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SPATIAL AND TIME DISTRIBUTION OF DAIRY CATTLE MANURE IN AN INTENSIVE PASTURE SYSTEM

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Abstract

This study determined distribution of feces and urine from dairy cattle managed in a rotationally grazed pasture. Lactating Holsteins (n=18) and Jerseys (n=18) were grazed on a .74 ha endophyte-free fescue (*Festuca arundinacea*)/white clover (*Trifolium repens*) pasture. All cows were constantly observed for 24 h 6 times over 12 mo. Cows had access to about 54% of the paddock during the first grazing period (12 h) and had access to the entire paddock during the second grazing period (8 h). Data included: (1) all feces and urine events from eight cows, observed while in the pasture, feed area, milking parlor or in transit; and (2) all urine and feces events on pasture for all 36 cows each grazing period. After each grazing period, urine (marked with color coded flags) and feces were surveyed and mapped. Data were transformed and then analyzed using statistical software. Percentages of the manure events were highly correlated with time spent in each area (r= .99). Feces and urine (estimated at .12 m^2 and .36 m^2, respectively) from the six 24-hr observations covered 10% of the total paddock. Within a 30-m radius of the water tank, spatial density of feces and urine from the warm season observations (July, August, September) were significantly greater than concentrations during the cool season observations (December, February, and April). Pasture systems can potentially reduce manure handling and

storage requirements proportional to the time cows are kept on pasture. Manure on pasture was relatively evenly distributed over multiple grazing periods.

Keywords: Dairy, pasture, manure management, nutrients, excreta

Introduction

Grazing livestock play an important role in pastureland ecology. Under some circumstances, the deposition of nutrients can be a potential source of non-point source pollution. Goetz (1999) found that nutrient runoff was much greater from a conventional drylot system than from a grazing system. In less intensive beef grazing systems the location of water source, shade and topography can affect the distribution of manure in pasture systems (Peterson and Gerrish, 1996). One objective of this study was to determine the distribution of feces and urine from dairy cattle managed in a rotationally stocked pasture system. A second objective was to compare the proportions of feces and urine events in the pasture to those occurring in the feeding and milking areas. These objectives can help assess the impact that dairy grazing systems can have on nutrient redistribution and manure storage needs.

Material and Methods

The study was conducted at the North Carolina State University Lake Wheeler Road Dairy Educational Unit near Raleigh, NC, USA. Lactating Holsteins (n=18) and Jerseys (n=18) were grazed on 29 ha of cool and warm season forage species all year around. Data were collected from a .74 ha endophyte-free fescue (*Festuca arundinacea*)/white clover (*Trifolium repens*) pasture. Cows were fed a grain supplement in a covered barn area before each milking and were allowed a fresh area of pasture after each milking. A portable water tank was located in the north east corner of the paddock near the entrance of the paddock. The paddock contained no natural or artificial shade and had a slope of approximately 5%, with the slope rising from east to the west. Location and time of each feces and urine event over 24-h periods from 4 Holsteins and 4 Jerseys from the herd of 36 were collected from May 1997 to April 1998 (data set one). Cows were numbered and observed very closely and continuously during each 24-h period. The data included any feces or urine events that occurred in the pasture, while on the travel lanes, in the feeding area, and in the milking parlor in addition to the time spent in each area. Data from each cow were added together for each observation period from each season and averaged. Correlations between the average number of events and time spent in each area were determined within each observation period. Location of all feces and urine events that occurred in the pasture from all 36 cows (data set two) were collected six times from July 1997 to April 1998. Data were collected during different seasons of the year so that the effect of warm (July, August and September) and cool (December, February and April) temperatures could be compared. Observation periods when the temperature-humidity index was above 22 °C (72 °F) for at least seven hours per period were considered warm, while the other periods were considered cool. Hourly temperature and humidity information was obtained from the State Climate Office of North Carolina at NC State University. Temperature-humidity indexes were calculated using an index (Dougherty et al. 1991). Cows were constantly observed with minimal disturbance to the cows, especially at night when cows were resting. With the exception of the September period, urine spots from the first (Urine 1) and second (Urine 2) grazing periods within each data collection were distinguished by colored flags. Each manure and urine spot was surveyed using the Topcon Total Station Laser Transit System ® (Topon Inc., Paramus, New Jersey, USA). For intact feces pats, the point was surveyed from the center of the pat. Estimated mid-points of scattered feces pats were surveyed. Locations of fence lines and the water tank were mapped.

Maps were developed using Arc View ® (ESRI Inc., Redlands, California, USA) software. To generate the maps, areas of coverage for each feces and urine event were estimated at .12 m^2 and .36 m^2, respectively. A series of eleven arcs in 10 m increments that radiated out from the water tank location were drawn. Each arc was lettered A through K with section A being closest to the water tank. The area of the paddock within each arc was calculated and the number of feces and urine events were counted within each arc and expressed as number of events per m^2. Correlations between the total number of feces and urine events for the 8 cows and time spent in each area were determined within each observation period using Excel Software (1997). Differences in the density of feces and urine events within each arc from the water tank was analyzed using general linear models procedures in SAS (1995).

Results and Discussion

Percentages of the excreted events were highly correlated with time spent in each area for each observation period (r = .99). Averages of 84.7% of feces and 84.1% of urination events occurred in the pasture, covering an estimated 10% of the total paddock area (Figure 1). Averages of 9.1% of feces and 12.3% of urination events occurred in the feed area. Only 2.1% of feces and 3.1% of urination events occurred in the parlor holding and parlor areas. Because most of the manure occurred in the paddock, pasture systems would require less manure storage and handling capacity, less labor for parlor clean up and could translate into less cost to produce milk. Our data and previous work with beef cattle (Peterson and Gerrish, 1996) showed that cattle congregate around the water source during heat stress. During the three observation periods when cattle were under mild heat stress, the density of both feces and urine events around the water tank were significantly ($P < .05$) higher than when there was no heat stress (Figure 2). This effect was especially seen within 30 m of the water tank (sections A through C). The use of portable water tanks that can be moved within a paddock could help to more uniformly distribute the excreted nutrients. Use of portable water sources during hot weather would be more critical than in cool conditions. Maximizing the time animals spend on pastures, controlling the stocking density and frequency of movement can have positive impact on excreta distribution. More uniform distribution of excreta can also have positive impact on plant nutrition and sward composition.

References

Dougherty, **C. T., Lauriault L.W, Bradley N.W.**, **Gay N. and Cornelius P.L.** (1991). Induction of tall fescue toxicosis in heat-stressed cattle and its alleviation with thiamin. J. Anim. Sci. **69**: 1008-1018.

Excel for Windows. (1997). Microsoft, Inc. Redmond, WA.

Goetz, **B. T.** (1999). Application of agricultural non-point source pollution model for predicting dairy pasture and heavy use area pollutant runoff. M.S. Thesis, North Carolina State University, Raleigh, NC.

Peterson, **P.R and Gerrish J.R.** (1996). Grazing systems and spatial distribution of nutrients in pastures: livestock management considerations. 203-212. Nutrient cycling in forage systems. Columbia, Missouri. Potash and Phosphate Institute and the Foundation for Agronomic Research.

SAS User's Guide: Statistics, Version 5 Edition. (1985). SAS Inst., Inc. Cary, NC.

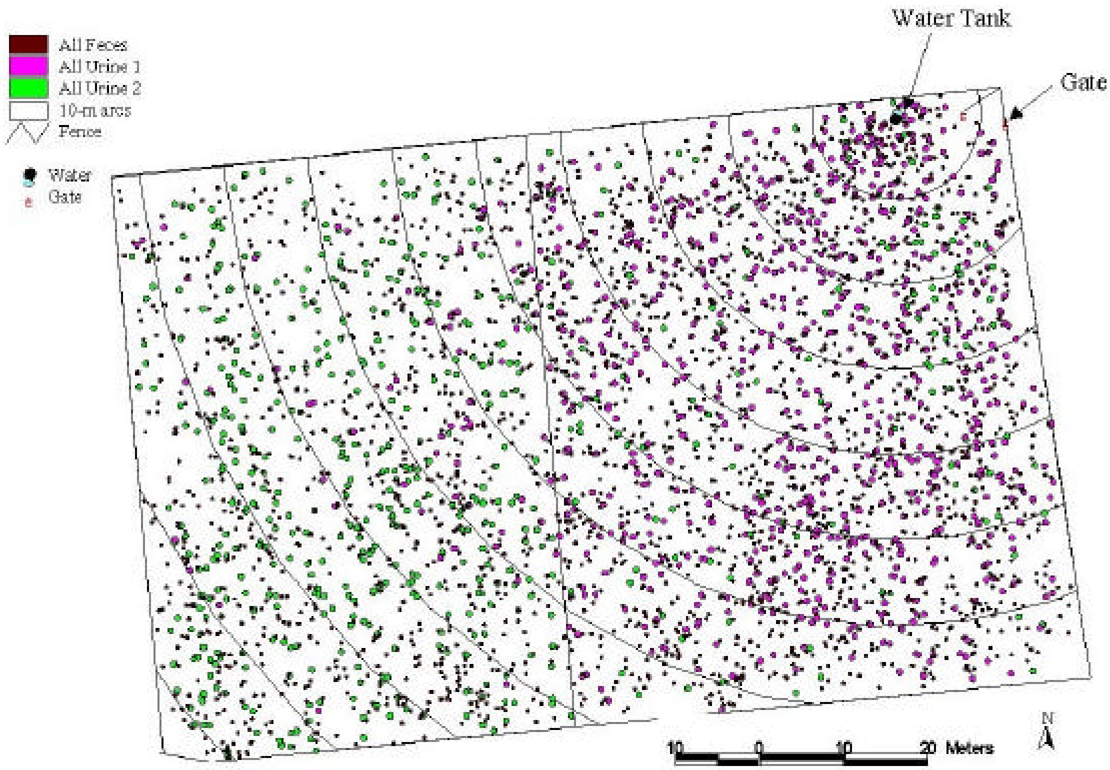

Figure 1 – Distribution of feces and urine from 36 lactating dairy cattle grazing a .74 ha pasture. Data were collected from six grazing days from July to april1998. Concentric arc lines are at 10-increments from the water tank.

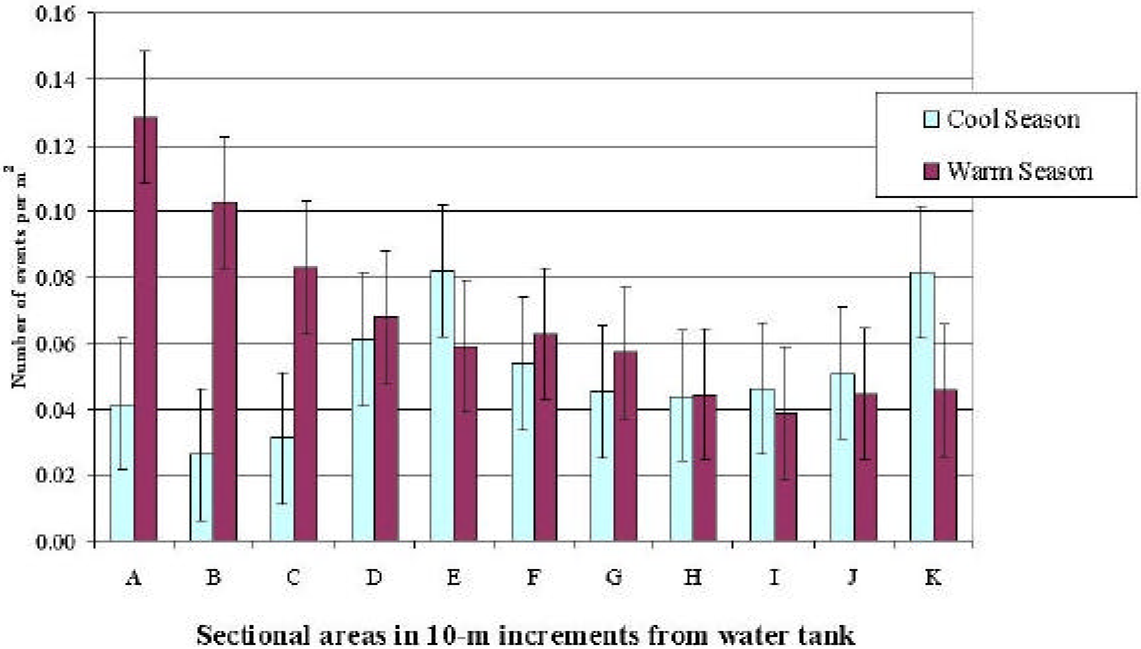

Figure 2 – Least squares means for fecal densities from 36 lactating dairy cows observed in July, August, September, (warm season) and December, February and April (cool season). Significant (P<.05) interaction of season x linear distance from water tank.