PROXIMITY OF WATER AFFECTS GRAZING DISTRIBUTION AND SOIL NUTRIENT CYCLING

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ABSTRACT
A three-year study was conducted to quantify the effects of travel distance to water on pasture utilization rate and soil nutrient gradients. A 64 ha unit was divided into 16 4 ha pastures having maximum travel distances ranging from 250 to 450 m. Temporal utilization rate (UR) and soil nutrient levels were determined at 30 m intervals beginning at the water source. Temporal UR significantly declined beyond 250 m in all pastures having travel distances exceeding 250 m while pastures with less than 250 m travel distance were uniformly grazed. Increased nutrient level gradients beginning within 60 m of water existed in pastures with greater than 250 m travel distance while pastures with less than 250 m travel distance showed no significant gradients towards water. We conclude that locating water within 250 m of all parts of the pasture will result in increased efficiency of land use and nutrient cycling.

KEYWORDS
Utilization rate, nutrient cycling, grazing, beef cattle, manure

INTRODUCTION
Location of watering sites in pastures is known to affect grazing distribution and also serves as the focal point for manure concentration. This phenomena has been reported in very different climates and in pastures of less than 1 ha and larger than 1000 ha. Hart et al (1989) reported that 77% of grazing in a 1000 ha range occurred within 400 m of the water sources. West et al. (1989) reported P and K concentrations in a zone extending 20 to 30 m from the water source in .44 ha pastures to be over five times greater than the general pasture levels of P and K. Gerrish et al. (1993) observed a zone of influence for P and K accumulation extending 35 to 40 m from the water source in paddocks varying in size from 2.2 to 4 ha. An understanding of the actual distances from water at which changes in grazing and manure distribution patterns occur would be useful in making pasture management decisions. Management precision could be increased and production costs lowered by knowing such things as from where to collect the most meaningful soil samples, what parts of the pasture are more or less likely to respond to fertilization, or where water sources might be developed to improve land use efficiency. The objective of this study was to determine key distances from water at which grazing distribution and nutrient accumulation patterns were affected.

MATERIALS AND METHODS
The study site was at the University of Missouri-Forage Systems Research Center located in northern Missouri (40˚ N;93˚W). A 64 ha field was divided into 16 4 ha paddocks having differing length:width ratios. From 1984 through 1991, each pasture was grazed separately by yearling steers at stocking rates from 500 to 800 kg animal liveweight/ha. From 1992 through 1994, the 16 pastures were rotationally grazed by a single herd of 75 to 82 cow-calf pairs (*Bos taurus*). Pastures consisted of diverse mixtures of cool-season perennial grasses and legumes with some summer-annual warm-season grass species. Grazing distribution was evaluated by determining temporal utilization rate for single grazing periods over a 3-year period in six of the 16 paddocks. Utilization was determined at 30 m intervals beginning at the water source and extending to the far end of the pasture. At each interval four strips .9m x 6m were harvested before and after each grazing period. Soil samples were collected at 25 to 35 m intervals in 1995 following completion of the grazing study. Soil cores were stratified into 0 to 7.5 cm and 7.5 to 15 cm depths. Regression analysis was used to determine the relation of distance from water to UR and soil nutrient gradients.

RESULTS AND DISCUSSION
Utilization rate was significantly affected by both distance to water and shape of paddock. The two factors will generally be confounded and cannot be discussed individually. That is a 4 ma paddock with a maximum travel distance to water of 200 m must be nearly square while a 4 ma paddock with a maximum travel distance of 450 m must be of an elongated shape of certain dimensions. In rectangular paddocks, UR declined at distances beyond approximately 250 m from the water source (Fig 1). This response occurred whether there was shade available at the far end of the paddock or not. The UR in nearly square paddocks was uniform from front to back (Fig 1). This response occurred with the same herd of cattle grazing all paddocks and with a random pattern of movement among paddocks of the different configurations.

Figure 1 represents the means of grazing periods from several months collected over a three year period. Examination of UR patterns in a paddock during a particular month indicate that early in the season when the ambient temperature is cooler, the difference between sites close to water and far from water is not as great as the difference occurring during the summer heat period. If the cattle establish a particular grazing pattern during early grazing cycles, the effect becomes much greater later in the season. Forage rejected at far distances from water early becomes more mature as the season progresses and is even more likely to be rejected later in the season.

In other studies we have observed that manure concentration around watering sites increases as travel distance increases (Peterson and Gerrish, 1996) and the P gradient becomes steeper (Gerrish et al, 1995). While manure distribution was not measured in this study, the effects of the manure gradient were clearly evident from soil sample data. Accumulation of P within 30 to 50 m of water was very apparent in the pastures with greater than 250 m travel distance while the P accumulation was negligible when travel distance was less than 250 m (Fig 2). A small zone of P accumulation extending 20 to 15 m from water was present in the more nearly square pastures.

Other nutrients including K, Mg, and Ca had accumulation patterns similar to P. The peak of the K gradient was proportionally much higher than that for P. This is likely due to the propensity of cattle to urinate almost immediately after drinking. As >95% of excreted K passes through urine, this response is not surprixing.

In conclusion, we believe that designing grazing systems in temperate climates to provide water within 250 m of all parts of a pasture will have a positive effect on efficiency of nutrient cycling and land use. If pastures are to be fertilized with P and K, avoiding areas within 50 m of watering sites will lower input costs without lowering pasture potential and avoid unnecessary nutrient accumulation.

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Figure 1
Impact of distance from water on temporal utilization rate in squart or rectangular 4 ha paddocks

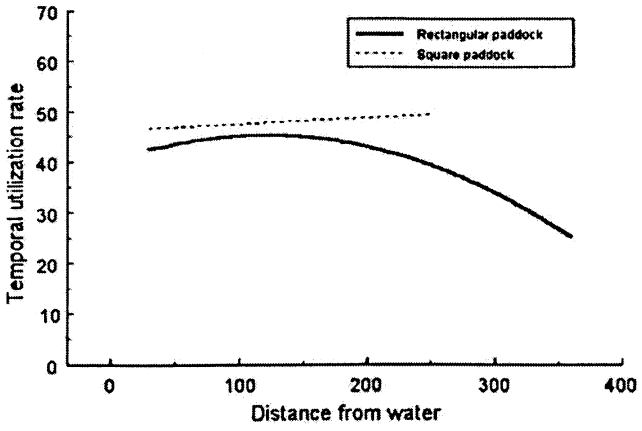

Figure 2
Impact of distance to water on Bray P1 soil test values in square and rectangular 4 ha paddocks