RIPARIAN BUFFER SYSTEMS FOR MANAGING EFFLUENTS

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Abstract. The concept of utilizing riparian buffer systems to manage agricultural effluents is being investigated in two separate studies at the Coastal Plain Experiment Station, Tifton, Georgia. In one study determination is being made of the effects of a restored forested riparian buffer system on nutrients entering from an upland site receiving dairy lagoon waste. In a second study management strategies for utilizing riparian buffer systems for direct application of swine lagoon waste by overland flow are being determined. Data collected from the restored wetland impacted by dairy effluent show that the system is effectively removing nutrients. Data collected since the start of swine effluent application indicate that the systems are utilizing N and P such that the high concentrations found in the waste are not observed in water at the bottom ends of the plots. Both of these projects are designed to aid land managers in developing systems for managing agricultural effluents so that soils and waters are not degraded.

RELATED RESEARCH

Land application of animal wastes is viewed as a mechanism for both disposing of and using the wastes to supply nutrients for plant growth. A number of researchers have investigated use of filter strips for treatment of animal wastes. Doyle et al., (1977) applied 850 kg N/ha from dairy manure and found that 3.8 m of forest buffer or 4.0 m of grass buffer improved the water quality of manure-polluted runoff. Edwards et al. (1971), Dickey et al. (1977), and Swanson et al. (1975) found that a 500-m heavily grassed waterway, vegetative filters, and a serpentine waterway, respectively, permitted highly polluted initial runoff from barnlots and feedlots to be infiltrated into the soil and diluted by runoff from outside areas.

Riparian forests are known to be effective in reducing nonpoint pollution from agricultural fields. Studies in the Gulf-Atlantic Coastal Plain region have shown that concentrations and loads of N in surface runoff and subsurface flow are markedly reduced after passage through a riparian forest (Lowrance et al., 1985).

The limited field data on using riparian forests to control agricultural non-point pollution have been integrated into draft national specifications for three zone riparian buffer systems by the USDA-Soil Conservation Service and Forest Service (Welsch, 1991). Zone 1 is a narrow band of permanent trees (5-10 m wide) immediately adjacent to the stream channel that provides streambank stabilization, organic debris input, and shading of streams. Zone 2 is a forest management zone where maximum biomass production is stressed. Zone 3 is a grass buffer strip up to 10 m wide to provide control of coarse sediment and spreading of overland flow.

Two Research Projects at Tifton, GA

Ongoing research at the Coastal Plain Experiment Station, Tifton, GA, is focusing on determining the feasibility of using riparian zones for utilization and treatment of effluent. In one study a riparian buffer zone downslope of a site receiving liquid dairy waste has been restored by planting hardwoods adjacent to the stream and pines in the Zone 2 portion of the landscape. A second study is determining the feasibility of using Zones 3 and 2 of riparian buffer systems to utilize and treat swine lagoon effluent. Both of these studies are designed to gain practical information on techniques for using animal wastes which will aid Georgia animal producers in maintaining water quality standards. This paper describes both projects and their objectives, and presents preliminary results.

PROJECT #1: WETLAND RESTORATION AND FILTERING OF DAIRY LAGOON EFFLUENT

This project is being conducted at a site where screened liquid dairy manure from a storage lagoon is applied on 5.6 ha by center pivot irrigation (Fig. 1). Waste is applied to the landscape portion directly above a restored riparian forest wetland at a rate approximating 600 kg N/ha/yr. Nutrients from the waste can then move via surface runoff and shallow subsurface flow into the downslope wetland.

The wetland was restored in February 1991 by reintroducing a combination of native trees. The specific objectives for the restoration were to: (a) measure nutrient (N, P) concentration changes in surface runoff and shallow groundwater as they move through the wetland; (b) determine nutrient uptake and removal in the wetland by soil microbial processes and vegetation; and (c) evaluate the wetland as a potential bioremediation site.

Surface runoff is sampled at two locations entering the wetland and at two locations near the stream (Vellidis et al., 1993). Groundwater in and around the perimeter of the wetland is monitored by wells.

Data from surface runoff events have shown reduction of both N and P concentrations as water passes through the wetland. Data from the study to date show that NO_3-N concentrations entering the upper end of the wetland in shallow groundwater average 8.2 mg/L while the mean NO_3-N concentration in the drainageway at the bottom of the wetland is 0.9 mg/L.

Evaluation of the wetland as a bioremediation site is being accomplished by maintaining a nutrient budget over the life of the project (Hubbard et al., 1992). This budget includes the observations of surface and shallow groundwater quality plus results from soil samples. Soil samples for denitrification and inorganic N measurements are being taken monthly at 5 depth increments to 0.3 m. Gaseous losses of N from the soil through denitrification are measured in intact core samples. It is anticipated that the effectiveness of the wetland as a bioremediation system will increase as the trees mature.

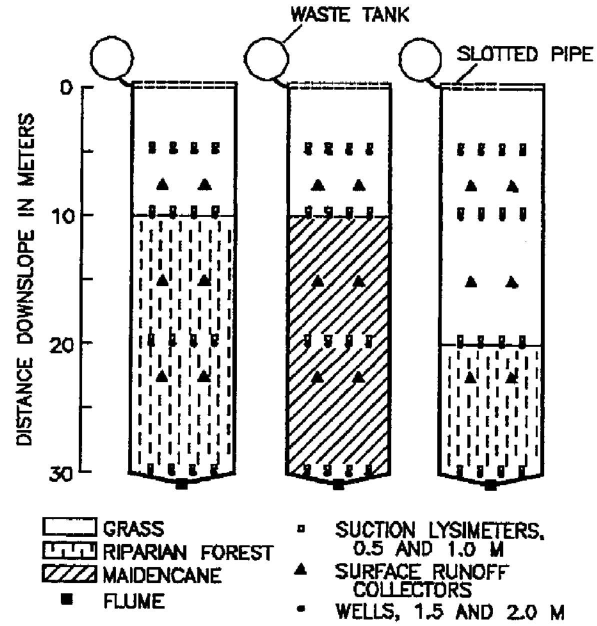

Figure 1. Vegetative treatments and instrumentation for swine waste project.

PROJECT #2: OVERLAND FLOW-RIPARIAN ZONE TREATMENT OF SWINE LAGOON WASTE

This project will (1) determine the ability of grass-riparian zone buffer strips to cleanse animal waste applied by overland flow, and (2) compare the filtering effectiveness of naturally occurring riparian vegetation with that of recommended wetland species.

Three different vegetative treatments are being used: (1) 10 m grass buffer (Tifton 78 Bermudagrass [*Cynondon dactylon* L. Perso.] with an interseeding of Georgia 5 fescue [*Festuca arundinacea*] cultivar [for winter cover]), draining into 20 m of natural riparian forest, (2) 20 m grass buffer draining into 10 m natural riparian forest, and (3) 10 m grass buffer draining into 20 m maidencane (*Panicum hematomon*). Swine lagoon effluent is applied by overland flow to replicated plots of each vegetative treatment at either high (2X) or low (1X) rates (Fig. 2).

Measurements are being made of solute movement in surface runoff and into shallow groundwater. Runoff samples are being collected within the 30 X 4 m plots and at the bottom edge. Groundwater quality is being determined in water samples collected from solution samplers at depths of 0.5 and 1.0 m, and from wells at 1.5 and 2.0 m. The runoff collectors, solution samplers and wells are located on transects from the top to the bottom edge of each plot.

Evaluation of data from the project so far has focused primarily on N. Mean NH_4-N concentrations in surface runoff within the plots over all treatments at 7.5, 15, and 22.5 m downslope during fall 1993 and winter 1994 were 25, 14, and

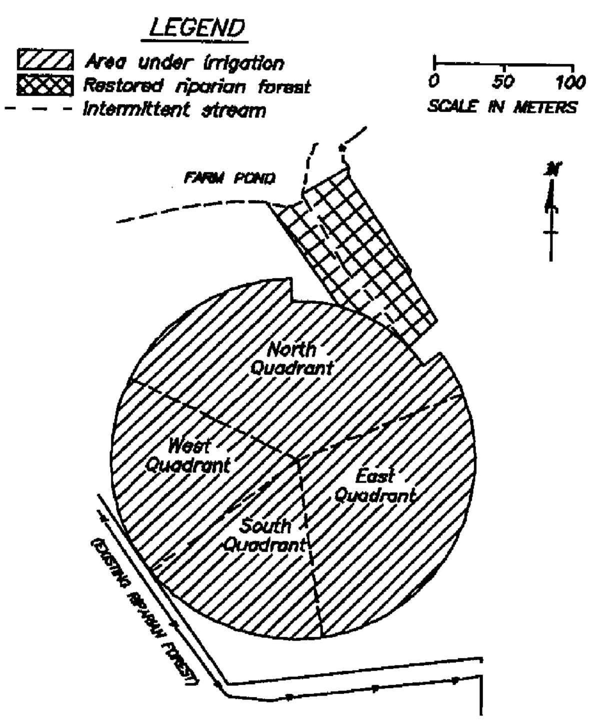

Figure 2. Dairy upland and restored riparian zone.

5 mg/L, respectively. Ammonium samples collected by automatic samplers at the ends of the plots had concentrations ranging from less than 0.1 to 3.6 mg/L with an overall mean of 0.3 mg/L. Nitrate concentrations in these same samples ranged from less than 0.1 to 3.2 mg/L with a mean of 0.8 mg/L. Chloride concentrations ranging from 0.1 to 16.8 mg/L with a mean of 3.7 mg/L in these same samples indicate that solutes from the waste are reaching the ends of the plots while the lower N concentrations indicate that N species are being effectively filtered.

Water samples collected from all four depths showed impact of the applied wastes at the upper ends of the plots, but little or no impact at the lower ends. For example, mean NO_3-N concentrations at 0.5 m depth over all treatments were 30.9, 22.7, 7.4, and 4.4 mg/L at 4.5, 9.5, 19.5, and 29.5 m downslope, respectively. At 1.5 m depth the mean NO_3-N concentrations over all treatments for these same locations were 19.3, 17.4, 10.2, and 7.8 mg/L, respectively. Denitrification rates measured on cores collected from the plots showed a response to the applied waste.

CONCLUSIONS

Data collected since 1991 from the restored wetland that is impacted by liquid dairy manure show that the wetland buffer system is effectively removing nutrients.

The swine waste overland flow grass riparian buffer plots first received waste in October 1993. Data collected to date indicate that these systems are utilizing N and P such that the high concentrations found in the waste are not observed in water at the bottom ends of the plots.

Both of these research projects are designed to aid land managers in developing systems for utilizing and treating animal waste so that soils and waters are not degraded.

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