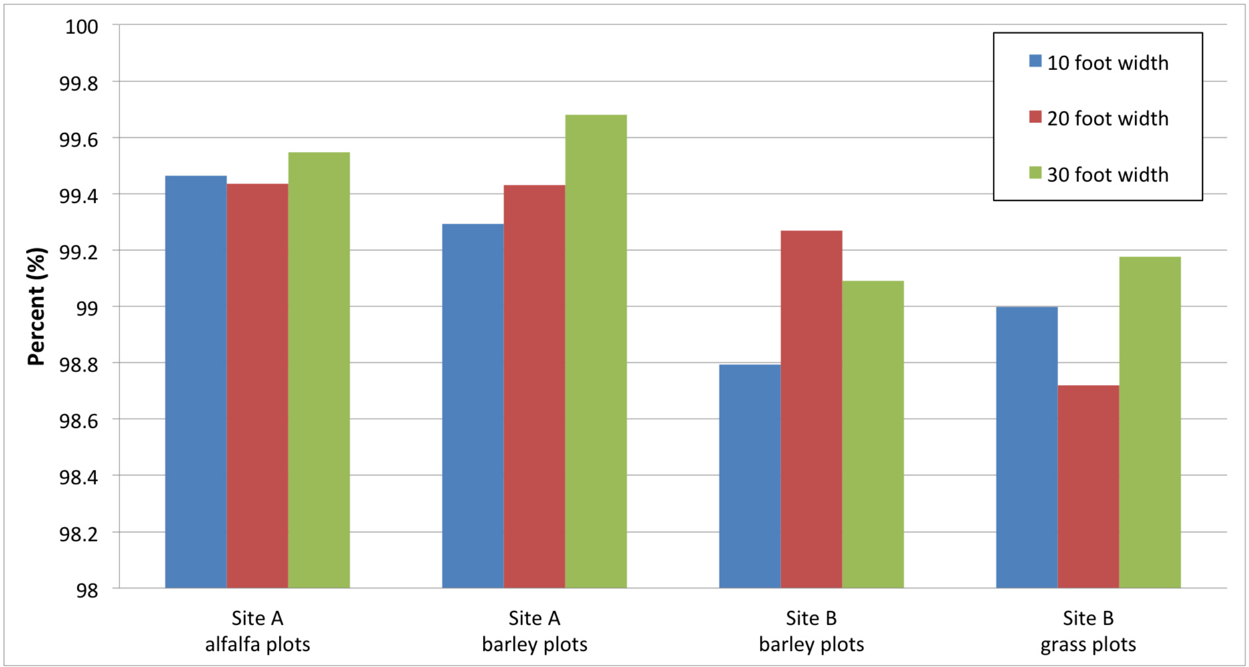

Figure 1. Average phosphate removal efficiencies of experimental VFS plots.

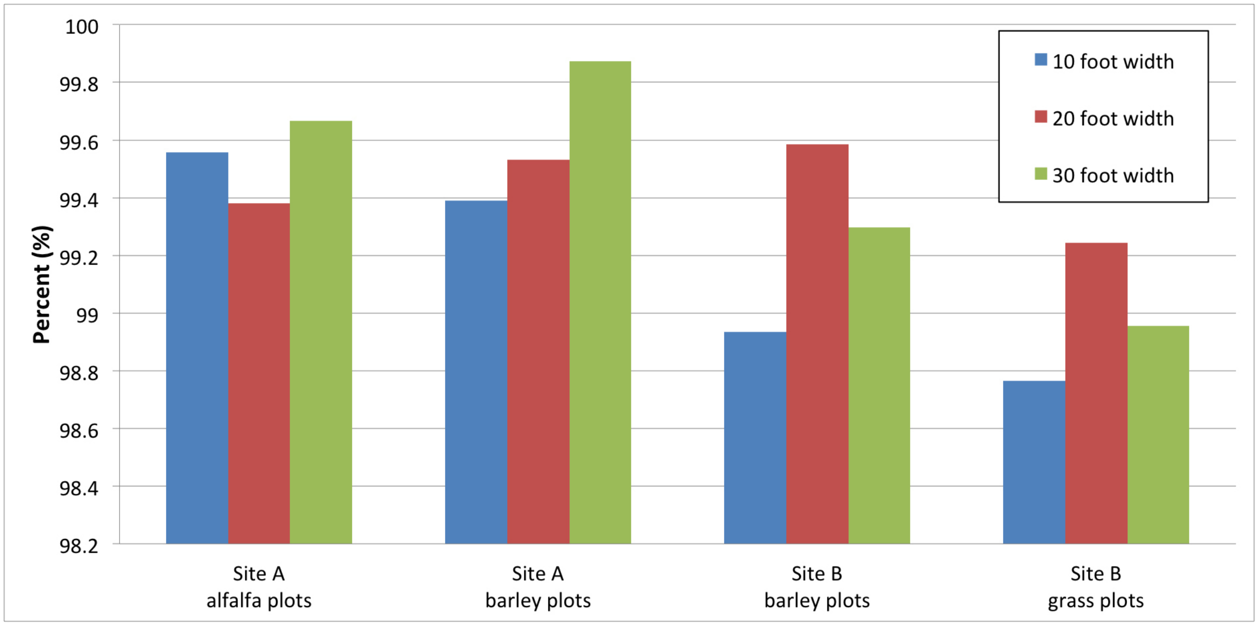

Figure 2. Average nitrate removal efficiencies of experimental VFS plots.

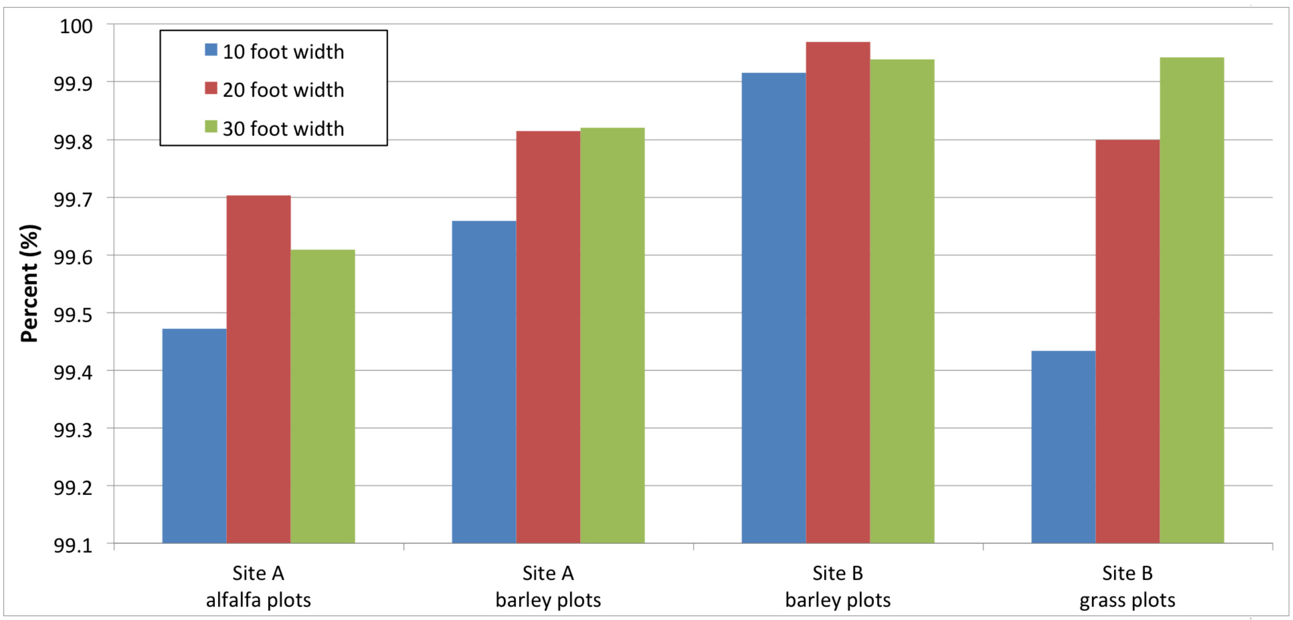

Figure 3. Average suspended sediment removal efficiencies of experimental VFS plots.

This document was adapted from: Bodah, B. W. "Effective Suspended Sediment and Soluble Nutrient Load Mitigation in Irrigated Agricultural Return Flows Through the Use of Vegetative Filter Strips." PhD diss., Washington State University, 2013.

References

Bodah, B.W., J.L. Ullman, R. Muñoz-Carpena, G.A. Kiker, O. Perez-Ovilla, W.L. Pan, R.T. Peters, and M. Stannard. 2012. Sediment and nutrient reduction in irrigated return flows by vegetated filter strips on surface irrigated fields. ASABE Paper #12-1336855. American Society of Agricultural and Biological Engineers, St. Joseph, MI.

Carballas, T., E. Diaz-Fierros, M.J. Acea, A. Cabaneiro, M. Carballas, F. Gil, M.C. Leiros, E. Lopez, A. Nunez, and M.C. Villar. 1990. El purin de vacuno en Galicia. Caracterizacion, poder fertilizante y problemas ambientales. COTOP, Xunta de Galacia, Santiago de Compostela, Spain.

Chaubey, I., D.R. Edwards, T.C. Daniel, P.A. Moore, Jr., and D.J. Nichols. 1995. Effectiveness of vegetative filter strips in controlling losses of surface-applied poultry litter constituents. Transactions of the ASAE. 38(6): 1687-1692.

Díaz-Fierros, E., A. Nuñez, and E. Lopez. 1990. Risk of water contamination by superficial runoff resulting from the spreading of cattle slurry. Nitrates, Agriculture, Eau. INRA Editions, Paris, pp. 482-6.

Dillaha, T.A., J.H. Sherrard, D. Lee, S. Mostaghimi, and V.O. Shanholtz. 1988. Evaluation of vegetative filter strips as a best management practice for feed lots. *Journal (Water Pollution Control Federation)* 60(7): 1231-1238.

Fajardo, J.J., J.W. Bauder, and S.D. Cash. 2001. Managing nitrate and bacteria in runoff from livestock confinement areas with vegetative filter strips. *Journal of Soil and Water Conservation* 56(3) 185-191.

Line, D. E. 1991. Sediment trapping effectiveness of grass strips. Fifth Federal Interagency Sediment Conference, 18–21 March, Las Vegas, Nevada, Volume 2: 53–56. U.S. Government Printing Office: Interagency Advisory Committee on Water Data, 0–288–410.

Nuñez, A., E. Lopez, and F. Diaz-Fierros. 1991. Contaminacion das augas por escorremento superficial en pradeiras en pendente tratadas con purin de vacuno. Cuadernos da area de ciencias agrarias do seminario de estudos galegos. 11: 163-182.

Osborne, L. L. and D.A. Kovacic. 1993. Riparian vegetated buffer strips in water-quality restoration and stream management. *Freshwater Biology* 29: 243-258.

Robinson, C.A., M. Ghaffarzadeh, and R.M. Cruse. 1996. Vegetative filter strip effects on sediment concentration in cropland runoff. *Journal of Soil and Water Conservation* 51(3): 227-230.

Schachtman, D. P., R. J. Reid, and S. M. Ayling. 1998. Phosphorus uptake by plants: from soil to cell. American Society of Plant Physiologists 116(2): 447-453.

Issued by Washington State University Extension and the U.S. Department of Agriculture in furtherance of the Acts of May 8 and June 30, 1914. Extension programs and policies are consistent with federal and state laws and regulations on nondiscrimination regarding race, sex, religion, age, color, creed, and national or ethnic origin; physical, mental, or sensory disability; marital status or sexual orientation; and status as a Vietnam-era or disabled veteran. Evidence of noncompliance may be reported through your local WSU Extension office. Trade names have been used to simplify information; no endorsement is intended. Published April 2016.