



FORAGE PRODUCTIVITY OF VEGETATIVE FILTER STRIPS ESTABLISHED ON RILL- IRRIGATED ROW CROP FIELDS

By

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Vegetative filter strips (VFSs) are a best management practice (BMP) consisting of planted areas that remove pollutants from surface water runoff. These systems are traditionally implemented along streams and rivers (referred to as riparian zones), but a joint study conducted by Washington State University and the University of Florida explored the possibility of using VFSs as an option to mitigate the flow of pollutants from rill (furrow) irrigated fields to irrigation canals. A 10-foot wide VFS was found to remove over 98% of the sediment and soluble nutrients (nitrogen and phosphorus) when operated and maintained correctly (Bodah et al, 2012). More information on the effectiveness of VFSs at the end of rill irrigated row crop fields can be found in WSU Extension Technical Bulletin 2015-1386, and on VFSs in general in WSU Extension Fact Sheets 2015-1385, 2015-1387, and 2015-1410. An additional aim of the study was to examine the potential for harvesting the biomass for use as animal feed. Harvest of a VFS for hay or silage will help growers to recover costs of taking land out of production. This document provides information on the potential forage productivity that may be gained by implementation of VFSs as a best management practice (BMP).

Study description

Filter strips were planted at three sites (designated A, B and C here) in the Yakima River Basin. The VFSs were implemented on private operating farms to represent real-world conditions.

Site A was located on the end of a 787 ft. long field with a consistent 0.2% slope. The soil was a deep, somewhat poorly drained Toppenish silt loam. The crop rotation for this field for the past 10 years consisted of a cycle of one year of wheat followed by two years of corn. Site A was used in 2011 and 2012. The 2011 crop was field (grain) corn, which was fertilized using 200 lb./ac. anhydrous ammonia. The 2012 crop was chipping potatoes, fertilized with 200 lb./ac. anhydrous ammonia. The VFS was not fertilized at any time. Two, 1¼ in. diameter siphon tubes were used to irrigate every other furrow on the field on which site A was located. The irrigation water was run for a period of 12 hours. The irrigation return interval for each furrow was 7-10 days.

Site B was located on the end of a 600 ft. long field with a highly variable slope. The upper 30% of the field had a 3% slope, the center 40% of the field had a 5% slope, and the final 30% of the field had a 1.5% slope. The soil was a deep, poorly drained Wapato silty clay loam. The field was in its tenth consecutive year of field (grain) corn production.

Site B was used only in 2011. The field was last fertilized with dairy manure at the start of the 2010 growing season at an application rate of approximately 2 ton/ac. No additional fertilizer was applied in 2011. One, 1¼ in. diameter siphon tube was used to irrigate every other furrow on the field on which site B was located. The irrigation water was run for a period of 12-24 hours. The irrigation return interval for each furrow was 7-10 days.

Site C was located on the end of a 1320 ft. long field with a consistent 1% slope. The soil C was a deep, well drained Warden silt loam. The field was in its twentieth consecutive year of field (grain) corn production. Site C was used only in 2012. The site was fertilized annually with liquid manure at an application rate of 3,000 gal/square mile. The VFS was not fertilized with the field. One, 2 in. diameter PVC pipe was used to irrigate every other furrow on the field on which site C was located. The irrigation water ran for a period of 12 hours. The irrigation return interval for each furrow was 7-10 days.

Four different forage species were tested on working row cropped farms in central Washington utilizing rill (furrow) irrigation in the 2011 and 2012 growing seasons. The treatments examined were: 'Baronesse' barley (*Hordeum vulgare* L.), alfalfa (*Medicago sativa* L.) / arrowleaf clover (*Trifolium vesiculosum* Savi.), Bull tall fescue (*Lolium arundinaceum* (Schreb.) S.J. Darbyshire) and Durar hard fescue (*Festuca brevipila* Tracey). The biomass was harvested from 1 m² (10.8 ft²) plots and oven-dried at 60°C (140°F) for 24 hours. The grass plots were harvested in the milk stage (seed forming), while the alfalfa plots were harvested in mid-bloom, and cut from each plot to a height of 4 inches. The rates reported below are dry weights. Table 1 exhibits the vegetation types planted at each of the three sites, along with the average dry weight biomass production.

Several of the VFS plantings at site B were outcompeted and overtaken by an impressively pure stand of two weed species; barnyard grass (*Echinochloa crus-galli*), comprising approximately 70% of plot density, and lambs quarters (*Chenopodium album*), comprising the remaining 30%. These plots were retained and sampled purely in an effort to examine the biomass production capability of a plot consisting almost exclusively of an annual weedy grass that is naturally present in the seed bank and is able to self-establish under disturbed soil conditions. The results from these plots represent a conservative estimate of the potential production that could be generated by a VFS.

Table 1. Average dry matter forage production rates generated by harvest of vegetative filter strips located at the end of rill irrigated fields.

Forage crop	Seeding rate (lb/ac)	Dry matter harvested (lb/ac)		
		Site A (2011-2012)	Site B (2011)	Site C (2012)
'Baronesse' Barley	160	1189	1305	
Alfalfa/ Clover	16 / 4	248 (2011)		
		514 (2012)		
Bull Tall Fescue	25	237		832
Durar Hard Fescue	25	87		654
Barnyard Grass/ Lambs Quarters	N/A		746	

Table 2. Potential value generated by harvest of vegetative filter strips located at the end of rill irrigated fields.

		Avg. Filter Strip Study Plot Forage Production (1st cutting)		Avg. Washington Forage Production (single cutting)	
Forage Crop	Price ¹ (\$/ton)	Yield ² (ton/acre)	Value (\$/acre)	Yield ³ (ton/acre)	Value (\$/acre)
'Baronesse' Barley	\$104 - 132	0.59 - 0.62	\$62 - 86	1.0	\$104 - 132
Bull Tall Fescue	\$104 - 132	0.22 - 0.42	\$12 - 55	1.0	\$104 - 132
Alfalfa/clover	\$130 - 190	0.12 - 0.26	\$16 - 49	1.3	\$162 - 238

¹ USDA AMS price data for Washington-Oregon (Columbia Basin) hay sales for equivalent class and grade, 2005-2012.

² Harvested dry matter rates in Table 1 are divided by 2,000 lb. to arrive at the equivalent hay yield (ton/acre).

³ Hay yield for a single cutting is estimated by dividing average Washington State hay yields by 3 and 4 cuttings annually for grass and alfalfa, respectively (USDA NASS 2002-2012).

During the irrigation season, wet soil conditions made it nearly impossible to access the strip with heavy machinery for cutting, drying, and baling. Therefore it is our assumption that only a single cutting would be harvestable from each strip for hay/forage production per year. In our estimation, the optimal time to perform this cutting is immediately before the commencement of the first irrigation event of the season, allowing for adequate drying time for the forage prior to baling. However, depending on the operation, there may be the potential to harvest more frequently. For instance, there may be the opportunity to harvest a previously established filter strip prior to the beginning of the irrigation season, as well as after irrigation to the crop field has ended. This determination would need to be made by each farm manager based on their own conditions. For the purposes of this document, only the first cutting of the year was examined.

The VFSs used for this research were situated on the bottom 30 ft. of the irrigated row cropped fields, and were designed to exist along the entire length of the field. Our economic conclusions stipulate that the size of the VFS established must reflect that of the equipment utilized for harvest if forage production is to be attempted for economic return.

Potential returns from filter strip forage crop

Forage harvested from VFSs could be used on-farm or sold as hay. The value of hay on VFSs depends on yield potential, hay class and grade, and market prices. Different users have different preferences for quality and bale size, which also affects the marketability of hay in specific areas. Forage production for this study was not tested for quality, only quantity produced was measured.

Table 2 contains market value estimates for VFS hay based on (first cutting) dry matter production rates on VFS test plots in this study. The market prices used are from USDA Agricultural Marketing Service weekly price reports for Columbia Basin hay classes: low grade forage mix (barley and tall fescue) and alfalfa/grass mix (alfalfa/clover). The estimated market value of VFS hay ranges from \$62-\$86 per acre for barley, \$12-\$55 per acre for tall fescue, and \$16-\$49 for alfalfa/clover mix for the study test plots. The market value of a single cutting from a comparable quality hay field in Washington is included in the far right column of Table 2 for comparison. Barnyard grass is not a commercial crop in the Pacific Northwest and Durar hard fescue is not a suitable forage species, so market value is not estimated for these VFS treatments.

It is worth noting that the yields found in Table 1 are not representative of the potential productivity of the sites, but in essence reflect limitations in water availability for the growing forage. In general, the better the water management of the cash crop, the lower the excess water available for the filter strip, and the lower the forage yields. Poor cash crop water management leads to more excess water availability for strip forage, and better forage yields. Individuals implementing VFSs as a BMP should recognize the fact that forage yields will generally decrease as effective water management increases.

In the study plots, harvest data was predominately taken in the same year the VFS was established. It is possible that perennial forage crop species' yield potential would increase in subsequent years when the VFS is fully established and may approach yields comparable to typical forage fields given successful dense, weed-free filter strip establishment.

Forage production costs on vegetative filter strips

Managing a VFS for forage production requires additional work, so management costs should be compared with the potential value of the forage crop. Costs will vary substantially depending on the farm, field and primary crop characteristics, and the VFS size and species selected. Two cost categories are important to consider: management costs and opportunity costs.

- Management costs include inputs, labor, and machinery costs incurred to install, manage, and harvest the VFS. For a perennial VFS, costs will likely be higher in the first year when the VFS is becoming established and weed control is critical, compared to annual maintenance costs in later years. Machinery and labor costs may be higher if the VFS is difficult to access or navigate without damaging the primary crop. Alternatively, costs may be lower if the VFS is adjacent to another forage crop and can be managed simultaneously. Refer to the extension bulletin series on VFS (include document citations for #1, #3 & #4) for establishment and maintenance recommendations. Transportation costs should also be considered if the field is located far from the final user.
- Installing a VFS may displace a section of the primary crop resulting in lost net returns, also known as the 'opportunity cost' of the VFS. Reducing the primary crop area impacts both revenue (by lowering yield) and costs. Costs may decrease if fewer inputs are needed on the reduced primary crop area. Costs may increase if maneuvering around the VFS takes extra time. Hence the opportunity cost is the value of lost *net* returns from the primary crop.

We showed that a 10-foot VFS can effectively treat irrigation return flow (see previous documents in this series <<include document citation>>); however, the VFS may need to be above a minimum size for haying equipment to maneuver, thus displacing more of the primary crop.

Cost share programs exist that may cover some costs of establishing a filter strip. Consult your local extension office or Natural Resource Conservation Service (NRCS) office to inquire about programs in your area.

Is filter strip forage production worthwhile?

In addition to removing suspended sediment and excess nutrients from agricultural return flows (Bodah et al., 2012), vegetative filter strips can be managed to produce a forage crop. The data on which this document is based was produced on small-scale VFSs that were designed primarily for nutrient and sediment reduction in agricultural return flows, not designed primarily for forage production. Each farmer should evaluate his or her own situation to determine if the value of harvested forage, either sold or used on-farm, is worth the additional management and opportunity costs. The overall cost of establishing and managing a vegetative filter strip may prove to be less than or equal to other BMPs, while achieving similar results and providing a forage crop.

No farm manager should expect ideal results utilizing this BMP in the first year of establishment. Strip sizes, forage planted, the water, nutrient, and chemical needs of the cash crop displaced, cash crop and forage species compatibility, and harvesting/drying schedules will need to be examined in detail prior to attempting this BMP on your own land. The authors recommend consulting with your local Extension office before attempting this.

References

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