A LIGHTWEIGHT ELECTRONIC DEVICE FOR MEASUREMENT OF GRAZING TIME OF CATTLE

R.J. JONES* and L.J. COWPER*

ABSTRACT

A simple lightweight and compact electronic device (referred to as a grazing clock) which is attached to a halter on the animal for measuring grazing time of cattle is described. Essentially it utilizes a mercury switch to activate an elapsed time indicator when the animal grazes. A battery supplies sufficient power for more than one month of operation in the field.

*Grazing time measured by the grazing clock was invariably lower than that measured by the Vibracorder by approximately 100 min/day for a grazing day of 700 min. Vibracorder results were highly correlated with grazing clock results on spring grazed tropical pastures (r = 0.90***) but correlations were much lower for taller autumn grazed pastures (r = 0.73**).*

Reasons for the differences in grazing time measured by the two methods are discussed.

INTRODUCTION

Grazing time can give an indication of the adaptability of cattle to any particular environment (Payne, Laing and Raivoka 1951) and also some measure of the quality of the feed available (Stobbs 1970, 1974). Methods available for measurement of grazing time have not been ideally suited to beef animals for several reasons. Visual observation on animals in anything other than small paddocks is difficult and in any event very costly under Australian conditions. The Vibracorder, as used by Stobbs (1970), necessitates the changing of charts daily or weekly. Telemetric methods of recording grazing time as proposed by Nichols (1966) were considered to be too expensive.

The most suitable equipment for routine use appeared to be that described by O'Shea (1969). Basically the equipment consisted of an elapsed time indicator (ETI) activated through a mercury switch whenever the animal lowered its head to graze. The system developed by O'Shea was unsuitable for our purposes for several reasons. Firstly, the equipment was bulky — consisting of attachments to a halter and to a 'saddle' arrangement. Secondly, the circuit was wasteful of battery power, a large battery only lasting for 5 days in field use; and thirdly, the animal had to be captured to read the ETI.

We required a lightweight unit capable of being fixed to a halter with a low power drain so that batteries need only be changed monthly when animals were brought to the yards for weighing. Ability to read the grazing time without capturing the animal was a desirable though not essential requirement.

CONSTRUCTION OF THE GRAZING CLOCK

Description

The grazing clock is essentially a battery operated digital clock which registers in units of fifteen seconds. Several models, of decreasing size and weight, were constructed and tested in the field. The final model incorporates all the components in one plastic box measuring 10.3 x 8.3 x 4.2 cm which is mounted inside an aluminium box bolted onto a standard halter. The clock, excluding the halter, but including the batteries, weighs only 450 g (Plate 1).

* C.S.I.R.O. Division of Tropical Agronomy, Cunningham Laboratory, Mill Road, St. Lucia, Queensland 4067, Australia.

The grazing clock consists of a pulse generator, pulse shaping amplifier, mercury switch and an electrical impulse counter. The pulse generator and shaping amplifier run constantly, producing a signal every 15 seconds. When the animal lowers its head to graze the mercury switch closes and the signals from the generator are then amplified before being registered on the impulse counter. When the animal starts or stops grazing the pulse generator can be at any part of the timing cycle. In the short term this could introduce an error but when looking at grazing times over a period of hours this effect tends to be cancelled out.

Grazing time is displayed as units of 15 seconds on the impulse counter which can be read through a perspex window from a distance of 2 m with the naked eye or from about 6 m using a pair of binoculars.

The angle of the mercury switch can be readily altered to give the correct angle for sensitive recording. If the angle is too shallow the switch can be activated in the absence of grazing and very long grazing times will be recorded. At the other extreme position, the mercury switch may only be activated when the animal is grazing at ground level.

The correct angle is achieved by noting that the clock is activated when the animal grazes normally but is stopped when grazing ceases. The clicking of the recorder when activated facilities making the correct adjustment. Lock nuts are needed for the wing nuts used to position the clock on the harness and for the small bolts used for fixing the clock to the harness. Without these the clocks have become detached after use in the field.

PLATE 1

Steer fitted with halter and grazing clock.

Clock assembly (Figure 1)

The electronic circuit and mercury switch were attached to a printed circuit board 7 cm x 2.7 cm. This was fitted into the lower section of the plastic box directly below the impulse counter, in such a position that the mercury switch could be seen through the window. This section was then sealed to make it water tight. Directly above this, the impulse counter was fitted to permit easy reading of grazing time. The battery compartment was situated in the uppermost section to facilitate battery replacement.

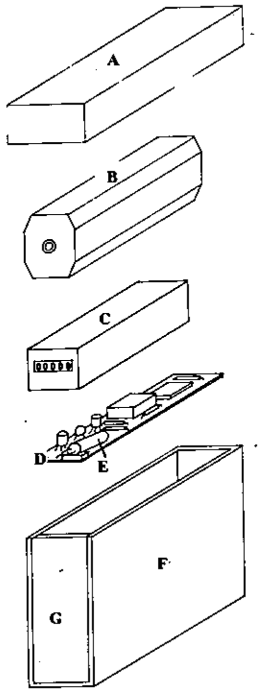

FIGURE 1
An exploded view of the clock assembly; A — plastic lid; B — battery; Eveready no. 2362; C — Elmeg impulse counter; D — printed circuit board; E — mercury switch; F — plastic box; G — clear perspex window.

The circuit (Figure 2)

An integrated circuit IC1 was used as the principal element of the pulse generator. It was connected as a free running multivibrator with a buffered output. The timing components consist of a high stability capacitor C1 and three resistors R3, R4 and R5, the latter two of which were selected to produce the exact time cycle required.

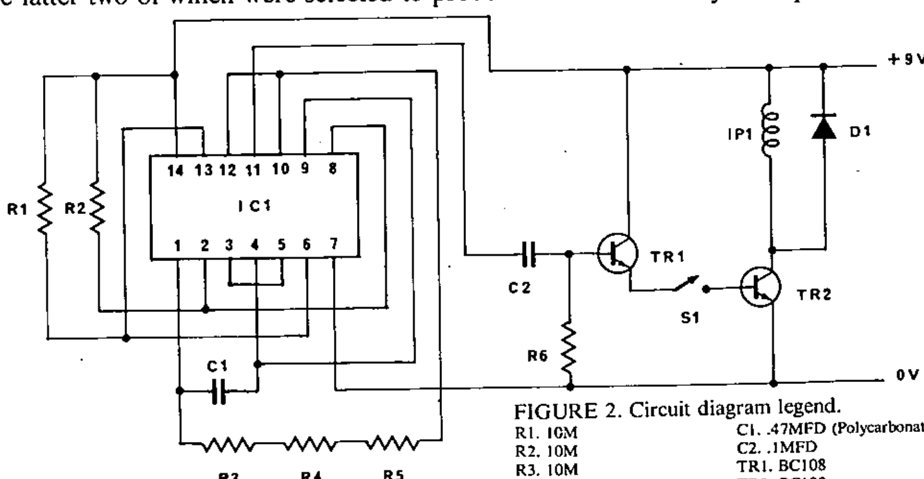

FIGURE 2. Circuit diagram legend.

R1. 10M	C1. .47MFD (Polycarbonate)
R2. 10M	C2. .1MFD
R3. 10M	TR1. BC108
R4.) R5.) See text	TR2. BC108
R6. 1M	D1. OA202

All resistors 1/4W 5% tolerance
IC1 Motorola MC 14011CL
S1. Honeywell mercury switch no. AS417B1
IP1. Elmeg impulse counter type QZ5 251PS 12 VDC

A positive going change in output from the multivibrator causes transistor TR1 to conduct for a period of time determined by C2 and R6; this is of the order of 300 ms. When the mercury switch S1 is closed the pulse is amplified by the transistor TR2 and recorded on the impulse counter. The diode D1 protects the transistor from any reverse voltage generated when the impulse counter switches off.

The cost of the components, excluding leather halter, was approximately $27.

Laboratory calibration

The instrument was calibrated for a 15 second pulse interval at 9.2 V but the pulse interval was shown to be linearly related to battery voltage: $y = 16.18 - 0.129x$ ($r = 0.999^{***}$) where y is the pulse interval in seconds and x is the battery voltage. The high initial voltage of a new battery (up to 9.8 v) rapidly declines when put into service, and after a couple of hours it has usually reached about 9.3 V. A battery was tested in an instrument which was recording continually for six weeks. After an initial period of two hours the voltage was 9.4 V and at the end of the test it was 8.5 V. The variation in the condition of batteries even when new, could therefore result in a maximum error of about $\pm$ 1% of recorded time.

FIELD RESULTS

Comparison with the Vibracorder

The Vibracorder had been used successfully to record grazing time (Stobbs 1970) and so the grazing clock was compared with the Vibracorder. A Jersey cow fitted with both a Vibracorder and a grazing clock was used. The cow was accustomed to studies with the Vibracorder attached and grazed normally. Daily records of grazing time were made on 34 days in May and June 1973 and 54 days in July to September 1973. The pastures grazed were arbitarily divided into two groups: Autumn-grazed pastures of green panic, Rhodes grass and kikuyu grass and spring-grazed setaria, Rhodes and pangola pastures. Linear regressions of Vibracorder times of grazing clock time were made for both categories of pasture.

The results are presented in Figure 3. Only for the spring-grazed pastures was the correlation between the two methods very good ($r = +0.902$, $P<0.001$) although for the autumn pasture the linear regression was also significant, $P < 0.01$. Grazing times

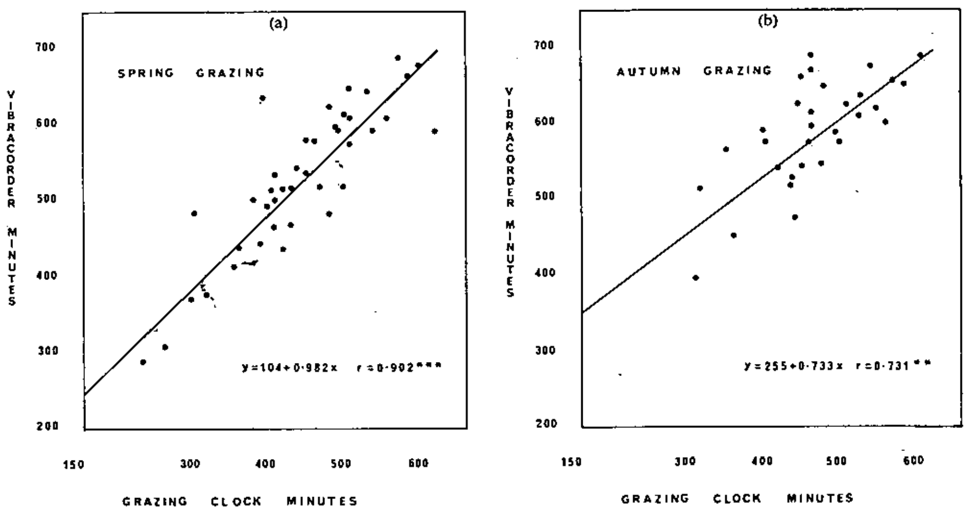

FIGURE 3

The relation between grazing time per day as measured by the Vibracorder and the grazing clock for (a) Spring grazing and (b) autumn grazing.

measured with the grazing clock were shorter than those measured by the Vibracorder by approximately 100 minutes for a daily grazing of 700 minutes measured on the Vibracorder. Furthermore, the slopes of the regression lines differed for the two sets of data ($P < 0.01$) and the intercepts differed widely ($P < 0.001$).

Comparison with observers and stopwatch

To understand the reason for the discrepancies between the Vibracorder and the grazing clock, observers with stopwatches recorded the grazing time of an animal fitted with both devices.

The Vibracorder disc was marked at the commencement of each run so that the experimental period could be detected. Stopwatch readings and grazing clock readings were noted and compared with each other and with the Vibracorder.

Seven pastures (see Table 1) of different species composition and of differing heights were selected for the studies. The cow was observed for about 60 minutes on each occasion during a grazing phase. The results (Table 1) indicated that the Vibracorder over-estimated grazing time when compared with measurements made with a stopwatch, with a mean over-estimation of 18.3%. The grazing clock under-estimated grazing time with the taller pastures, particularly the taller setaria pasture, but gave reasonable estimates of grazing time on the shorter pastures.

TABLE 1

The relation between actual grazing time (measured with a stopwatch) and the grazing time estimated by the Vibracorder and Grazing clock for seven different pastures. Grazing was recorded for about 60 minutes on each pasture but actual time has been set at 100 in each instance.

Pasture type and mean pasture height	Grazing time by Vibracorder	Actual grazing time	Grazing time by grazing clock
1. *Setaria ancepts* cv Kazungula 18 cm	114	100	103
2. *Chloris gayana* cv Pioneer and *Digitaria didactyla* 15 cm	119	100	100
3. *Pennisetum clandestinum* cv Whittett 10 cm	121	100	101
4. *Cyndon-Brachiaria-Setaria* 30 cm	123	100	90
5. *Setaria anceps* cv Nandi 91 cm	110	100	77
6. *Setaria anceps* cv Kazungula 70 cm	123	100	84
7. *Avena sativa* 46 cm	N/A†	100	99

† Not Available

DISCUSSION

The consistently lower grazing times recorded with the grazing clock, compared with the Vibracorder, mean that care should be taken in making any comparisons of grazing times measured in different ways. The longer grazing time with the Vibracorder appeared to be due to the lack of sensitivity in recording brief pauses in the actual grazing routine. Such pauses occurred frequently in the pastures studied. Investigation of the waxed Vibracorder card under the microscope showed that each stylus stroke on the Vibracorder occupied a space of approximately 30-40 seconds. Thus breaks in the actual grazing of 30 seconds or less would not be detected. With the grazing clock these breaks were readily detected. There would be little problem with either method for comparative work, but the definition of 'grazing' by the two methods would differ. If grazing "includes short periods of walking while selecting suitable grass for eating" (Hancock 1950) then the Vibracorder measures this. The grazing clock measures the time that the cow spends with her head down, either eating or walking from site to site.

In view of consistently longer grazing times measured with the Vibracorder compared with the grazing clock it was surprising that the slopes of the regression lines in Figure 3 were not greater than 1. The low 'b' values are however associated with a high positive intercept. Such a situation is explicable if the number of unrecorded pauses in the grazing varies with grazing time. In this instance the number of short pauses in the grazing cycle would be high for low grazing times and low for long grazing times.

The low grazing times recorded by the grazing clock in tall pasture are due to insufficient depression of the head to activate the mercury switch. The low value for pasture number 4 (Table 1) was unusual for a pasture of only 30 cm height. We have found, however, that cattle can graze a new area by extending the head without moving forward. This action reduces the angle of the head and opens the mercury switch. To overcome this it is necessary to position the mercury switch at a shallower angle than that thought necessary by simply depressing the animal's head to a grazing position. Of course, if the grazing occurs consistently at normal head height of about 1 m then there would be no record.

Observations in the field suggest that location of the mercury switch along the neck of the animal, just forward of the withers, would reduce the problems associated with positioning the angle of the mercury switch for individual animals. It would, however, involve separating the mercury switch from the remainder of the clock. Whilst this is technically very simple, in practice it may be less satisfactory because it would be more difficult to prevent the animal removing it. Provided pastures do not exceed 40-50 cm in height, we believe that the device described will give a good estimate of grazing time if it is correctly located on the animal.

In the field the units have remained on grazing beef heifers and have performed satisfactorily in a pasture of setaria — Siratro which rarely exceeded 30 cm in height at the stocking rate used. Mean daily grazing times on a monthly basis varied from 6.2 hr in winter to 10.2 hr in summer.

ACKNOWLEDGEMENTS

We thank Dr. T.H. Stobbs for the use of the Vibracorders and the Jersey cows used in the observations, Mr. R.B. Waite, C.G. McDowall and E.P. Cardoso for competent technical assistance in the field and B. Gibbs for assistance in the construction of the grazing clocks. Mr. R.L. Sandland, C.S.I.R.O. Division of Mathematics and Statistics, St. Lucia, Brisbane, provided statistical assistance and we are grateful to him for the interpretation of the regression analysis results.

REFERENCES

HANCOCK, J. (1950) — Grazing habits of dairy cows in New Zealand. *Empire Journal of Experimental Agriculture* **18**: 249-263.

NICHOLS, G. de la M. (1966) — Radio transmission of sheep's jaw movements. *New Zealand Journal of Agricultural Research* **9**: 468-473.

O'SHEA, J. (1969) — Evaluation of a simple device for measuring the time animals spend grazing. *Irish Journal of Agricultural Research* **8**: 329-333.

PAYNE, W.J.A., LAING, W.I., and RAIVOKA, E.N. (1951) — Grazing behaviour of dairy cattle in the tropics. *Nature* **167**: 610-611.

STOBBS, T.H. (1970) — Automatic measurement of grazing time by dairy cows on tropical grass and legume pastures. *Tropical Grasslands* **4**: 237-244.

STOBBS, T.H. (1974) — Components of grazing behaviour of dairy cows on some tropical and temperate pastures. *Proceedings of the Australian Society of Animal Production* **19**: 299-302.

(Accepted for publication July 25, 1975)