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ScienceDirect
Livestock Science 113 (2008) 62–73
LIVESTOCK SCIENCE
www.elsevier.com/locate/livsci

Dairy cow defecation and urination frequency and spatial distribution in relation to time-limited grazing

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Received 11 May 2006; received in revised form 22 February 2007; accepted 22 February 2007

Abstract

The objective of this paper was to investigate the effect of limited grazing time on urination and defecation frequency, spatial distribution of excrement in the paddock, and the resulting nitrogen balance at animal and field level. During a 6-week period in early summer, 60 Holstein Frisian dairy cows (31.0±5.4 kg ECM) were randomly allocated to three different treatments, with grazing at clover-grass pasture during daytime for 4, 6.5 or 9 h daily. Indoor feeding, with a mixture of roughage and concentrates (13% crude protein), was restricted for treatment 4 and 6.5 h to the amount the 9-h treatment could eat. Cows allowed grazing at pasture for 4 h moved more rapidly during pasture, moved longer distance per active hour and used a higher proportion of the time eating, both at pasture and indoor, than the cows allowed longer time at pasture. Limiting the grazing time had no influence on the urination (mean=0.26) and defecation (mean=0.37) frequency per cow per hour during pasture. Even though the proportion of time active (eating, drinking, standing or walking), and the actual time active during pasture was different for the treatments, the frequency of urination and defecation per active hour was also unaffected by the treatments. Urine and faeces were distributed in the pasture, without specific hot-spots. The estimated daily N-balance at animal level showed increased N excretion with time at pasture. Assuming that excretion follows the active periods during the day and 7000 kg DM foliage is available on yearly basis, this would result in total excretion at field level of 58, 86 and 108 kg N per ha respectively for treatment 4, 6.5 and 9 h. The results of this experiment show that it is possible to reduce the nitrogen excretion in a grazing system by restricting the grazing time of dairy cows together with restricted indoor feeding while maintaining high foliage intake.

Keywords: Time-limited grazing; Nitrogen excretion; Urination frequency; Defecation frequency; Spatial distribution; Time budget

1. Introduction

Pasturing high-yielding dairy cows increases the potential risk of nitrate leaching, in comparison with zero grazing and barn feeding of roughage (Eriksen et al., 2004). Surplus nitrogen can be high because of high stocking rates, excessive fertilization without taking animal manure deposition in account, or the presence of 'hot-spots' (non-uniform excretion), where animals gather and tend to urinate or defecate more than average (Eriksen and Kristensen, 2001; White et al., 2001; McGechan and Topp, 2004). High stocking rates could arise due to shortage of land around the barn. The demand for documentation of mineral budgets, the extra

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doi:10.1016/j.livsci.2007.02.021

labour necessary to pasture the cows, and also the lack of an economic incentive, are often given as the reasons for dairy farmers to decrease grazing or abandon it altogether (Pol-van Dasselaar et al., 2002). This is increasingly causing the dairy farmers to have an image problem, as many consumers connect dairy cows with grazing. In addition, a direct correlation has been found between cow health and outdoor movement of the cows (Somers et al., 2003). Institutional activity gives us reason to believe that obligatory pasturing at summer time might be a future requirement in Denmark (Anonymous, 2006), as it already is in Sweden. A challenge for the future is to design grazing systems that accommodate the varied demands of animals, farmers, consumers and the environment. It has been suggested that time-limited grazing could be a way to reduce nutrient surpluses (van Duinkerken et al., 2000). Earlier experiments indicate that roughage uptake per hour of grazing time can be increased by limiting the grazing time to a restricted period, thereby still providing the animals with satisfactory amounts of fresh grass (de Visser and Valk, 2004). Research on continuous day and night grazing (24 h) gives some information on the relationship between the time that highly productive dairy cows are grazing, and urination and defecation deposition (White et al., 2001). Only a few investigations have been made on the spatial distribution of urine and faeces in a grazing environment (Franzluebbers et al., 2000; Eriksen and Kristensen, 2001; White et al., 2001). In order to study spatial distribution and frequency of urine and faecal manure with varying grazing times, a grazing experiment was conducted.

The main objective of this experiment was to investigate the effect of limited grazing time on the frequency and distribution of urination and defecation in relation to the nitrogen balance at animal (cow) and field level. The research aimed to generate management solutions for how and when to graze, in order to decrease the risk of leaching of nitrogen (N) from the grazed areas.

2. Materials and methods

2.1. Design

The experimental treatments were imposed for 6 weeks in the period from 9 May until 19 June 2005. Sixty Holstein Frisian cows, averaging 31.0±5.4 kg energy corrected milk (ECM) and live weights of 592±62 kg (mean±SD) were randomly allocated to three treatments, P4, P6.5 or P9, representing 4, 6.5 or 9 h at pasture, with grazing starting at 06:30 h for all treatments. Energy corrected milk (ECM) was calculated according to Sjaunja et al. (1990). Each group of cows was grazed in separate paddocks and housed separately in a cubicle system with slatted floors during the remaining part of the day. The same amount of supplement was fed on a daily basis in each treatment. The actual amount was adjusted according to the *ad libitum* intake in treatment P9 the previous day. Production results of this experiment are presented by Kristensen et al. (in press).

2.2. Sward and herd management

Three fields were divided into three paddocks of 1.5 ha each, of which 0.5 ha was used as a buffer area. Each field was located in a different direction from the barn, with average distances of 300, 1000 and 1100 m to the entrance of the three paddocks in each field. There was no visual contact between the three groups of cows either during grazing or from the races between the barn and each paddock. Each paddock was only grazed every third day and always by the same group of cows. This design was chosen in order to obtain replications at field level without introducing bias between treatments and fields. The area of each paddock was adjusted to keep a sward height of 8 cm in the grazed part of the paddock. The pastures consisted of mixed grass swards dominated by perennial ryegrass (*Lolium perenne* L.) and white clover (*Trifolium repens* L.). The average proportion of white clover was 24%, 31% and 22% in treatments P4, P6.5 and P9, respectively. One of the fields was fertilized with 35 t slurry ha^{-1} (135 kg total N) at the beginning of April, while no fertilizer was given to the other fields. Following a predetermined route, herbage samples were collected in each paddock, three times during the experiment, by hand-plucking the herbage at the height at which cows were observed to graze. The herd was milked at 04:30 and 15:30 h, with the cows in treatment P9 being milked last at the evening milking. After the morning milking, the cows were automatically separated when passing through the weighing box (by a forced gate system) into three groups (treatments P4, P6.5 and P9) and moved to their own field at approximately 06:30 h. They returned to the barn at approximately 10:30, 13:00 and 15:30 h in each of the treatments, respectively.

The cows had access to supplementary feed mixture immediately after coming into the barn, although for treatment P9 this was after evening milking, as this group was milked directly after they were taken in. The mixture consisted of (on a dry matter (DM) basis) rolled oats (42%), clover-grass silage (25%), maize silage (22%), rolled lupine (10%) and a mineral mix (1%). The mean DM content was 45% and energy concentration was 6.7 MJ net energy of lactation (NEL) per kg DM, with a