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Grazing Management Affects Runoff Water Quality and Forage Yield

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Introduction

In 2008, most of the 30,000 beef farms in Arkansas were family owned (97 percent), averaged about 30 head per farm and accounted for about 1.8 million cows and calves, worth $432 million. The total economic impact of the Arkansas beef industry is well over $1.4 billion. Part of the beef industry's success is attributed to its symbiotic relationship with the broiler industry. In fact, the two industries experienced paralleled growth with the broiler industry, providing litter to grow the forage on otherwise unproductive soils and terrain.

While both industries are well established and will continue to thrive, preserving and maintaining good water quality is becoming an ever-increasing priority for land owners, citizens, state/federal agencies and the legal community. Stream water quality in established pasture regions is generally high as runoff and erosion are minimized because the soil is protected from raindrop impact by the forage (surface cover = ~100 percent). However, uncontrolled grazing management can result in overgrazed pastures and lead to high runoff volumes, increased erosion and poor water quality. Overgrazed pastures have low vegetative surface cover and forage yield, increased soil compaction and lower water infiltration, which can lead to increased erosion and runoff.

When litter or any other fertilizer is applied to such pastures, the risk of nutrient loss in runoff increases, especially for phosphorus (P). Too much P in our lakes and streams accelerates the natural aging process, called eutrophication, resulting in excessive aquatic weeds and algae, reduced recreational use and taste and odor problems in drinking water supplies.

Water quality is a national concern, especially in Northwest Arkansas, where some streams flow into bordering states. There are many sources of runoff from agricultural and urban areas like those in Northwest Arkansas. One of the more prominent agricultural sources is runoff from pastures. Although pasture management is known to affect the quantity and quality of runoff, the effects of grazing management are neither fully understood nor quantified in terms of P loss.

While studies are limited, researchers have shown a close correlation between P loads in runoff (lb P/ac/yr) and land use. For example, some studies have shown that potential P losses from forested areas are much less than from agricultural areas which are much less than from urban areas. For pastures, P losses have been shown to vary depending on watershed conditions and management. For example, runoff loadings within the Illinois River Watershed were shown to range from 0.2 to 1.2 lb P/ac/yr with annual loads of 0.6 lb P/ac/yr attributed to pasture watersheds not influenced by point source discharge. A study in the southern grasslands of Oklahoma found that the highest (3.5 lb P/ac/yr) and lowest (0.2 lb P/ac/yr) loads were associated with poor and well managed pasture, respectively.

What Do Studies in Arkansas Indicate?

Recent research at the USDA-ARS Dale Bumpers Small Farm Research Center in Booneville and the University of Arkansas Research and Extension Center in Fayetteville is addressing the question "How does grazing management affect runoff water quality and forage yield?" One study utilized replicated pasture watersheds. In both studies, runoff under different grazing management practices was monitored for total solids (TS), total P (TP), dissolved P (DP) and forage yields. For every runoff event, runoff volume and concentrations of TS, TP and DP were measured. Event loads or loss of TS, TP and DP were calculated from runoff volumes and concentrations. Total solids (TS) represent the amount of erosion or sediment lost during the event, while TP loss is a measure of the total amount of P lost. How much of the TP is available to aquatic algae? Not much, maybe 5 percent, but all of the P in the DP parameter is available and can, if conditions are ideal, produce rapid algae blooms in receiving lakes and reservoirs.

The USDA-ARS study was located on soils with ~8 percent slope. Pastures were a mix of common bermudagrass and annual ryegrass and received poultry litter as fertilizer at ~2 ton/ac annually in the spring. Forage yields were measured monthly. Treatments for the USDA-ARS watersheds in Booneville included hayed only, overgrazed, rotational grazed and rotational grazed with a buffer. **Hayed only** watersheds were hayed three times annually, in April, June and again in the fall. The grazed watersheds varied in grazing intensity as defined by the number of animal units (AU) per acre combined with the grazing time. **Overgrazed** is defined as a stocking rate of ~3 AUs/ac with a grazing period of several months at a time, whereas **rotational grazed** is defined as a higher stocking rate of ~6 to ~12 AUs/ac but with a shorter grazing period of only ~3 to ~4 days with a two-week or more rest/regrowth period for the forage. The **rotational with buffer** treatment included the same rotational grazing regime plus a 50-foot buffer (fertilizer setback) at the base of the watershed.

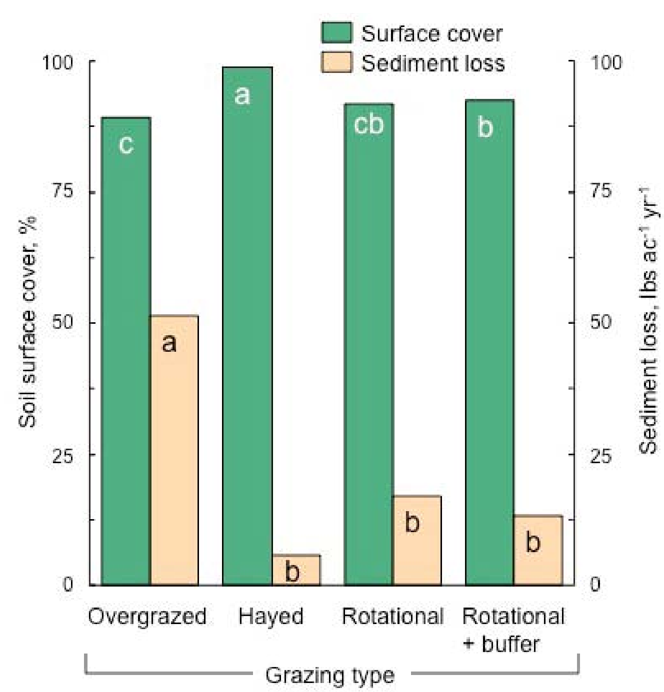
The University of Arkansas study in Fayetteville examined runoff from similar treatments of hayed, overgrazing and rotational grazing in tall fescue pastures with ~5 percent slopes. Nutrient loadings from these land uses were compared to those from a typical Ozark natural hardwood forest, which was used to represent background/natural levels.

Runoff Water Quality Results

Percent cover and sediment loss. Generally, the higher the surface cover, the better the soil is protected from raindrop impact, resulting in less runoff and erosion. Percent soil surface cover provided by the forage and sediment loss as a function of grazing type are shown in Figure 1. While surface cover for all treatments was high (>80 percent), hayed watersheds were significantly higher in percent cover than other treatments. Typical of most pasture situations, erosion losses from all treatments were very low because of the high surface cover. Even though the losses were low, erosion from the overgrazed was roughly four times greater than the other treatments, which were not different.

Soil compaction and runoff. The more dense or compacted the surface soil, the greater the risk the rainwater will runoff rather than infiltrate into the soil. Figure 2 shows the effect of grazing type on soil compaction. Overgrazing resulted in the highest compaction and the highest amount of runoff, being nearly two to five times higher than the other

Figure 1. Effect of grazing on soil surface cover and sediment loss. Different letters represent significant differences in the same parameter.



treatments, which were not different in either compaction or runoff volume. The hayed watershed was the lowest both in amount of runoff and compaction, with the rotational-grazed treatment in between, showing no difference with or without a buffer.

Figure 2. Effect of grazing on runoff and soil compaction. Different letters represent significant differences in the same parameter.

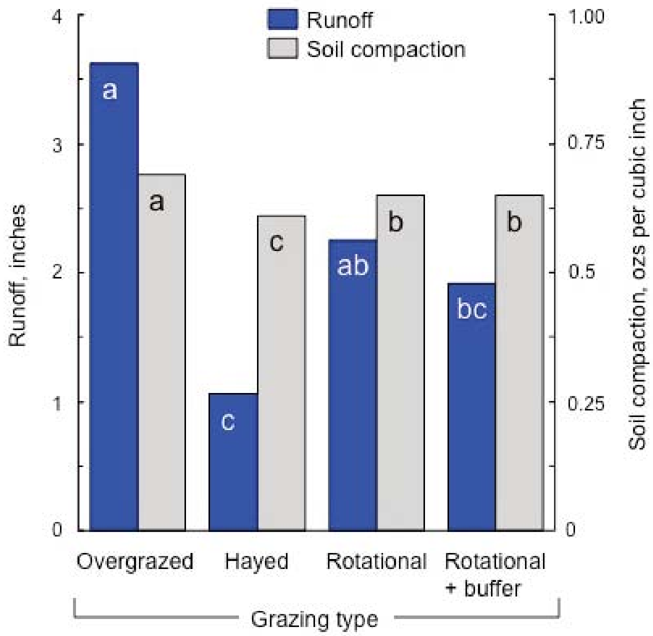
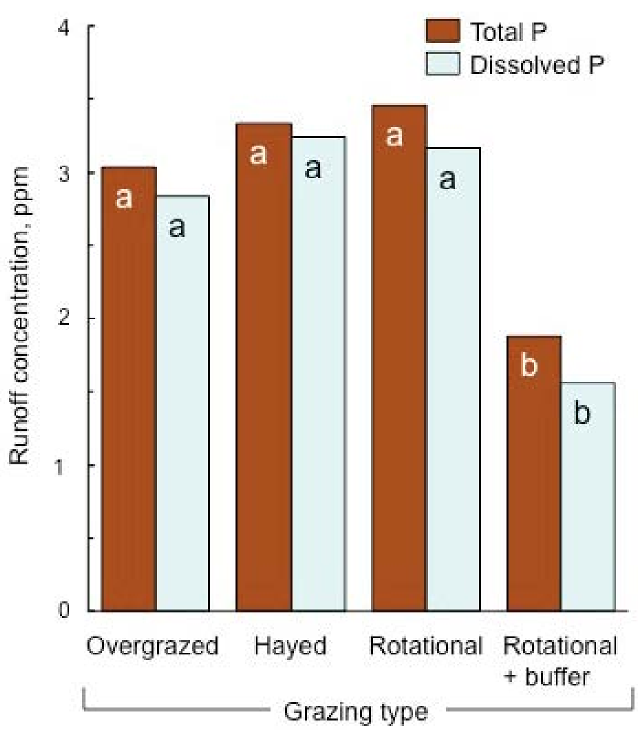


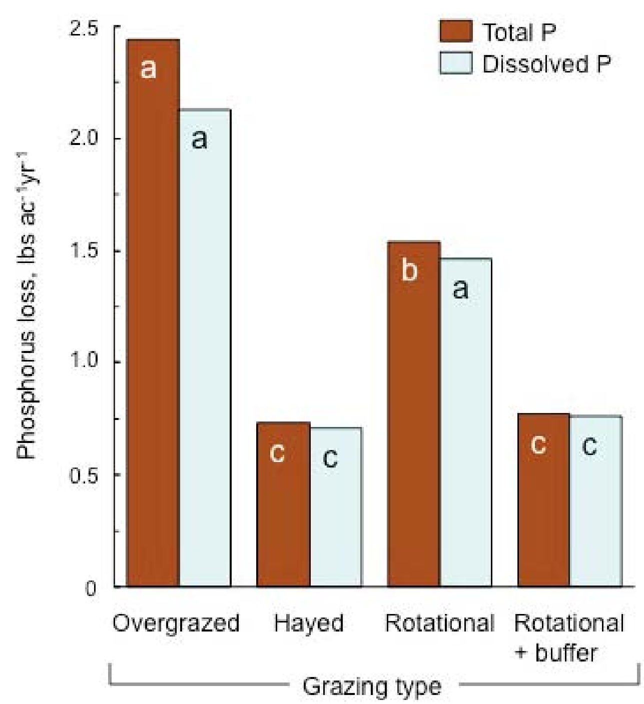
Figure 3. Effect of grazing on total and dissolved runoff P concentrations. Different letters represent significant differences in the same parameter.



Total and dissolved phosphorus runoff losses. There was no difference in the concentration of TP and DP in runoff with overgrazed, hayed and rotational grazed (Figure 3). However, significantly lower concentrations of both TP and DP occur with the rotational-plus-buffer watershed. Other pasture studies, particularly when manure is applied, have shown that most of the TP in runoff is in the DP form, probably because the P in manure is water soluble and therefore at a high risk of being transported in runoff water. Presence of the 50-foot vegetative buffer reduced P concentration in runoff considerably by having the runoff travel relatively short distances through vegetative material.

While P concentrations are important, P loads are probably more meaningful because this parameter combines both concentration and runoff volume. Figure 4 depicts the effect of grazing on loads of TP and DP. While the concentrations of both TP and DP from several treatments (Figure 3) were the same, the runoff volume between treatments was very different. These factors are combined and demonstrated in Figure 4, with overgrazing being significantly higher than the other treatments because the soil was more compacted, producing higher runoff volumes. Hayed was one of the lowest ranking treatments for P load because of the low runoff volume, even though P concentrations were high. Rotational grazed with a buffer had low P concentrations as well as low runoff, making it again one of the lowest ranking treatments.

Figure 4. Effect of grazing on total and dissolved P runoff loads. Different letters represent significant differences in the same parameter.



Similarly, the study at Fayetteville showed the overgrazing treatment produced the highest runoff and TP loads, followed by hayed and rotational grazed watersheds (Figure 5). In addition, when compared to the traditional Ozark hardwood forest representing natural/background levels, the overgrazed treatment was ~5 times higher both in runoff and TP loads.

Figure 5. Effect of grazing on runoff and total P loads compared to forest/background levels. From the UA demonstration project.

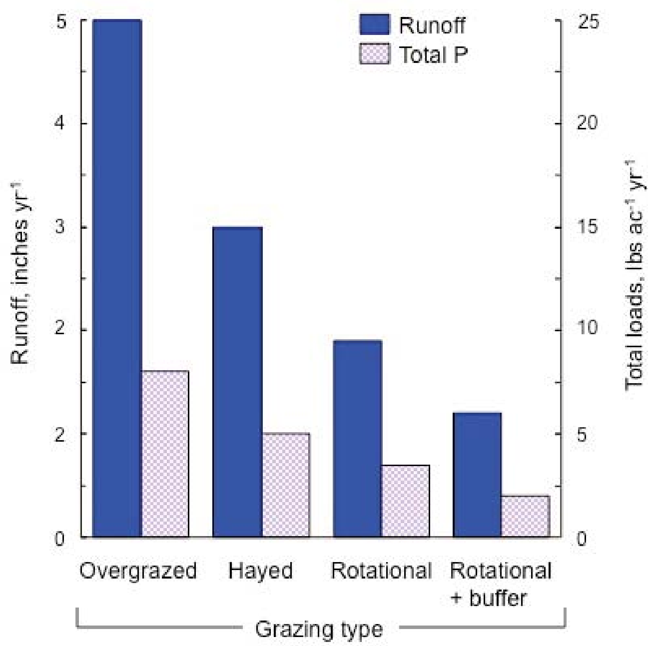
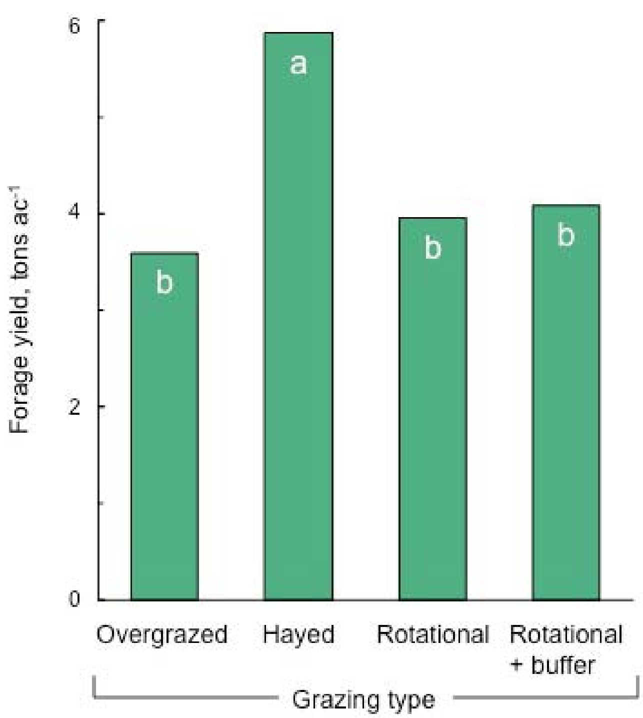


Figure 6. Effect of grazing on forage yield. Different letters represent significant differences in the same parameter.



Forage Yield and Management

Forage yield. The hayed watersheds produced significantly higher forage yield than all other treatments and were over 50 percent higher compared to the overgrazed treatment (Figure 6). These results are similar to other pasture studies in the literature which attribute increased soil moisture to the hayed treatment due to increased infiltration of rainwater. Due to increased moisture and rest periods for the forage, rotational grazing management can potentially increase forage production as compared to an overgrazing management system. Other commonly observed benefits of rotational grazing are increased AU carrying capacity of the farm and the opportunity to harvest excess forage as hay for sale or later use and reduced fertilizer input costs.

Management. It's a given that there isn't one particular grazing management system that is the best fit for every single producer. Likewise, every grazing system has its own strengths and weaknesses. Overall, the most important aspect of any successful grazing management system is for a producer to match farm resources, goals and management availability with a particular grazing system in order to optimize profits while also achieving environmental and economic sustainability.

With improved grazing management, cool-season forages may be stockpiled in the fall for winter grazing and warm-season forages can be hayed in the summer to be fed in drought periods or winter. Improved grazing management should be designed to extend the grazing season for both warm- and cool-season forages. This will result in better utilization of forages, which will reduce the number of days that hay must be fed. In many cases, improving a grazing system makes it possible to graze in Arkansas for 300 days, or more, out of the year.

It is true that a controlled grazing management system will require increased cost initially because of additional fencing supplies, watering facilities and labor. However, with time, controlled grazing management is more productive, flexible and sustainable. Additionally, although it is possible, there is no need to fully implement a controlled grazing system at once. In many cases it may be better in terms of finance and management time to increase control of grazing management one fence and one pasture at a time.

Summary and Conclusions

Results from these and other studies clearly show that grazing management affects forage yield and runoff water quality. Inherent in the different grazing techniques is the potential to reduce compaction and improve vegetative surface cover (percent), which has a dramatic impact on runoff, erosion and P loss. Unfortunately, the less management intensive and more traditional grazing practice of overgrazing ultimately results in lower forage production and increases conditions for runoff and erosion, which can degrade water quality. While it is clear that better grazing management can indeed benefit production as well as the environment, inclusion of BMPs, such as buffers, can have even a more dramatic impact on nutrient concentration in runoff water. For example, the inclusion of the 50-foot buffer on the rotational-grazed treatment reduced P loading three to four times.

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