MIDSOUTH

Grassed Filter Strips Can Reduce Losses of Nitrogen and Phosphorus in Runoff

By D.R. Edwards, P.A. Moore, Jr. and T.C. Daniel

Many studies have been conducted over the past three decades to learn the quantity of nutrients lost in runoff, what variables affect these losses, and how nutrient loss can be minimized. Most studies have focused on row crops, which are managed intensively in comparison to forage crops. We have investigated similar questions over the past seven years for pasture systems, because they are the dominant agricultural activity in some regions, especially in areas unsuitable for row crop production. When nutrients are applied as manure or fertilizer, pasture systems should also be managed so that nutrient runoff is minimized.

> Farmers have for many years used various management techniques to minimize runoff losses of nutrients. In the past, this was primarily because losses represented wasted time, effort and money. With increased awareness of the potential environmental impacts of nutrient losses, these management techniques are now considered an essential element of good stewardship of natural resources.

Preliminary Studies

The goal of our initial field experiments was to determine how nutrient loss in runoff was related to application rate and storm severity. We did this work on 5 ft. by 20 ft. plots with fescue established on a silt loam soil. Animal manures (broiler litter, poultry manure and swine manure) were applied (at 0.5, 1, and 2 times the recommended rates) to moist soil. Simulated rainfall was applied the following day at 2 and 4 inches/hour until 30 minutes of runoff had occurred. Runoff losses increased with application rate and storm severity, as expected. Nutrient losses amounted to reasonably low (less than 5 percent) proportions of the amounts applied, even though the experimental conditions were severe.

In follow-up work the same experimental set-up was used to compare poultry litter, swine manure, poultry manure, and inorganic fertilizer in terms of nutrient loss and to learn how nutrient loss varied with the number of runoff events following application. Runoff loss of total nitrogen (N) was generally the same for all sources, but more phosphorus (P) was lost from the plots that received inorganic fertilizer than with those treated with animal manure. We also found that considerably more fertilizer was lost in the first simulated storm following application than in succeeding storms (**Figure 1**), and that runoff reached background levels of N and P after 2 or 3 simulated storms. Our chemical analyses also showed that most nutrient loss (especially for inorganic fertilizer) consisted of soluble forms, as opposed to particulate forms. This indicates that techniques that reduce erosion would

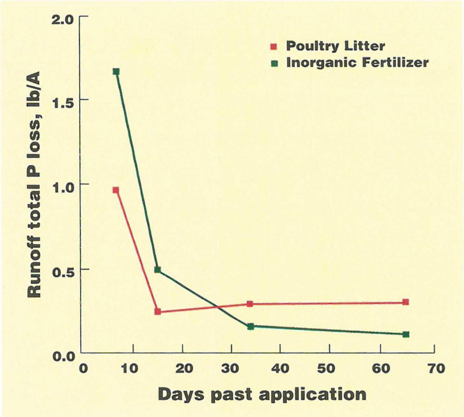

Figure 1. Relationship between time past application and runoff P loss for inorganic fertilizer (13-13-13) and poultry litter. Total N applied was 244 lb/A, with the balance of N from ammonium nitrate in the fertilizer treatment. Total P_2O_5 rate was 230 lb/A.

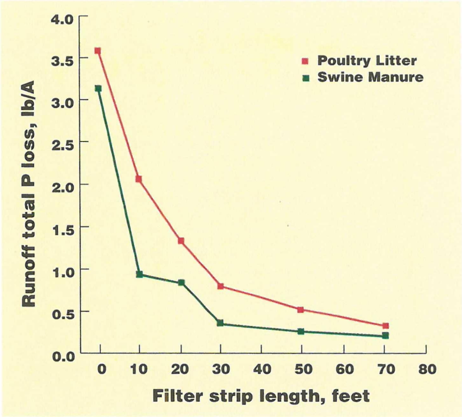

Figure 2. Effect of grassed filter strip length on runoff P loss for swine manure and poultry litter. Total N applied was 208 and 227 lb/A, and total P_2O_5 applied was 230 and 360 lb/A, for the poultry litter and swine manure, respectively.

have little or no impact on reducing nutrient losses under our conditions.

It is tempting to dismiss runoff losses of a few pounds per acre of N and P as insignificant from the standpoint of environmental impacts. While these small losses might be of little or no agronomic significance, aquatic systems can be considerably more sensitive to relatively small nutrient loadings than row crop and pasture systems. In other words, seemingly small amounts of N and/or P can cause undesirable growth of algae and aquatic weeds in ponds or lakes, even though they might have no noticeable impact if applied to pasture or row crops. Therefore, we began work to study management techniques that could reduce nutrient runoff losses to levels even lower than what we had observed.

Grassed Filter Strip Studies

In 1993, we began to examine how effective grassed filter strips (GFS) were in terms of removing nutrients in runoff from pasture. Grassed filter strips (also known as buffer zones and buffer strips) are simply grassed areas installed downslope of fertilized areas to filter and purify entering runoff as it flows across the filter. Other scientists had studied GFS previously, finding that they could be quite effective (better than 95 percent) in removing sediment and nutrients, but relatively little work has been done to establish their effectiveness for pastures. Our experimental set-up was similar to that described earlier, but we used 80 ft. plot lengths instead of 20 ft. We applied poultry litter and swine manure to the upper 10 ft. of the plots having a 3 percent slope, letting the remaining 70 ft. act as a GFS, and analyzed runoff samples collected at various distances down the GFS. Our results were similar to those from other studies, showing that 90 percent or more of the incoming N and P was removed by the GFS (**Figure 2**). There was generally

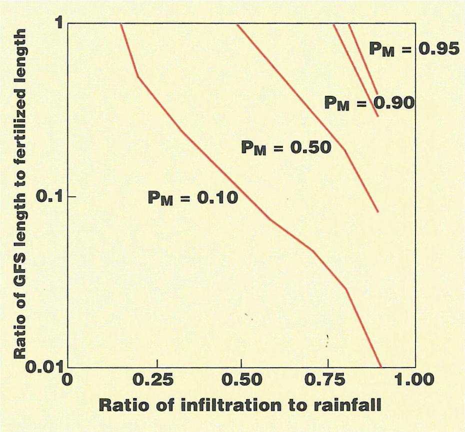

Figure 3. Required ratio of grassed filter length to fertilized field length as a function of the ratio of infiltration to rainfall and the desired reduction in soluble N and P loss (P_M).

no additional removal beyond a GFS length of 30 ft.

We followed the preliminary GFS work with a study to learn how filter effectiveness varied depending on the length of fertilized runoff source. In this work, we applied poultry litter to 20, 40 and 60 ft. of the 80 ft. long plots, having a 3 percent slope and allowed the remaining plot lengths to serve as GFS. Even for the longest fertilized length, small GFS lengths were effective (20 to 40 percent) in removing incoming N and P. However, the effectiveness of a particular GFS length decreased with increasing length of the contributing fertilized area, as expected. This is because under our conditions, the GFS removed N and P primarily through infiltration. Water in the GFS could infiltrate only at a certain rate, regardless of how much water was entering the GFS. The longer fertilized lengths contributed more water to the GFS than the shorter fertilized lengths, so the proportion of water and soluble N and P that infiltrated in the GFS was less for the longer fertilized lengths than for the shorter ones.

Our most recent work with the GFS has involved developing methods that allow one to determine how long a filter strip should be under a given set of conditions. In this study, we combined our experimental observations with other methods of predicting runoff and GFS performance to develop sets of charts and equations. These charts and equations can be used with field dimensions and readily-available crop, soil and rainfall data to easily determine what GFS length is required to reduce nutrient runoff to particular levels. A chart such as that given in **Figure 3**, can be used to select filter length for pasture on silt loam soil as a function of field length and GFS effectiveness.

Practical Considerations

Because of the way they operate, installation and maintenance of GFS are critical to ensure that they perform as expected. First, they should be installed on the contour, without regard to fence or property lines. The filters should be laid out upstream of any defined channels; i.e., the runoff should be filtered before it reaches the point that even small channels can be identified. Similarly, the filters should be maintained so that "sheet flow" occurs across the filter, as opposed to concentrated flow in even small channels. If channels develop within the GFS, then proportionately less runoff will infiltrate, decreasing the GFS' effectiveness. These considerations can make it difficult to designate and implement GFS areas, particularly in fields with irregular topography and having many low regions that function as small channels during runoff. Unless the GFS are properly installed, however, it could be questionable whether they provide any measurable benefit at all. Finally, the GFS should be fertilized. The amount of nutrient entering the GFS, as mentioned earlier, is quite small in agronomic terms. Additional fertilizer should be added as necessary to ensure a good stand of grass within the filter. Perhaps the best time to fertilize the GFS is some time after the first runoff has occurred from the fertilized field; this way, the GFS will be effective in filtering the most heavily concentrated runoff from the contributing field.

Summary

Our studies have shown that regardless of the source (organic or inorganic), runoff losses of N and P from fertilized pasture are relatively small proportions of the amount applied. These losses are also associated primarily with soluble N and P forms, rather than particulate forms, indicating that reducing erosion from pasture fields will have little impact on reducing nutrient losses. Grassed filter strips can be quite effective in reducing nutrient losses. The keys to using GFS to the best advantage are using the appropriate length and installing and maintaining them properly. We have developed methods to size GFS in general cases; but those wishing to use GFS should consult with USDA Natural Resources Conservation Service or Cooperative Extension Service personnel for the latest information specific to their locale. BC

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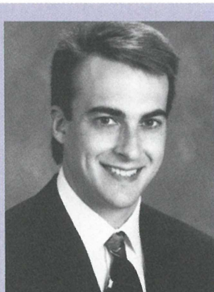

PPI Announces T. Scott Murrell as Director for Northcentral Region

T. Scott Murrell has joined the staff of PPI as Northcentral Regional Director. He will be responsible for the agronomic research and education programs of the Institute.

"Scott Murrell has a great future with PPI and will contribute immensely to our organization," said Dr. David W. Dibb, President of PPI.

In 1986, Dr. Murrell earned a B.A. degree, with distinction, in general history at Purdue University. He did graduate work at Yale University before returning to Purdue, where he was awarded the M.S. degree in agronomy in 1991. He recently completed his Ph.D. degree in Soil Chemistry at Texas A&M University.

Over the past five years Dr. Murrell's study has centered around establishing interdisciplinary research between chemistry and soil science to investigate the mechanisms of phosphate reactions with iron oxides using techniques that analyze soil surfaces directly.

In his new responsibilities, he will direct PPI programs in North and South Dakota, Iowa, Minnesota, Nebraska and Wisconsin. His office is located in the Minneapolis-St. Paul area. BC