# Creating a Multivariate Queryable Database of Filter Strip Nutrient Removal Effectiveness in Agriculture

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## Introduction

As the United States looks to preserve and increase water quality, more nonpoint source water regulations are being put in place. This means that the water quality of field runoff from farms will need to meet a certain standard of cleanliness. While not all states have these regulations, farmers in states that do—like Colorado—might appreciate resources to aid the process of implementing the best management practices (BMPs) needed to meet nonpoint source water quality standards. One such BMP that can help maintain or improve the water quality of agricultural runoff is a vegetative filter strip. Filter strips are vegetated areas located at the end of a plant or animal agricultural field and designed to prevent nutrients like nitrogen (N) and phosphorus (P) from entering streams and other bodies of water. However, the effectiveness of the filter strips can vary greatly depending on variables related to strip installation and maintenance, as well as field site and strip characteristics. In hopes of aiding farmers across the United States, including those in the semi-arid west, the goal of this research is to create a comprehensive, query-able database that contains information about filter strips and their effectiveness under various conditions. This database will allow farmers to search key terms related to filter strip performance and use filter strip effectiveness results from previous studies to make informed judgments about how to best implement their own filter strip. It will also be helpful to researchers who are looking to contribute information or conduct studies with variables that have not been well represented.

## Methods

Vegetative filter strips are used to prevent soil runoff and nutrient loss in agricultural fields; however, the effectiveness of the filter strips varies depending on variables related to field size, filter strip size, time of year, and best management practices for upkeeping the filter strips, among many other variables that we determined were important to list in the database. The information in this database has been collected from all published filter strip studies that we could find. When reading through studies, it became clear that in some studies the terms filter strips and buffer strips were used interchangeably. At first we were only going to include data that specifically mentioned filter strips (which typically channel runoff from the field into the strip), but we ended up including information on buffer strips as well as filter strips as long as the strip was located at the end of the field it was filtering. Filter strip data were compiled by searching for filter strip studies that included several site characteristics and variables, such as information on N and P levels. Variables compiled for each study include site and filter strip dimensions, vegetation types, location, and filter strip efficiency, which is reported as percent reduction in N and P concentrations in runoff. To build the database, we used a coding language called Structured Query Language (SQL). MySQL allows for efficient organization and linking of related data tables and provides tools for making data queries. For the user interface, we used RMarkdown and Shiny widgets to build an HTML webpage with user input features. RMarkdown was incorporated to make the database user friendly for those who are searching for filter strip information. The combination of these tools makes the information easy to navigate and provides a way to display information in charts and graphs.

**Results and Discussion**

Dosskey et al. reported that wider strips tend to increase efficiency; however, if a strip is too wide it adds unnecessary cost. For a given strip width, the load trapped is also related to the pollutant load, type of pollutant, and dimensions of the field such as area and slope. These field dimensions along with weather patterns determine the runoff load that encounters the filter strip; a larger runoff load for a given filter strip width decreases the trapping efficiency for that strip, as does a higher slope, and increased concentration of the pollutant (DOSSKEY; HELMERS; EISENHAUER, 2008). The Natural Resources Conservation Service documented best practices in regards to planting and maintaining a vegetative filter strip to maximize efficiency, which includes the following parameters: species of vegetation, seed and stem density, field slopes leading to the strip, when and how to upkeep the strip, and lifespan, among others (NRCS, 2016). This information and similar types of information are shown in the database. Once the database is published, farmers and researchers will be able to look at the information and use it to form their own conclusions about how to best implement filter strips in their specific settings.

Filter Cols: « < 1 – 50 > »

| | Author.Date | Notes | location | BMP_type | vegetation_type |
|---|---|---|---|---|---|
| 1 | Ahiablame-2012 | | Texas, US | VBS/VFS | grass_swales |
| 2 | Ahiablame-2012 | | Melbourn, Australia | VBS/VFS | grass_swales |
| 3 | Ahiablame-2012 | | Virginia, US | VBS/VFS | grass_swales |
| 4 | Ahiablame-2012 | | Lab Experiment, Sweden | VBS/VFS | grass_swales |
| 5 | Ahiablame-2012 | | Aberdeen and Brisbane, Australia | VBS/VFS | grass_swales |
| 6 | Rahman-2013 | | Richland,ND | VBS/VFS | mixed vegetation |
| 7 | Rahman-2013 | has settling basin at end | Cass,ND | VBS/VFS | common cattails grass |
| 8 | Rahman-2013 | has settling basin at end | Cass,ND | VBS/VFS | common cattails grass |
| 9 | Rahman-2013 | has retaining pond at end | Sargent,ND | VBS/VFS | garrison creeping foxta |
| 0 | Rahman-2013 | has retaining pond at end | Sargent,ND | VBS/VFS | garrison creeping foxta |
| 1 | Ahiablame-2012 | | Texas, US | VBS/VFS | grass_swales |
| 2 | Ahiablame-2012 | | Melbourn, Australia | VBS/VFS | grass_swales |

Showing 1 to 13 of 20 entries, 55 total columns

*Figure 1. Database Snapshot*

**Conclusion**

Maximizing the efficiency of a filter strip is a complicated task—it relies on several variables and parameters. It is possible to maximize the efficiency of a vegetative filter strip with the right measurements and information, which will be specific to each site and its conditions. The database includes as much information as possible about each agricultural site, its filter strip, and other properties that might affect the percent reduction of nitrogen and phosphorus in runoff. Currently, the database includes 67 datapoints, more than 12 locations, and around 36 variables. The most commonly noted variables include location, filter strip length and width, field length and width, agriculture type, filter strip vegetation type, grazing patterns, annual rainfall, filter strip slope, season of study, and influent N and P concentrations. The database will be made available to the public in a web interface created using MySQL and RMarkdown. Not only do these programs allow us versatility in creating the webpage, the two also provide versatility for the users by displaying information through interactive tables, graphs, charts, and other ways that are convenient for viewing. Two main tables will be linked together, one with the information on filter strips, and one that contains author/source information. The database will eventually be queryable so that anyone looking for filter strip information can easily find data on various filter strip set-ups and efficiencies. This information will be available to the public, allowing farmers to search various site conditions and filter strip variables and view the associated N and P reductions.

Citations

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ROBINSON, C.; GHAFFARZADEH, M.; CRUSE, R. Vegetative filter strip effects on sediment concentration in cropland runoff. **Journal of Soil and Water Conservation**, 51, n. 3, p. 227-230, 1996.

(ROBINSON; GHAFFARZADEH; CRUSE, 1996)