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Management Intensive Grazing Systems and the Environment

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Nitrogen and Phosphorus Leaching

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Introduction

One of the primary benefits of management intensive grazing (MIG) is increased forage production which allows for a higher stocking rate and increased per-acre profitability. However, as the stocking rate increases, so does the potential for nutrient leaching. When nutrients leach past the root zone, they are unavailable for plant use (an economic loss) and have the potential to harm surface and groundwater sources.

Nitrates in the groundwater can pose human health concerns such as methemoglobinemia (blue baby syndrome) and gastric disorders. Areas with high groundwater tables are especially at risk for nitrate contamination.

Nitrate contamination of groundwater has primarily been a concern in agriculturally intensive areas such as the Midwest. However, studies in Idaho have identified groundwater nitrate concentrations over the Environmental Protection Agency (EPA) allowable standard of 10 mg of nitrogen per liter in 44% of the wells in southern Washington and northern Payette counties, demonstrating that nutrient leaching is an issue that also affects the West.

Phosphorus is more mobile than previously thought and can pose a serious risk to the environment once the soil becomes saturated with this nutrient. As phosphorus levels increase in surface water, eutrophication (nutrient enrichment which accelerates algae growth and leads to potential anaerobic conditions in water) can become a severe problem.

Phosphorus entering groundwater sources can resurface and contribute to eutrophication of surface waters. The Environmental Protection Agency has determined that 10-20% of the phosphorus entering the Chesapeake Bay comes from groundwater sources. Minimizing nutrient leaching is essential to maintaining a clean and healthy water supply.

Nutrient Leaching in MIG

Current MIG practices involve high inorganic fertilization rates to help the grass regrow quickly and to support high forage production rates. High stocking rates also result in increased amounts of manure in the pasture which significantly increases the potential for nutrient leaching.

Large herbivores retain a very small amount of the nitrogen they consume, with the majority of the nitrogen ingested by the ruminant being excreted in feces and urine. This process alters the nitrogen cycle by increasing the rate of cycling and significantly altering the distribution of nitrogen. Areas containing urine and fecal material contain high concentrations of nitrogen (exceeding 250 lb. nitrogen/acre). Those areas not receiving urine and fecal matter are depleted in nitrogen. Nitrogen leaching is increased in MIG systems due to the uneven recycling of nitrogen from cattle urine and feces, and the high application rates of nitrogen, whether from synthetic means or biological fixation.

Phosphorus enters the farm system in feed and fertilizer. If more phosphorus enters than leaves the farm system, which is typical of animal-based systems, increasing phosphorus levels and saturation of the soil is a very real possibility. Phosphorus is excreted primarily in the feces of herbivores. This not only allows for uneven distribution of the phosphorus, but the increased soil organic matter content due to manure application may result in increased phosphorus mobilization.

Current Study

A study currently underway at Utah State University is examining the environmental implications of MIG systems. The goal is to identify forages that have high yield potentials, and also minimize environmental contamination.

Eight grass-legume mixtures selected for their yield potential and nutritional value were evaluated for nitrogen and phosphorus leaching using typical MIG practices. Paddocks were grazed within a 24-hour time period by replacement heifers. Paddocks were regrazed when the forage reached approximately 10 inches.

The grasses used in this study were meadow brome (*Bromus riparius* Rehm), perennial ryegrass (*Lolium perenne* L.), tall fescue (*Festuca arundinacea* Schreb.), and orchardgrass (*Dactylis glomerata* L.). The legume in each mixture was either birdsfoot trefoil (*Lotus corniculatus* L.) or white clover (*Trifolium repens* L.).

To determine nutrient leaching, porous ceramic cup soil water lysimeters were installed at 2-foot and 3-foot depths near the center of study plots. Leachate was collected weekly during the growing season. Each sample was analyzed for leachable nitrogen (nitrate) and dissolved phosphorus.

First-year data showed significant differences among the grass-legume mixtures for nitrate leaching. The nitrate concentration in the orchardgrass/white clover leachate was three to ten times higher than in the other six grass-legume mixtures. Orchardgrass mixed with white clover or birdsfoot trefoil produced leachate with significantly higher nitrate concentrations than the other grass/legume mixtures. Nitrate concentrations in the orchardgrass leachate (>20 mg of nitrogen per liter) were significantly above the EPA standard for drinking water throughout the season. This may be attributed to the shallow rooting depth of orchardgrass, which reduces the chance for roots to intercept and utilize the nitrogen.

A significant difference in nitrate leaching was also observed between the legumes, with white clover allowing more nitrate to leach past the root zone than birdsfoot trefoil. Again, this difference may be attributed to the rooting depth of the two legumes: birdsfoot trefoil has a greater rooting depth than white clover.

Phosphorus leaching was also observed. All of the grasses were significantly different from each other at the 2-foot depth, with perennial ryegrass exhibiting the greatest phosphorus leaching, followed by tall fescue, meadow brome, and orchardgrass. Most of the phosphorus concentrations measured were at, or below, the EPA standard for streams and rivers entering lakes (.05 mg/l). No significant differences in phosphorus leaching were observed between the two legumes.

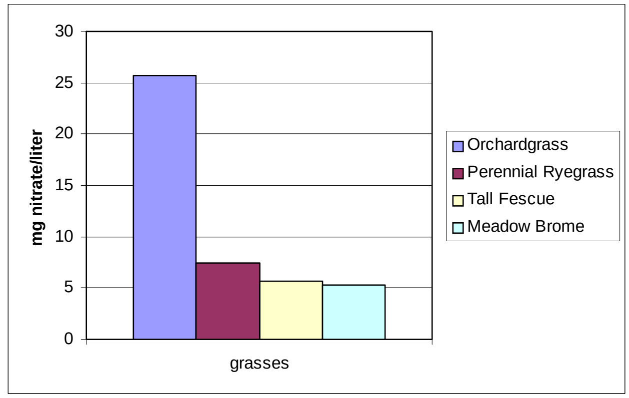

Figure 1. Average nitrate concentrations at the 2-foot depth.

Conclusions

Based on first year data, forages with a greater rooting depth should be selected for use in MIG systems. Forages such as orchardgrass and white clover appear to be a poor choice, as the potential for nitrate leaching is significant. When using forages such as orchardgrass and white clover, fertilizer management should be altered to include more frequent but lower rate applications of fertilizer to minimize nitrate leaching.

Data will be collected for two more years to more fully assess the environmental impacts of the grasses and legumes used in this study. Selecting forages that utilize nutrients efficiently not only minimizes fertilizer waste, but also helps protect the quality of our groundwater.

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