The Effects of Recording Interval on the Estimation of Grazing Behavior of Cattle in a Daytime Grazing System

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ABSTRACT : The effects of recording interval (1, 2, 3, 4, 5, 10, 15, 20 and 30 min) on the estimation of some grazing behavior variables in beef cows and calves (<4 months old) were investigated in a daytime grazing (7 h) system utilizing a bahiagrass (*Paspalum notatum* Flügge) pasture (a 1.1 ha paddock and a 0.4 ha resting area). Recording intervals of 10-30 min tended to underestimate the time spent grazing and ruminating and overestimate the time spent resting by animals, whereas intervals of 1-5 min resulted in almost constant estimates. In all grazing activities, the errors of estimation became larger when the recording interval exceeded 5 min. The accuracy of estimation was higher for grazing time>rumination time>resting time. An increase in recording interval always decreased estimates of the distance walked by animals. It was concluded that recording intervals of 1-5 min provide reliable estimates of the time spent grazing, ruminating and resting. It was also concluded that positioning of animals at 1 min intervals may provide estimates of walking distance with acceptable bias toward underestimation. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 5 : 745-750)***

Key Words : Grazing Activity, Walking Distance, Recording Interval, Cattle

INTRODUCTION

Measurement of grazing behavior of animals is an important component of many researches of grazing systems. Time spent by animals in grazing activities such as grazing, rumination and resting reflects climatic and pasture (availability and quality) conditions and physiological states of animals, and thus relate to the performance of animals (e.g. Allden and Whittaker, 1970; Chacon and Stobbs, 1976; Hendricksen and Minson, 1980; Higashiyama and Hirata, 1995; Hasegawa and Hidari, 2001). Distance walked by grazing animals also reflects conditions of climate, pasture and animals, and relates to the performance of animals by affecting their energy expenditure (e.g. Quinn and Hervey, 1970; SCA, 1990; Vallentine, 1990).

Although grazing behavior can be measured using automatic recording devices (e.g. vibracorder, pedometer) or video or audio records, direct observation has been widely used in many grazing studies. In the direct observation method, estimates of the time spent in grazing activities are often derived by using an interval sampling technique, mainly because the technique is less difficult to conduct, less laborious and as accurate as the continuous monitoring of activity. Gary et al. (1970) showed that observations at 15 min intervals provide a reliable sample of characters of a continuous nature (e.g. grazing). Hodgson (1982) concluded that recording intervals of 5-10 min are preferred, particularly where the periodicity of grazing activity is of interest. The frequency of observation needed to obtain reliable estimates depends mainly on the occurrence nature (continuous or discrete event) and occurrence duration of activities and the duration of the grazing period.

Estimates of the distance walked by a grazing animal are also often derived from periodical recordings of the position of the animal in a pasture (e.g. Sneva, 1970; Sato et al., 1996). Similarly to the estimation of the time spent in grazing activities, this technique is less difficult to carry out and less laborious than the continuous monitoring of animal positions. However, the interval sampling technique always tends to underestimate the walking distance, because it treats the trajectory of an animal between 2 consecutive observations as a straight line. This kind of underestimation with the interval sampling can occur even when animal positions are recorded automatically (e.g. GPS). The extent of underestimation depends mainly on the true walking distance by the animal and the straightness of the animal progress. The straightness is considered to be affected by the size, topography and vegetation of the pasture.

This study deals with estimates of grazing behavior of animals in an intensively managed beef cow-calf system where animals graze a relatively small area of a dense, sown tropical grass pasture (a 1.1 ha paddock and a 0.4 ha resting area) only in the daytime (7 h). Calves (<4 months old) show considerable variations in the occurrence duration of individual activities (younger calves tend to spend less time grazing and more resting). The effects of recording interval on the estimates of 4 grazing behavior variables were investigated, in an effort (1) to determine the recording frequency required to obtain reliable estimates of the time spent grazing, ruminating and resting, and (2) to evaluate the extent of underestimation of the distance walked by animals with the interval sampling technique.

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MATERIALS AND METHODS

Study site, pasture and animals

The study was conducted in a 1.1 ha paddock of a bahiagrass (*Paspalum notatum* Flügge cv. Pensacola) pasture at the Sumiyoshi Livestock Farm (31°59'N, 131°28'E), Faculty of Agriculture, Miyazaki University, Japan. The paddock was 1 of 5 paddocks rotationally grazed by Japanese Black cows and calves, and adjoined a resting area (0.4 ha) with a watering point and shade trees.

During the grazing season (May-October) of 1996 and 1997, the paddock was grazed by a herd of 28-33 cows and 6-13 calves with a 2 to 6 day duration (09:00-16:00 h each day) at intervals of 11-37 days. The total duration of grazing periods in 1996 and 1997 was 23 and 22 days, respectively. The animals could move freely between the paddock and the resting area. Calves consumed negligible amounts of herbage in the pasture, because they were at a pre-weaning stage (<4 months old) and separately fed with concentrate (TDN=74%, CP=20%).

The annual fertilization rates in the paddock were 77 kg N (split applications in March and August), 20 kg P (March) and 30 kg K (March) per ha in 1996, and 45 kg N (April), 20 kg P (April) and 30 kg K (April) per ha in 1997. The mean pre-grazing herbage mass (above a height of 3 cm) over the paddock increased from 60 g DM/m^2 in May to 420 g DM/m^2 in September, then decreased to 190 g DM/m^2 in October 1996. The herbage mass in May 1997 was 150 g DM/m^2.

Field observations

Observations were made on 12 occasions, selecting a cow and her calf on each occasion (table 1). The focal animals were selected to cover a wide range in calf age and thus in grazing behavior (younger calves tend to spend less time grazing and more resting).

During the daytime grazing period from 09:00 to 16:00 h, each focal animal was followed by an observer, and the grazing activity (grazing, rumination, resting or other) and the position (coordinates) of the animal were recorded at intervals of 1 min. Only animal coordinates were recorded on 26 May 1996 (no recording of grazing activity). The coordinates of animals were determined using poles on fence-lines surrounding the paddock and the resting area as marks. Poles at important locations were painted to facilitate the coordinate determination.

Data analyses

Estimates of grazing behavior variables for each focal animal were obtained for 9 recording intervals (1, 2, 3, 4, 5, 10, 15, 20 and 30 min), by selecting the initial data at 09:00 h and the subsequent data at respective recording intervals until 16:00 h. The time spent grazing, ruminating and resting by the animal was estimated as the proportion of the occurrence of each activity multiplied by 7 h. The distance walked by the animal was estimated as the sum of the distance between 2 consecutive sets of coordinates.

The accuracy of the estimates was evaluated using relative estimates, to normalize the non-replicated data from a wide range of climatic, animal and pasture conditions (see above and table 1). Because the current study did not conduct continuous monitoring of grazing activity and animal position, the relative estimates were calculated as the proportions to the estimates at 1 min intervals, which are regarded as the nearest to the true values. Gary et al. (1970) also adopted observations at 1 min intervals as continuous observation.

Table 1. Outlines of climate and focal animals on measurement dates

Date[1]	Mean air temp. (°C)	Solar radiation (MJ/m^2/d)	Rainfall (mm/d)	Cow			Calf			
				Tag no.	Age (yr)	BW (kg)[2]	Tag no.	Sex	Age (d)	BW (kg)[2]
26 May 1996	22.7	26.8	0.0	30	6.1	433	811	M	27	40
29 June	29.1	28.4	0.0	37	4.6	382	814	M	1	28
30 June	25.4	9.2	14.5	37	4.6	381	814	M	2	29
3 Aug.	27.4	27.7	0.0	37	4.7	362	814	M	36	51
4 Aug.	27.4	27.2	0.0	37	4.7	362	814	M	37	52
5 Aug.	27.4	27.9	0.5	30	6.3	408	811	M	98	96
14 Sep.	23.9	22.8	0.0	31	6.1	584	819	F	2	34
15 Sep.	22.7	20.5	0.0	40	3.9	450	813	M	107	119
16 Sep	22.7	12.1	6.0	32	6.1	427	815	F	76	81
26 Oct.	17.0	6.5	0.0	24	7.4	516	818	F	61	66
27 Oct.	13.8	14.1	0.0	43	3.3	372	817	M	87	73
24 May 1997	19.8	20.5	0.0	42	4.5	398	903	M	104	86

[1] Grazing activities were not measured on 26 May 1996.
[2] Calculated from monthly data.

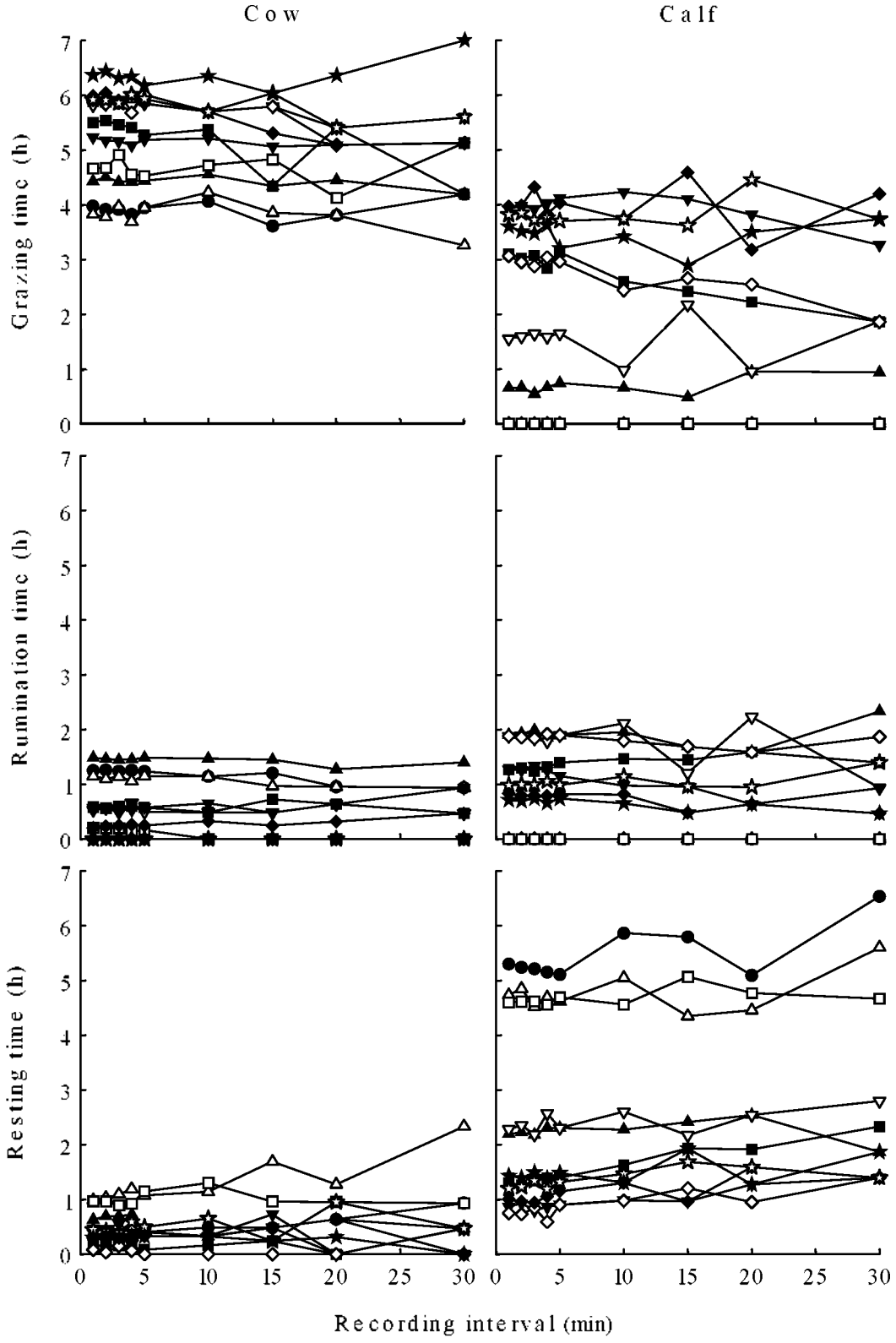

Figure 1. Effects of recording interval on estimates of time spent grazing, ruminating and resting by cows and calves during a 7 h grazing period. Measurement dates are 29 June (●). 30 June (△), 3 August (▲). 4 August (▽), 5 August (▼). 14 September (□). 15 September (■), 16 September (´), 26 October (◆). 27 October 1996 (☆) and 24 May 1997 (★).

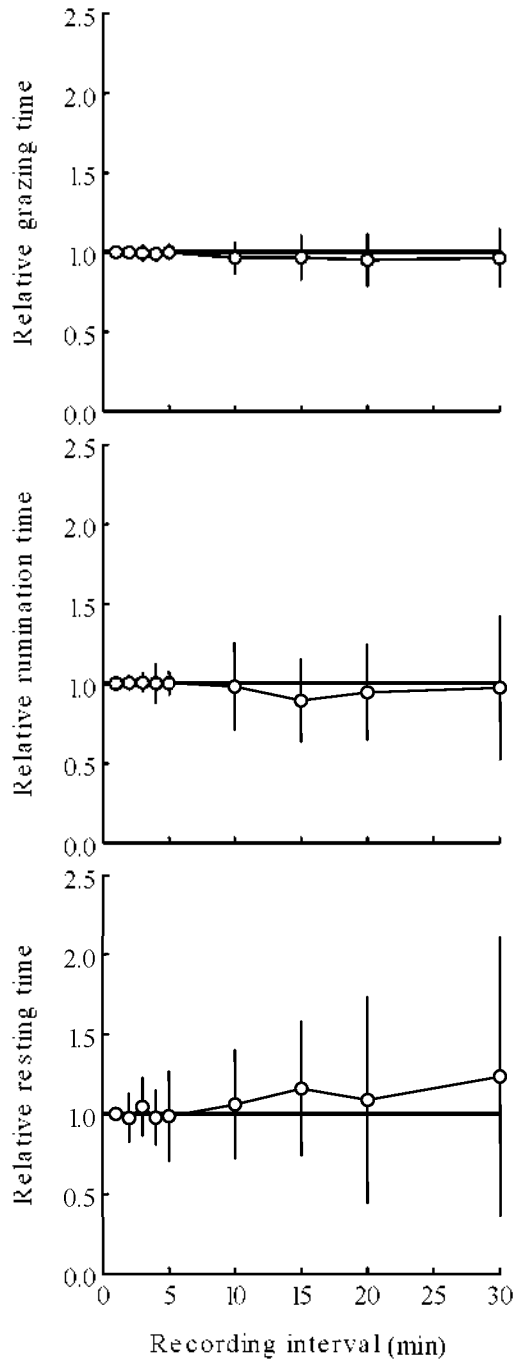

Figure 2. Effects of recording interval on relative estimates of time spent grazing, ruminating and resting by cows and calves during a 7 h grazing period, as meaned over measurement dates and animals (table 1). Vertical bars indicate SD.

RESULTS AND DISCUSSION

Time spent in grazing activity

The focal animals produced relatively large variations in their grazing activity, particularly in the time spent grazing and resting (figure 1). The calves tended to spend less time grazing and more time resting than their cows. In addition to such variations due to the animal categories, the grazing time within the cows and within the calves and the resting time within the calves showed considerable day-to-day or animal-to-animal variations.

The estimates of the time spent grazing, ruminating and resting by the cows and the calves during the 7 h grazing period were always almost constant over the recording intervals of 1-5 min (figure 1). However, when the recording interval exceeded 5 min, the estimates often differed considerably from the estimates obtained from the recording intervals of 1-5 min.

The relative estimates of the time spent in the grazing activities showed that the recording intervals of 10-30 min tended to underestimate the grazing and ruminating time and overestimate the resting time (figure 2). In all grazing activities, the errors of estimation became larger when the recording interval exceeded 5 min. The accuracy of estimation was higher for grazing time>rumination time> resting time.

The above results thus indicate that the recording intervals of 1-5 min provide reliable estimates of the time spent grazing, ruminating and resting by animals in the grazing system of the present study. These intervals are shorter than those recommended by Gary et al. (1970) (15 min) and Hodgson (1982) (5-10 min). The major reason for this may be the shorter grazing period (7 h) in the current study than in the previous studies (24 and 16 h, respectively). The difference in the accuracy of estimation among the activities (grazing time>rumination time>resting time) may be attributed mainly to the difference in the nature of occurrence of the activities (Gary et al., 1970); i.e. grazing activity tended to be most continuous.

Distance walked

The focal animals also produced relatively large variations in their walking distance (figure 3). There were considerable day-to-day or animal-to-animal variations within each animal category (cow and calf). On the other hand, differences between the cows and calves were relatively small.

The estimates of the distance walked by the cows and the calves during the 7 h grazing period always exponentially decreased as the recording interval increased (figure 3). The relative estimates of the walking distance showed that an increase in the recording interval even from 1 min to 5 min sharply decreased the estimates (figure 4). The errors of estimation were similar among the recording intervals of 3-30 min. The response of the relative estimates to the recording interval was well expressed by the following exponential equation:

$$D_{est}=0.288+0.737 \exp(-0.0847\ T_{rec})\ (r^2=0.992,\ p<0.001)$$

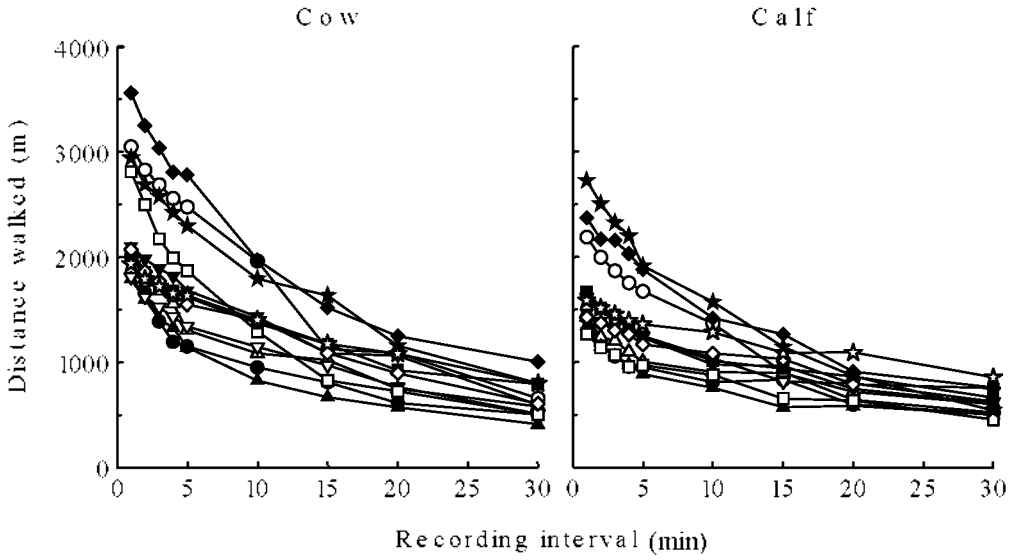

Figure 3. Effects of recording interval on estimates of distance walked by cows and calves during a 7 h grazing period. Measurement dates are 26 May (○), 29 June (●), 30 June (△), 3 August (▲), 4 August (▽), 5 August (▼), 14 September (□), 15 September (■), 16 September (´), 26 October (◆), 27 October 1996 (☆) and 24 May 1997 (★).

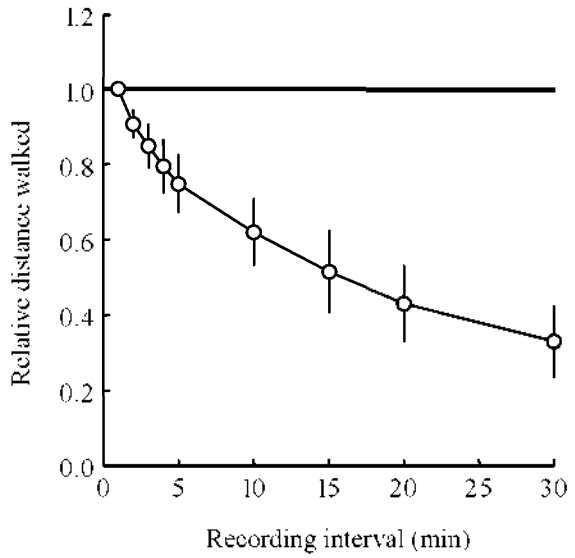

Figure 4. Effects of recording interval on relative estimates of distance walked by cows and calves during a 7 h grazing period, as meaned over measurement dates and animals (table 1). Vertical bars indicate SD.

where D_{est} is the relative estimate of walking distance and T_{rec} is the recording interval. The equation indicates that D_{est}=1.025 when T_{rec}=0, despite some extrapolation. Taking this D_{est} as a true value, the extent of the underestimation of the walking distance with the recording intervals of 1, 2, 3, 4, 5, 10, 15, 20 and 30 min is calculated as 2, 12, 17, 23, 27, 39, 50, 58 and 68%, respectively. The extrapolation may be justified by the constant rate of decrease in the relative estimate with an increase in recording interval; i.e. relative estimate in excess of 0.288 decreases at a rate of 8.47% per unit increase in recording interval.

Thus the above results indicate that the interval sampling technique always underestimates the distance walked by animals with increasing extent of underestimation at longer recording intervals. Matsui et al. (1996) also report data suggesting lower estimates of the distance walked by cattle with discrete positioning than with continuous positioning. However, positioning of animals at 1 min intervals may provide estimates of walking distance with acceptable errors (mean underestimation=2%) in the grazing system of the present study.

CONCLUSIONS

Our study provides some information on the effects of recording frequency on estimates of grazing behavior of animals in an intensively managed beef cow-calf system, where animals graze a relatively small area of a dense, sown tropical grass pasture for 7 h in the daytime and calves show considerable variations in the occurrence duration of individual grazing activities. We conclude that recording intervals of 1-5 min provide reliable estimates of the times spent grazing, ruminating and resting. We also conclude that positioning of animals at 1 min intervals may provide estimates of walking distance with acceptable bias toward underestimation. These conclusions are strengthened by the relatively large variations in the behavior variables across animals and time (season and year).

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