LEOPOLD CENTER
FOR SUSTAINABLE AGRICULTURE

Impacts of managed grazing on stream ecology and water quality

Abstract: The project measures and analyzes the varying effects different grazing systems have on the nutrients that appear in surface runoff.

Question & Answer

Q: Can sediment and phosphorus pollution of pasture streams be controlled by grazing management?

A: The results of the project demonstrated that sediment and phosphorus loading from upland areas of pastures may be controlled by using grazing management practices that maintained forage height at 4 inches or greater. Similarly, maintaining adequate forage along pasture streams limited sediment and phosphorus loading from stream bank erosion. However, the confounding of stocking management practices with stocking rate and climatic variables make it difficult to define which management practices are most beneficial.

Background

Researchers hypothesized that there would be no differences in the amount of sediment, phosphorus (P) and nitrogen (N) contributed to the stream from upland and riparian pasture and stream banks. They suspected that certain conditions would increase the contribution of sediment, P and N to the stream channel from either erosion or manure deposition. They also wanted to consider how degradation of some riparian features would affect P and N losses and the quality of the stream bank.

Overall project objectives were to:

1. Demonstrate the impact of different grazing systems on the structure and growth of forage and the production of sediment, phosphorus and nitrogen in surface runoff.
   a. Determine the amount of phosphorus and nitrogen in the stream associated with sediment from upland and riparian surface runoff, ephemeral and classic gullies, and stream bank erosion.
   b. Demonstrate the effects of grazing management practices on changes in soil phosphorus.
2. Develop whole-farm phosphorus budgets for each demonstrated grazing system.

Approach and methods

The project compared the contribution of non-point source (NPS) pollutants, sediment, P, and N from upland and riparian grazing systems to streams. Four different types of demonstrations were conducted in two landscape positions.

An upland demonstration was conducted at the Iowa State University Rhodes Research and Demonstration Farm near State Center. This demonstration focused on the impacts of different upland grazing practices, with and without toe slope buffers, on P, N, and sediment production and potential movement to a stream.

A second group of demonstrations was established in riparian grazing systems on private farms in northeast,

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central and southeast Iowa. The sites were chosen based on landowner grazing practices. A major component of these demonstrations was the monitoring of stream bank erosion on the selected pasture sites and additional land-use practice sites.

In each of these demonstrations, investigators monitored the contributions of sheet, rill, and gully erosion to sediment; and P and N reaching the stream using both natural and simulated precipitation events. They checked different intensities and patterns of grazing, which included grazing to different forage heights in the upland demonstration and grazing under the broadly defined practices of continuous, rotational, and intensive rotational riparian grazing with livestock access to the stream or grazing in the riparian zone with no access to the stream.

The effort to track movement of sediment, P and N from pastures under more controlled conditions was expanded with a demonstration at the ISU Swine Nutrition Farm located west of Ames. This site has three fully instrumented grass buffers on which livestock was grazed to determine their contribution to P and N in surface runoff.

Information from several components of these demonstrations was used to develop whole-farm P and sediment budgets using several different modeling techniques.

Results and discussion

Upland grazing demonstrations. Of the soil and sward characteristics measured, vegetative cover was most highly related to the amounts of sediment and total phosphorus lost in the precipitation runoff. These relationships seem to imply that maintaining adequate forage through grazing management or the establishment of vegetative buffers will be effective in limiting sediment and phosphorus losses from upland areas of the pastures. The use of a rotational stocking system to a minimum forage height of 4 inches is one practice that can be used to maintain adequate forage cover in pastures. Areas of the pasture with high slope have greater potential to generate surface runoff and sediment loss than do areas with low slope. Managing these areas separately, at a lower stocking rate, may be necessary to reduce sediment loss from hilly pastures.

Soil and root sampling efforts. Soil test P may be related to total, soluble, and particulate P in runoff from grazed land, but significant correlations in heavily grazed and ungrazed pastures were not observed in this study. This suggests that due to the large amount of variability in grazing systems, P in runoff is hard to predict from a soil test alone.

Runoff plot demonstrations. During the three field seasons covered, there were 13 rainfall/runoff events. The study showed that VFS (vegetative filter strips) removed significant quantities of nutrients such as NO_3-N and PO_4-P from the surface runoff, with certain area ratios offering more effective VFS treatment than others. It also was noted that grazing practices provide potential for spatial temporal variability of nutrient runoff from grazed pastures.

Riparian grazing demonstrations. These concentrated on the impact of grazing in the riparian landscape position, building on work done previously in Wisconsin. There were mixed results when comparing rotational and intensive rotation pastures to continuous pastures. In some cases, researchers saw significant decreases in erosion rates and soil and phosphorus losses, while in others there were increases. These differences likely occurred because many landowners do not follow the textbook definition of rotational and intensive rotational

Aerial view of research plots for grazing surface runoff project grazing and because many of the systems only recently have been converted from continuous grazing to rotational or intensively grazed rotational practices. In general, intensive rotational pastures should improve the stream bank stability and decrease soil and phosphorus losses.

There probably would be higher levels of bank stabilization when the number of paddocks along the streams is decreased. Fewer stream paddocks would mean more rest time for the stream reach, and less impact of upstream paddocks on downstream paddocks. Finally, other studies have shown that stocking rates and the season and number of days the pasture is grazed are as important (if not more important) than changes to the grazing systems.

Conclusions

1. From the upland demonstration, it is evident that sediment and P move down slope on steep slopes, and grazing practices that keep forage near 2 inches in height for longer periods of time produce more sediment and P than practices that maintain at least 4 inches of forage.

2. Buffers located along the foot and toe slopes of steep upland pastures were found to be effective at reducing P and sediment movement to the stream.

3. Root length density of the length of root per unit of soil volume varied across treatments, pastures, and depths, but did not significantly differ among treatments. Root length density to a soil depth to 6 inches tended to be lower in ungrazed pastures than in grazed pastures, implying a deeper root system in ungrazed pastures.

Rhodes Farm field day

4. Soil test P may be related to total, soluble, and particulate P in runoff from grazed land, but significant correlations in heavily grazed and ungrazed pastures were not observed at this site. This suggests that due to the high variability among grazing systems, P in runoff is difficult to predict merely from a soil test.

5. The riparian demonstration showed that continuous grazing produces more sediment and P movement in surface runoff than other less intense rotational grazing practices. There was little difference between the sediment and P produced under rotational and intensive rotational grazing practices—although there were no clearly defined differences between the management of the two systems.

6. It is evident from the riparian demonstration that riparian grazing has its greatest impact on stream bank erosion. Stream banks along continuously grazed pastures

Cattle grazing in demonstration plot at Rhodes Farm had erosion occurring along more than 40 percent of the channel length. Intensive rotational grazing pastures showed erosion along about 30 percent of their channel length, while pastures with livestock excluded from the channel or stream banks with grass filters or riparian forest buffers exhibited erosion along less than 15 percent of their channel length. (Streams are considered healthy if 20 percent or less of the channel length displays eroding banks.)

7. From whole farm calculations, it appears that P was efficiently recycled in the rotational systems. In the stockpiled system, a net loss of P occurred annually. In the continuous grazing system, greater runoff occurred and forage production was minimally sufficient to maintain intake needs under the demonstrated stocking practice. Overall, the results suggest that the rotational systems have stronger potential to be managed in a sustainable manner. (The impact of buffers on the management practices was not considered at this point.)

Impact of results

This project has provided a much needed quantitative dataset on the effects of different riparian grazing systems compared to other riparian agricultural and conservation practices in Iowa. Stream bank erosion can be a major source of sediment and phosphorus to streams and the land use practices in the riparian area can strongly influence stream bank erosion. Excluding direct access of livestock to the stream channel and eliminating row cropping near the stream bank dramatically improves stream bank stability. The absence of these agricultural activities can reduce soil loss from stream bank erosion by hundreds of metric tons and decrease phosphorus by hundreds of kilograms. In general, there were fewer differences than expected between the grazing systems, although there are indications that moving to intensive rotational grazing could reduce stream bank erosion. Also, in many cases the stocking rates, number of grazing days and/or time of year the pasture is grazed are more important than shifting to different grazing systems.

Education and outreach

Members of the research team made 54 presentations about the project between November 2000 and March 2005. Twenty-one publications have been prepared. These appeared in publications such as the ISU Beef Research Report, the *Journal of Soil and Water Conservation*, and the *American Water Resources Association Journal*. Additional publications have been submitted to review in *Rangeland Ecology and Management*.

Leveraged funds

Funding from the Leopold Center and the Iowa Department of Natural Resources (IDNR) to support this project provided the basis for receiving $329,000 from the IDNR to establish another project on grazing and stream bank stabilization.

Rainfall simulator used in the project

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