AUTOMATIC MEASUREMENT OF GRAZING TIME BY DAIRY COWS ON TROPICAL GRASS AND LEGUME PASTURES

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ABSTRACT

The length and periodicity of grazing on pure stands of tropical grass and legume pasture were measured. Vibracorders were used and a method of attachment is described. Jersey cows had an average grazing time of 646 min/day, when offered the tropical legumes Desmodium intortum, Dolichos lab lab, Phaseolus atropurpureus *and* Leucaena leucocephala, *compared with a mean grazing time of 512 min/day when grazing the tropical grasses,* Setaria sphacelata, Digitaria decumbens *and* Chloris gayana. *In addition to the normal intensive periods of grazing at dawn, during the day, and at dusk, a further period of night grazing occurred, particularly with high yielding cows on both tropical grasses and legumes. Grazing time was reduced when a sorghum grain supplement was fed to cows grazing* Phaseolus atropurpureus, *with a major reduction in the period of night grazing. The practical application of these findings is discussed.*

INTRODUCTION

For high animal production it is essential to have high dry matter intake. Total grazing intake is the product of grazing time and intake rate so that grazing time and dry matter intake are not necessarily correlated (Reid, 1951). Many investigations have shown a tendency for animals to extend their grazing time in response to a decline in the amount of herbage available (Hodgson, 1933; Hancock and McMeekan, 1955). However when animals are provided with adequate herbage the amount of dry matter consumed is often closely related to the time devoted to grazing (Fernando and Carter, 1970). Brumby (1959) was able to establish a small but positive relationship between grazing time and dry matter intake and between grazing time and milk production. Comparisons of grazing time on various pasture types have received little attention although a study of grazing time on various pasture species, when feed is offered in abundance, is likely to reflect inherent differences in the ease of harvesting these species and possibly to give some indication of their relative intake.

Most of the information on grazing time has been obtained by visual observation studies over periods of a few days (Gary, Sherritt and Hale, 1970). These records are seldom continuous, difficult to take on a large number of animals on unrestricted grazing and are particularly difficult to obtain at night without disturbing stock. These problems would be largely eliminated by using some form of automatic recorder. Canaway Raymond and Taylor (1955) developed an apparatus for the continuous non-subjective recording of animal movements and activities (walking, lying, standing, grazing and cudding) under field conditions while a device for automatically recording jaw movements was developed by Young (1966). Due to either expense or operational difficulties these have not been extensively used. Recently grazing time has been recorded using an elapsed time indicator connected to a mercury switch positioned on a halter on the side of the animal's head (O'Shea, 1969). Although this device was valuable for measuring total grazing time the pattern of grazing was not obtained. Recorders developed for logging truck operating times, known as vibracorders, are com-

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mercially available, and these have been successfully developed for continuous recording of grazing time on sheep (Allden, 1962).

This paper describes a method of attaching vibracorders to cattle and the pattern of grazing obtained when cattle grazed tropical grass and legume species in south-eastern Queensland.

MATERIALS AND METHODS

The vibracorder (manufactured by Kienzle, W. Germany) which was used transmitted movements, by means of a stylus attached to a freely oscillating pendulum, to a waxed chart which was rotated once every 24 hrs by a clock mechanism. Initially some difficulty was experienced in attaching the instrument to the necks of cattle so that the axis of the recorder was vertical when the head of the animal was in a grazing position. This problem was overcome by fastening the vibracorder to a band of heavy canvas (18 oz gauge) measuring 80 cm long and 30 cm wide, and securing it round the neck by three adjustable straps. A 3 cm strip of leather was sown to the canvas 25 cm from one end so that when in place it ran along the top of the neck. To prevent the instrument slipping round the animal's neck it was tied to a halter and counterbalanced with weights. The correct position of the recorder on the neckband (see Plate 1) was maintained by attaching it to a circular metal plate, 18 cm in diameter, placed beneath the canvas. Using this equipment an accurate pattern of grazing time was obtained compared with visual observations.

The study of grazing time was made with both dry and lactating Jersey cows in the period February to June 1970 at Samford in south-eastern Queensland (Lat. 27° 22', Long. 152° 53', Alt. 50m). The pattern of grazing and the time cows spent grazing were measured on pure stands of the three tropical grasses, *Setaria sphacelata* cv. Kazungula, *Chloris gayana* cv. Pioneer and *Digitaria decumbens* and the four tropical legumes, *Phaseolus atropurpureus* cv. siratro, *Desmodium intortum* cv. greenleaf, *Dolichos lab lab* cv. rongai and *Leucaena leucocephala*. In all experiments pasture in excess of the animals requirement was provided so that at no stage was grazing time influenced by lack of feed. Grass swards were grazed as 3-week regrowth and the legumes in a pre-flowering stage. Cows were removed for milking between 06.30h and 08.00h and between 16.00h and 17.15h each day. Water and shade were always available.

A series of measurements of grazing time were taken between March 6th and May 19th 1970 when groups of 2-4 cows, in various stages of lactation, grazed together with other cows in the herd for periods of 3-7 days on the swards shown in Table 1. A comparison of the time spent grazing grass and legume pastures was obtained when groups of 3 cows grazed pure grass swards for 3-4 days whilst groups of 3 cows of similar liveweight and milk production grazed legume swards in adjacent paddocks. Grazing times were also recorded from six lactating Jersey cows grazing together on a pure sward of *Phaseolus atropurpureus* both with and without a 4 kg per day supplement of hammer-milled sorghum, fed twice daily. Half the animals changed treatments from unsupplemented to supplemented grazing whilst treatments were reversed for the remaining three animals. In this experiment grazing times were only measured for 4-6 days at the end of each 10-day grazing period. Grazing records were discarded for the first day of attachment, when breakdowns occurred and on a few occasions when a distinct chart pattern of grazing time was not obtained.

RESULTS

The distribution of grazing during the day followed a definite pattern that did not vary widely from cow to cow. This is illustrated by the chart shown in Plate

PLATE 1. Grazing time being measured with a vibracorder.

2. At first light all animals commenced grazing within 15 minutes of each other and continued until morning milking. Throughout the day there were up to three periods of intermittent grazing and a further period of intensive grazing occurred prior to and for up to 150 min after sunset. During the night animals behaved more as individuals, grazing at different times for periods up to 3 hours. This period of true night grazing, which occurred between dusk and dawn, was termed 'midnight' grazing.

A summary of the time cows spent grazing pure swards of tropical pastures is shown in Table 1. The two legumes *Dolichos lab lab* and *Leucaena leucocephala* had longer mean grazing times than the pasture grasses, *Digitaria decumbens, Chloris gayana* and *Setaria sphacelata.* There was considerable variation between animals grazing the same pasture as demonstrated by the high standard errors. Although liveweight of cows did not appear to influence grazing time there was a tendency for high milk producers to have the longest periods of 'midnight' grazing. Table 1 shows that the proportion of grazing at night for grass swards varied between 30 and 37% and that the proportion of grazing time between evening and morning milkings accounted for 52-58% of the total grazing time. A lower proportion of night grazing was measured on the *Dolichos lab lab* and *Leucaena*

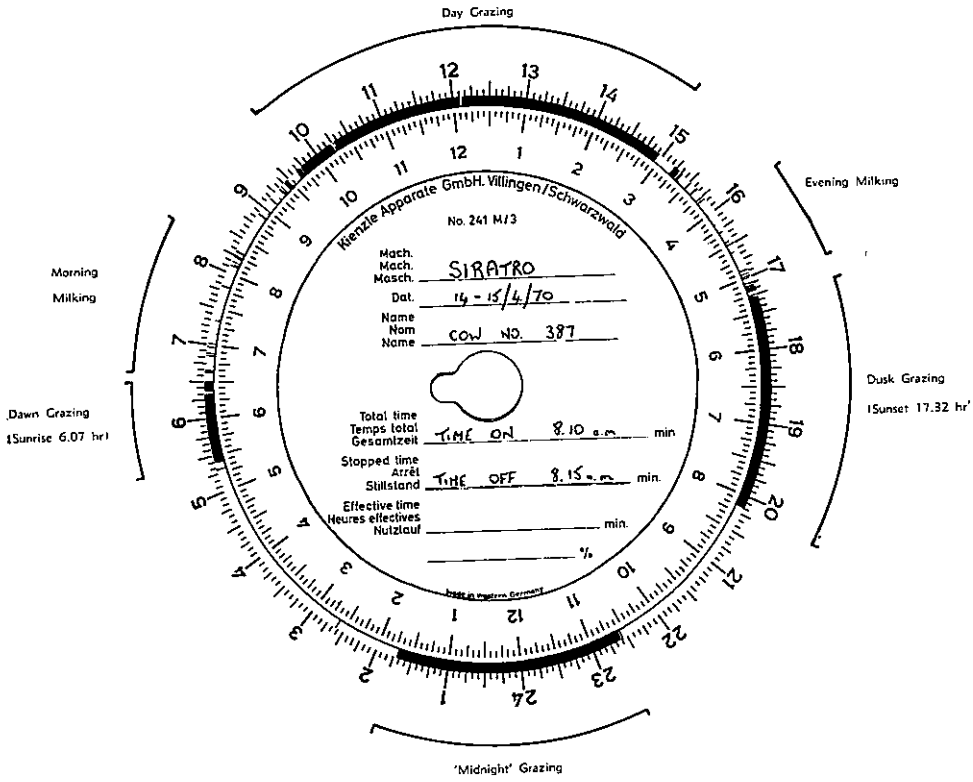

PLATE 2 A waxed vibracorder card showing a typical grazing pattern from *Phaseolus atropurpureus* pasture.

leucocephala pastures but these pastures were grazed in May 1970 when the daily mean maximum temperature was 6.3°C lower.

Grazing times recorded from groups of lactating cows of similar productivity on adjacent paddocks of grass and legume over periods of 3-4 days are shown in Table 2. The results show a significantly ($P < 0.01$) longer grazing time when animals were grazing the two legume swards, *Desmodium intortum* and *Phaseolus atropurpureus,* as compared with the grass swards, *Setaria sphacelata* and *Chloris gayana.* Grazing times varied for a mean of 501 mins (8h 21 min) on the *Chloris gayana* pasture to a mean of 814 mins (13h 34 min) on *Desmodium intortum.* Cows grazed the legume pastures for significantly longer both during the day ($P < 0.05$) and during the night ($P < 0.01$).

Table 3 summarises the grazing times recorded on the *Phaseolus atropurpureus* with and without the sorghum grain supplement. All unsupplemented cows had a longer mean daily grazing time (594 mins) than those fed grain (508 mins) the difference being significant at the $P < 0.08$ level. All unsupplemented cows had a longer grazing time during the hours of darkness and an analysis of variance of 'midnight' grazing showed that these animals grazed for a significantly ($P < 0.05$) longer period.

TABLE 1

Mean grazing times on different pasture species

Pasture species	Dates grazed	Number of animals	Mean milk production (kg/day)	Mean body weight (kg)	Mean daily grazing time (min)					
					Total	Day+	Night	% Night	% Between evening and morning milking	'Midnight'
S. sphacelata	6-9/3/70	4	10.3	371	523 ± 22*	328 ± 26	195 ± 15	37 ± 3	57 ± 7	103 ± 25
C. gayana	20-23/3/70	4	2.5	336	454 ± 41	319 ± 24	136 ± 17	30 ± 1	52 ± 1	71 ± 17
S. sphacelata	24-29/3/70	4	2.9	399	512 ± 21	341 ± 17	171 ± 10	34 ± 2	58 ± 2	101 ± 10
D. decumbens	1-5/4/70	4	4.2	381	496 ± 20	322 ± 13	174 ± 11	35 ± 2	52 ± 2	82 ± 11
Dolichos lab lab	29/4/-3/5/70	2	7.4	365	648 ± 45	494 ± 41	154 ± 10	24 ± 1	42 ± 2	124 ± 9
L. leucocephala	12-19/5/70	3	7.1	395	580 ± 36	437 ± 28	143 ± 12	25 ± 1	42 ± 2	118 ± 10

* ± se. mean

+ Between 06.00h and 18.00h

TABLE 2

Comparison of grazing times on grass and legume species

Pasture Species		Dates grazed	Mean milk yield (kg/day)	Mean body weight (kg)	Mean daily grazing time (min)					
					Total	Day	Night	% Night	% Between evening and morning milkings	'Midnight'
Grasses	*S. sphacelata*	9-12/3/70	7.8	340	560	346	214	38	75	94
	S. sphacelata	13-15/3/70	6.9	376	605	410	195	32	45	79
	C. gayana	16-19/3/70	6.6	340	501	374	127	25	55	9
	Mean		7.1	352	555	377	179	32	58	84
Legumes	*P. atropupureus*	9-12/3/70	5.3	339	631	400	231	37	63	72
	D. intortum	13-15/3/70	7.2	340	814	511	303	37	51	173
	D. intortum	16-19/3/70	7.8	383	754	515	239	32	49	103
	Mean		6.8	354	733	475	257	35	54	116
	Significance of difference		n.s.	n.s.	**	*	**	n.s.	n.s.	n.s.

n.s. = non significant, * $P<0.05$, ** $P<0.01$

TABLE 3

Grazing times on Phaseolus atropurpureus *pasture of supplemented and unsupplemented cows*

Grazing Time		*P. atropurpureus*	*P. atropurpureus* plus sorghum grain	Difference
Total daily grazing time (min)	Mean	594	508	86+
	Range	487-774	453-633	
'Midnight' grazing (min)	Mean	139	82	57*
	Range	81-191	63-109	

+significant $P<0.08$
*significant $P<0.05$

DISCUSSION

Measurement of Grazing Time

A full description of the behaviour of cattle at pasture would include the length of time and periodicity of grazing, resting and ruminating, the position in the paddock and the number of defaecations and urinations. Vibracorders attached to grazing cattle were shown to provide an easy means of measuring two of the more important of these behaviour functions, namely the time spent grazing and the pattern of grazing. This automatic device allowed 4920 cow hours of observation to be made over a short period of time, using 6 vibracorders and spending only a few minutes each day changing the charts and adjusting neck bands. Many behaviour studies reported in the literature are of necessity based on few observations. For example, Johnstone-Wallace and Kennedy (1944) drew conclusions from 96 cow-watching hours and even the more sophisticated trials of Hancock and McMeekan (1955) were based on only 4368 cow hours of observation. Vibracorders obviously provide a simple way of measuring grazing time and are likely to be particularly valuable where labour is scarce and small differences in grazing behaviour are to be measured.

A considerable variation between the grazing time of individual cows, particularly when at different levels of milk production, was demonstrated. Unless records are taken from large groups of animals, as suggested by Gary, Sherrit and Hale (1970), some form of change-over design, as used with the supplemented and unsupplemented *Phaseolus atropurpureus* grazing would be desirable to reduce experimental error.

Pattern of Grazing

The general pattern of grazing during daylight hours was similar to that reported by other workers (Hughes and Reid, 1951; Harker, Taylor and Rollinson, 1954; Smith, 1959). Little attention has been given to the 'midnight' grazing, and some workers have not considered this period of sufficient importance to continue recording grazing time at night (Fernando and Carter, 1970). The results of the current study suggest that during the night cows grazing tropical pastures behave more as individuals, rather than as a group, and that high yielding cows can spend a considerable length of time grazing during this period.

Animals receiving supplementary sorghum grain grazed the *Phaseolus atropurpureus* swards for a shorter time than the unsupplemented cows and therefore probably had a lower herbage intake, which agrees with the findings of Leaver, Campling and Holmes (1968) with cows fed temperate pastures. 'Midnight' grazing accounted for most of the difference in grazing time between the two groups so it appears that when a longer grazing time is required to meet the nutritional needs of the cows this is mainly achieved by lengthening the period of 'midnight' grazing.

Night grazing is usually reported for a 12 hr period between sunrise and sunset and the average proportion of night grazing in the current study was shown to be 34 percent during the hotter months of March and early April. Studies with lactating cows in temperate zones have shown that night grazing comprises approximately 40 percent of total grazing time (Johnstone-Wallace and Kennedy, 1944), and Payne, Laing and Raivoka (1951) have recorded up to 67 percent night grazing in the tropics, but these workers do not define the night grazing period which was chosen. An arbitary 12 hr period of night grazing is of less practical importance to farmers than the period between evening and morning milking when cattle are often moved to different paddocks. Night grazing between these periods constituted 57 percent of total grazing time during the hotter months and good pastures for night grazing would appear to be essential to obtain optimum production during this period.

Grazing Time

The results show that the mean daily grazing time on tropical pasture species in the Samford environment was 512 min for grasses and 646 min for legumes. Particularly long grazing times, up to 838 min, were recorded for the legumes *Desmodium intortum, Dolichos lab lab* and *Phaseolus atropurpureus.* These grazing times contrast strongly with records of grazing time on grass pastures in temperate climates where Castle, Foot and Halley (1950) and Hancock (1954) showed average grazing times of only 360 min out of each 24 hr. Hancock and McMeekan (1955) have shown that dairy cows attempted to maintain stable milk production during periods of adverse pasture availability by increasing their feeding time. Hancock and McMeekan (1955) and Brumby (1959) working in New Zealand recorded mean grazing times up to 540 min for lactating Jersey cows during the hotter periods of the year with individual cows grazing for more than 680 min per day. Payne, Laing and Raivoka (1951) observed the grazing habits of Friesian grade dairy cows in the tropics and found that from 390-630 min per day were spent in grazing, the actual time spent grazing varying between seasons. The upper limit of grazing time would appear to be approximately 800 min per day which was measured on tropical legume pasture and is similar to the grazing times reported by Smith (1959) for cattle grazing sparse poor quality pastures.

The long grazing times recorded for the legume swards indicate either a higher intake of feed than achieved with grasses, or a lower intake of feed per unit time due to the cows grazing less intensively. Intakes were not measured but milk production from tropical legumes was lower than from tropical grasses. Hence it appears that the long grazing time was due to a slow rate of eating, grazing less intensively and/or selecting only the most desirable parts of the plants. Cows grazing pure legume swards appeared to have difficulty in harvesting the leafy parts of the plant without consuming too much of the less favoured fibrous stems. Because of the tearing action of the grazing process, in which the tongue, lower teeth and the dental pad are used, the relative mechanical strength of the different parts of the plant determine which part is removed and which is left behind. Cows experienced some difficulty in pulling leafy parts from trailing legumes, such as *Phaseolus atropurpureus*, because when grown in pure stand the terminal vegetation was not well anchored to the ground. With the exception of *Dolichos lab lab* and possibly *Leucaena leucocephala* it is unlikely that these tropical legumes will be grazed in pure stand but it may be desirable to consider the relative ease with which animals can satisfy their feed requirements when selecting new cultivars or mixtures.

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