Abstract: The project considered what types and configurations of vegetative buffers might be effective in slowing soil loss at a Loess Hills site.

**Question & Answer**

**Q:** Will a planted buffer combined with periodic harvest of trees reduce phosphorus loss to adjacent stream, and prevent stream extension into the field?

**A:** A planted buffer (grass and trees) with periodic harvest of the cottonwood trees allowed phosphorus entrapment and removal before reaching the stream. Also, the stream did not extend further into the field as had occurred in the past.

**Background**

Land management practices that produce soil disturbance or include nutrient amendments are thought to contribute disproportionately to increasing levels of phosphorus (P) in surface waters. The growing risk of eutrophication of surface waters has made reduction of P export from agricultural land an urgent matter.

Vegetative buffers have been shown to reduce nutrient loss associated with the transport of detached soil particles, help stabilize stream banks, and through plant uptake offer a means to capture dissolved nutrients moving to surface waters through the soil solution. There is some evidence that various types of vegetative covers differ in the timing of their water needs and in their relative ability to capture water from the soil.

Using P in the standing biomass as an index, the first objective of this study was to assess the biomass production and P uptake of three vegetative components of a multi-species riparian buffer during their first four growing seasons. For comparative purposes, biomass production and P uptake occurring in an adjacent established single-species buffer also were measured.

The second objective was based on the hypothesis that a buffer composed of multiple vegetative cover types with different growth patterns would be more effective in reducing soil moisture level than would a single-species, cool-season grass buffer. The researchers tested this hypothesis by evaluating changes in the soil water balance as a function of vegetation cover type through a combination of soil and plant measurements.

If the project hypothesis were correct, a mixed tree-grass buffer planted along a first-order stream will dry the soil and lower the water table in fall and spring. The drier soil and lower water table combined with the developing root system will help stabilize the channel (bank) of the stream and prevent or reduce gully expansion. This could lead to a reduction of stream contamination by sediment, and help reduce phosphorus loss to the stream from groundwater.

**Approach and methods**

The study was conducted at the U.S. Department of Agriculture-Agricultural Research Service Deep Loess Research Station located in the Loess Hills region of western Iowa. In spring 2001, a multi-species riparian
buffer was established along the west side of an existing drainage way, extending 200 m downstream. Prior to establishment of the buffer, the study area had been in continuous corn-soybean rotation for more than 30 years. The buffer consisted of a 5-m-wide strip of switchgrass directly adjacent to the cropland, a 5-m-wide intermediate strip of alfalfa mixed with smooth brome, and a 15-m-wide strip containing four rows of fast-growing superior cottonwood adjacent to the drainage way. For comparison purposes, the opposing (east) side of the drainage way was left in an established stand of smooth brome (the single species control for the experiment) that had been in existence since 1964.

Periodic harvesting of aboveground vegetation was combined with root core sampling to estimate the total standing biomass, root surface area, and the pool of P in plant tissue in three vegetative cover types dominated by either switchgrass and alfalfa-smooth bromegrass mix, or a fast-growing superior cottonwood. Soil water was monitored with a neutron probe and hydraulic head was monitored in piezometer nests.

Results and discussion

Standing biomass increased in all three cover types during the four years of the study, with the greatest increases observed in the cottonwood and switchgrass. Biomass production in the smooth brome control did not change during the study period. Based on the fourth year samples, standing pools of P closely paralleled total plant biomass with cottonwood accumulating the greatest amount of P, more than four times as much as the smooth brome control.

Estimates of potential P removal from the site via biomass harvest from a mixed buffer when compared with the smooth brome control over a four-year interval suggested a 63 percent increase in removal capacity (largely due to the inclusion of cottonwood). The early study water table was more shallow on the buffer side than on the control side due to less slope and natural differences in lateral recharge. Cottonwood was more effective at lowering the water table than were the grasses because of more extensive rooting systems. Although the soil under the buffer vegetation was initially wetter, after 2002 there usually were no significant differences in subsoil moisture. Rainfall simulator studies showed reduced runoff and soil loss under buffer vegetation compared with cropped areas. During this study, there was no stream bank erosion and the stream did not extend further into the field.

Conclusions

The addition of a fast-growing woody species combined with periodic biomass harvests has the potential to reduce P movement to surface waters. Planted riparian vegetation is recommended for drying soil near first order streams and thus reducing soil loss due to bank sloughing. Grass and tree buffer vegetation along first-order streams can help reduce headcut extension in the Loess Hills.

At the end of four years, the peak amount of biomass present in the alfalfa, switchgrass, and smooth brome control cover types was of similar magnitude, while the amount of biomass present in the cottonwood cover type was an order of magnitude greater. These data also indicate that the smooth brome control cover type which had been in place for several years had reached a level of stability in terms of the amount of biomass produced each year, while there is at least a suggestion that the alfalfa and switchgrass communities have the potential to continue to increase to a higher level of production before stabilization occurs.

If the management goal is to minimize P transport to surface waters by plant capture, then it will be essential to have a system in place that will allow the P captured in the above-ground plant parts to be removed from the site periodically in order to sustain and maximize the capture potentials. Otherwise, it is likely that the herbaceous cover types will come to equilibrium fairly quickly and P uptake on a seasonal basis will be equal to return when biomass levels reach relative stability.

Impact of results

While not the focus of the study, one of the beneficial aspects of having a continuous vegetative cover, in addition to its ability to capture nutrients through plant uptake, is the positive impact of organic additions on rebuilding soil structure in previously cultivated soils.
Education and outreach

Articles on this project appeared in the *Journal of Environmental Quality, Plant and Soil*, and *Nutrient Cycling in Agroecosystems*. A presentation was made by the lead investigator at the 2004 Soil Science Society of America annual meeting. Manuscripts about the project results have been submitted for publication to *Agroforestry Systems*, and the *Journal of the Total Environment*.

Leveraged funds

Funds from this project supported half the salary of a post-doctoral research associate. The other half of his salary came from a grant provided by the USDA-ARS post-doctoral program. This arrangement allowed the post-doc to contribute directly to the project while also doing research in a closely related area. This was equivalent to approximately $50,000 over a two-year period.

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