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Whole Farm Nutrient Balance Under Different Grazing Systems: Project Overview

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Abstract
The amount of phosphorus (P) in surface runoff from agricultural lands is of concern because of the potential for eutrophication of Iowa's waterways. Currently, there is limited information about the total P loads in surface runoff coming from pastureland in the Midwest. Much of the P runoff is likely associated with sediment. Because foliage limits soil disruption caused by the impact of raindrops and because forage roots hold soil particles, forages harvested at an appropriate height, through suitable grazing management, should maintain water infiltration and minimize sediment and P loss in surface runoff from pastures. Grazing management may influence utilization of P by the animal, by impacting P digestibility. The objective of this project is to quantify P flows through systems operated under different grazing management practices. Figure 1 illustrates P inputs and outputs in the grazing system.

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Introduction

The amount of phosphorus (P) in surface runoff from agricultural lands is of concern because of the potential for eutrophication of Iowa's waterways. Currently, there is limited information about the total P loads in surface runoff coming from pastureland in the Midwest. Much of the P runoff is likely associated with sediment. Because foliage limits soil disruption caused by the impact of raindrops and because forage roots hold soil particles, forages harvested at an appropriate height, through suitable grazing management, should maintain water infiltration and minimize sediment and P loss in surface runoff from pastures. Grazing management may influence utilization of P by the animal, by impacting P digestibility. The objective of this project is to quantify P flows through systems operated under different grazing management practices. Figure 1 illustrates P inputs and outputs in the grazing system.

The project consists of a series of upland grazing studies being conducted at the Iowa State University Rhodes Research Farm, whereby data from each component will be compiled to establish whole-farm nutrient flows within each system. The three-year study was begun in late May 2001.

Materials and Methods

Three plots of approximately 2.75 hectares acres were identified on hills with slopes up to 15° in a smooth bromegrass pasture. Each plot was subdivided into five 0.4-hectare paddocks with a 10 m wide buffer area at the bottom. Initial soil samples were collected to depths of 0–6 cm and 6–12 cm to determine available soil phosphorus level. Soil samples also were collected from individual paddocks to determine initial surface and subsoil levels of total P. Phosphorus was applied in the spring of 2001 so that all pastures were at a minimum of an optimum level (11 to 15 ppm P_2O_5). Nitrogen was applied as urea at a rate of 90 kg N/ha to all pastures. No additional potassium was applied.

Grazing treatments were randomly assigned to each of the five paddocks in each plot. Treatments included: an ungrazed control, summer hay harvest and winter stockpiled grazing, continuous stocking to a residual sward height of 5 cm, rotational stocking to a residual sward height of 5 cm, and rotational stocking to a residual sward height of 10 cm. Grazing was initiated on May 29, 2001, with three mature cows in each grazed paddock. In the continuous stocking system, cattle were removed from the paddocks after sward height decreased to 5 cm. Paddocks were allowed a rest period of 7–10 days to limit regrowth and, thereby simulate continuous stocking. In the rotational stocking systems, cattle were removed from the paddocks after their sward heights decreased to 5 or 10 cm. Paddocks were allowed rest periods of 35 days to simulate plant regrowth in rotational stocking. Forage sward heights were measured twice weekly during the grazing season to determine when cattle should be removed. Mean total grazing days for the 2001 grazing season were 492, 378, and 289 cow-days/ha for the 5-cm continuous stocking, 5-cm rotational stocking, and 10-cm rotational stocking systems, respectively. First-cutting hay was harvested from the hay/stockpile treatment on June 8. Each paddock in the hay/stockpile system was stocked with two cows on

November 12 and grazed to a residual sward height on 5 cm on November 21, 2001.

To determine sediment and P loss in water runoff, rainfall simulations were conducted in June, August, and October 2001, and May 2002. Six simulation sites were selected within each paddock; three within a low slope range (1°–7°) and three within a high slope range (7°–15°). Six simulation sites were selected within the buffer zone below each paddock. Three of these sites were at the base of the paddock and three were 10 m within the buffer strip. The same sites were used for each set of rainfall simulations. Each rainfall simulation ran for 1.5 hours at a precipitation rate of 6 L/10 minutes (2.8 inches/hour). During simulations, the amount of rainfall and runoff was measured at 10-minute intervals, and a sample of runoff was collected and added to a composite sample that was used to determine total sediment, total P, and soluble P. Before conducting rainfall simulations, a digital photo of each simulation site was taken to determine ground cover by image analysis. Sward height was measured using a rising plate meter (4.8 kg/m^2), and a forage sample was clipped from a 0.25-m^2 area to determine dry matter mass.

Fecal samples were collected from individual animals within each replication of grazing treatment and samples analyzed for fecal P content. Fecal samples were collected twice from each animal on the summer grazing treatments, between June 1 and August 15, 2001, and once from each animal on the winter stockpiled grazing treatment, in November 2001. To estimate intake of feed and P intake, animals were dosed with an indigestible marker twice daily for five days and fecal samples collected twice daily during the last 48 hours of the dosing period. Fecal samples were pooled to create a composite sample for each cow for P analysis. During the five-day period, pasture samples were collected for analysis of P content.

Feed intake will be estimated by determining the relationship between the amount (g) of indigestible marker consumed and marker concentration of collected feces. Following analysis of soil and runoff P content, we will begin to characterize P flows for each grazing treatment.

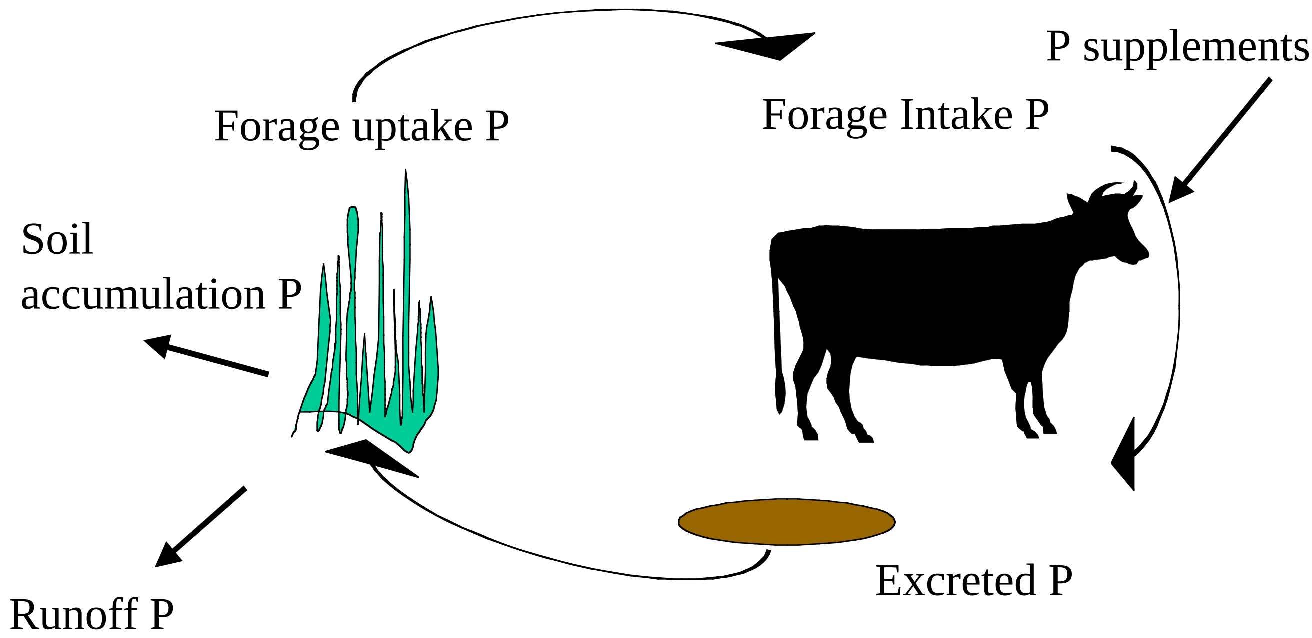

Figure 1. Whole-farm phosphorus flow in the grazing system.