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ORIGINAL ARTICLE

The effect of extended grazing time and supplementary forage on the dry matter intake and foraging behaviour of cattle kept under traditional African grazing systems

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Abstract An experiment was carried out at Alemaya University in Ethiopia to investigate the effect of night kraaling on the dry matter intake (DMI), live weight gain (LWG) and foraging behaviour of Ogaden cattle. Three groups of four animals were given either 7 h access to pasture per day, simulating traditional grazing (TG) practice; extended grazing (EG) access for 11 h per day; or traditional grazing access plus a nocturnal forage supplement (TF). Live weight gain, DMI and foraging behaviour were measured during the late dry season (EP1) and the wet season (EP2). None of the treatments had any significant effect on either DMI or LWG during EP1 or EP2. Extending pasture access time from 7 h to 11 h did not significantly increase the amount time spent grazing, but grazing intensity was significantly ($p < 0.05$) reduced during the non-common grazing hours. Step rate was significantly lower ($p < 0.01$) during EP2 than during EP1 and bites per step were significantly higher ($p < 0.001$) during EP2 than EP1, indicating that animals had to travel a shorter distance before selecting material to eat during the wet season (EP2). Providing supplementary forage (TF) had no significant effect on any measured parameter. In this study neither of the two low-cost methods (EG and TF) of improving access to forage had any beneficial effect on cattle productivity. It is concluded that, under the prevailing conditions, the traditional grazing practices of this part of Ethiopia do provide sufficient pasture access time to achieve daily voluntary food intake.

Keywords Cattle · Dry matter intake · Ethiopia · Foraging behaviour · Grazing access

Abbreviations

ADF	acid detergent fibre
C_{em}	concentration of external marker
CP	crude protein
D_{em}	dose rate of external marker
DM	dry matter
DMD	dry matter digestibility
DMI	dry matter intake
EG	extended grazing
EP	experimental period
FO	faecal output
kg $M^{0.75}$	metabolic live weight
LWG	live weight gain
NDF	neutral detergent fibre
OM	organic matter
SEM	standard error of the mean

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SED standard error of the difference
TF traditional grazing and nocturnal forage
TG traditional grazing

Introduction

In order to protect livestock from predators and theft, or to protect crops from damage by livestock, night kraaling is a common management practice throughout Africa (Bayer and Waters-Bayer, 1998). Typically, the animals are herded to grazing in the early morning and then returned to the kraal during the late afternoon. Control of grazing animals is generally maintained either by herd-boys (Bayer and Otchere, 1985) or by tethering in the case of sheep and goats (Romney *et al.*, 1996).

The time at which animals are taken out to graze depends on the farming system and the season of the year. In strictly pastoral communities, where there are few other demands for labour, animals are generally released from the kraal soon after daybreak (Smith, 1961). In mixed systems of crop and animal production, where there are frequently labour priorities in addition to those of herding livestock, animals may not be taken to grazing until late in the morning (Bayer and Otchere, 1985). The amount of time animals spend grazing is seldom more than 10 h and is frequently less than 7 h (Perrier, 1986).

The specific effects of night-kraaling on livestock productivity have not been widely investigated. Smith (1961) showed that severely restricting grazing to 7 h per day only reduced LWG of cattle in Zambia when the quality or availability of the herbage was low. The animals compensated for the reduced grazing time by increasing grazing intensity while at pasture. Conversely, Kurtu (1985) estimated that when dairy cattle in the Ethiopian highlands were given restricted pasture access for 7 h per day they consumed less than half the dry matter of animals given free access.

In addition to limiting the amount of time an animal has to eat, restriction of grazing time radically alters the natural circadian pattern of grazing activity (Bayer and Waters-Bayer, 1998). Foraging activity in animals given free access to grazing tends to peak during the hours just after sunrise and during the hours just before sunset (Arnold and Dudzinski, 1978; Hodgson, 1990). Under traditional management practices, animals frequently miss the opportunity to graze during these periods and are forced to graze during periods of the day they would naturally use for thermoregulatory activities such as shade-seeking or drinking (Kabuga *et al.*, 1992).

The overall effect of night kraaling on feeding behaviour is to limit foraging time and to distort natural circadian distribution. The ramifications of these effects on productivity and dry matter intake (DMI) have not been investigated in detail. While some workers have demonstrated that ruminants are able to compensate for restricted foraging time (Smith 1961; Romney *et al*., 1996), the mechanism and limits of these strategies have not been investigated. This paper compares two methods of increasing the amount of eating time for cattle managed under traditional communal grazing systems of southern-central highlands of Ethiopia. The aim was to test whether low-cost methods of increasing forage availability resulted in increased dry matter intake and improved LWG and to provide insights into the compensation strategies of cattle that had limited time available for eating under free-range conditions.

Materials and methods

Alemaya University of Agriculture is located in the southern-central highlands of Ethiopia, on the eastern escarpment of the rift valley (longitude 41°5′E, latitude 9°24′N) at 1980 m above sea level. Rainfall distribution is bi-modal, with a short rainy season occurring between mid-February and April and a longer rainy season, from June to September (Thorton, 1972). Mean annual rainfall is ∼736 mm (Shenkoru, 1987).

During a 16-week period, two month-long, detailed studies were carried out, the first (EP1) between mid-March and mid-April, 1995 during the late dry season, and the second (EP2) between early June and early July 1995 during the long rains. Sward characteristics during EP1 and EP2 are detailed in Table 1.

A group of 12 entire, male Ogaden cattle (mean starting live weight 292 kg) was selected from a herd of 50. Animals were divided into three groups of 4 animals that were balanced in terms of live weight and maturity. Each group was allocated to different grazing access treatment for the full course of the experiment. The three treatments were as follows.

Traditional grazing (TG): Animals had approximately 7 h grazing access per day following release from the kraal at 08:00; they were herded back to the kraal and

Table 1 Mean percentage cover of the ten most common herbage species in the two ecological zones used for grazing, showing mean herbage mass and sward quality during EP1 and EP2 at these sites

	Slope zone	Alluvial zone
Species	Mean cover (%)	
Chloris prieurii	15	0
Cynodon dactylon	4	10
Cyperus esculentus	0	13
Eleusine floccifloia	9	16
Hyparrhenia dissoluta	10	0
Hyparrhenia filipendula	15	0
Pennisetum glabrum (adoensis)	11	12
Pennisetum clandestinum	0	42
Pennisetum villosum	14	0
Trifolium rueppellianum	4	7
Other grasses species	2	0
Bare ground	16	0
Number of quadrats sampled	59	187
	Sward quality	
EP1		
Dry matter (g/kg)	351	342
Dry herbage mass (g/m^2)	35	42
Organic matter (g/kg)	902	912
NDF (g/kg)	674	581
ADF (g/kg)	310	320
Crude protein (g/kg)	82	140
EP2		
Dry matter (g/kg)	623	379
Dry herbage mass (g/m^2)	59	129
Organic matter (g/kg)	897	899
NDF (g/kg)	645	590
ADF (g/kg)	340	330
Crude protein (g/kg)	69	114

allowed to drink at around 12:00 for approximately 1 h, then allowed to graze again and finally returned to the kraal for the night at 16:00. This pattern of grazing was similar to that of the main herd.

Extended grazing (EG): Animals had approximately 11 h grazing access, following release from the kraal at 06:00, returning for approximately 1 h around 12:00 to drink, and were then allowed to graze again before returning to the kraal for the night at 18:00.

Traditional grazing plus supplementary fodder (TF): Animals had approximately 7 h grazing access mimicking the grazing regime of the traditional grazing group. However, when this group returned to the kraal at night they were provided with bush-hay (DM = 894 g/kg, OM = 933 g/kg DM, NDF = 753 g/kg DM, ADF = 454 g/kg DM, CP 43 g/kg DM) to approximately one-quarter of their daily voluntary food intake as estimated by ARC (1980) predictive equations.

A further 4 animals were selected to act as companion animals to the cattle in the EG group, in order to reduce the effect of herd size on feeding behaviour when groups TG and TF were confined in the kraal. No measurements were made on these companion animals. The group of 16 animals was herded separately from the main herd during the day in order to facilitate handling and sampling. Groups TG and EG and the companion animals were reunited with the main herd during the night. Animals in group TF were housed in four individual wooden stalls at night.

All animals in the study group received the same tick-control treatment as the main herd. Tick control was administered on an ad-hoc basis according to the availability of acaricide. Animals were weighed once weekly at the same time of day using a Rudd-weigh K1200, portable weighbridge (Ruddweigh International Pty, PO Box 30, Guyra, NSW, Australia). Animals had access to water for 1 h per day between 12:00 and 13:00, as was normal management practice for the whole herd. The experiment was preceded by an adaptation period of 1 month. During this adaptation period, observers closely followed cattle so that the animals were used to the presence of humans.

The sequence of events during each experimental period is shown in Table 2. During the first two weeks of each of study, the DMI of the animals was estimated using external markers and *in vitro* dry matter digestibility (DMD) of the sward using the Tilley and Terry (1963) technique. In the second fortnight of each study period,

Table 2 Schedule of events during each of the two experimental periods carried out during the study

Event	Week of each experimental period
Intake study	
Feeding marker	Weeks 1 and 2
Sward sampling	Week 2
Faecal sampling	Week 2
Behaviour study	
Focal observations	Weeks 1 and 4
Scan observations	Weeks 3 and 4

behavioural observations were carried out to determine time budgets and diurnal grazing behaviour patterns. Two focal studies were carried out in the first and last week of each study period, in which the number of bites and steps were recorded.

DMI was estimated from faecal output (FO) estimated using Cr_2O_3 as an external marker and *in vitro* dry matter digestibility according to the method described by Le Du and Penning (1982). A single 5 g pellet of Cr_2O_3-mordanted hay (Uden *et al.*, 1980) was administered to each animal once per day over a 12-day period at 12:00 when the cattle returned to the kraal to drink.

Faecal samples were collected from animals by observers who followed them closely each day for the full 12-day dosing period. Where possible, two faecal samples were collected each day from each animal, one during the morning and one during the afternoon. Samples were collected from the ground by an observer who was assigned four animals to follow from 08:00 until 12:00 and then from 14:00 until 16:00.

At the end of each day, a 100 g sub-sample from each animal's sample was dried at 100°C to constant weight and retained for analysis in the UK. This protocol provided 12 dried faecal samples per animal per collection period. On return to the UK, the samples gathered in the final five days of each collection period were analysed in duplicate for their chromium content according to the method of Uden and colleagues (1980). Daily dry faecal output of each animal was calculated using the equation (Hodgson and Rodriguez Capriles, 1971):

$$FO = \frac{D_{\mathrm{em}}}{C_{\mathrm{em}}}$$

where FO is faecal dry matter output, D_{em} is the amount of external marker dosed per day and C_{em} is the concentration of external marker in the dry faeces. A correction factor of 0.90 was applied to the faecal outputs to account for incomplete recovery of the external marker (Mir *et al.*, 1989).

A representative sample of material equivalent to that which the animals consumed was obtained by taking at least six samples per day from the sward, for the final eight days of the intake study. The structure of the sward was such that the selection opportunities for the cattle were limited to bite depth and patch choice. The sward samples were, therefore, taken from a 1 m^2 quadrat placed immediately in front of one of the grazing cattle. The herbage enclosed by the quadrat was clipped to a height of 2 cm above ground level and placed in a large re-sealable plastic bag of known weight. On return to the laboratory, the fresh herbage mass was determined by weighing the sealed plastic bag and subtracting the initial empty bag weight. The herbage was then cut into 2–3 cm lengths with clippers and mixed, and a 100 g sub-sample was taken. The sample was dried at 60°C to constant weight in a forced-draught oven and retained for chemical and *in vitro* DMD analysis in the UK according to the procedures described by AOAC (1990). A smaller herbage sample of known weight was dried in a forced-draught oven at 100°C to constant weight, in order to calculate DM after drying; this sample was then discarded.

In the two weeks following the intake study, diurnal patterns of foraging behaviour were recorded by scan-sampling observations carried out at 5 min intervals during 3 h long observation sessions staggered between 06:00 and 18:00, with each observation session being replicated three times. This provided a composite 12 h feeding behaviour profile for each animal, made from a total of twelve 3 h observation sessions. A Psion LZ64 organiser data recorder (Psion Inc., Concord, MA, USA) was used to collect the data. During the period of the day when all animals were grazing together (between 08:00 and 16:00), scan observations were recorded for all 12 animals simultaneously. On the occasions when groups were not herded together, treatment groups were observed separately from one another. Time spent eating per hour was calculated from the total number of times an activity occurred, multiplied by the average observation interval during the hour.

Bite and step rate of cattle when feeding were measured by focal observations of individual animals carried out in the first and last week of each study period. During each of these observation periods data were collected over a 5-day period. The data were collected and recorded by trained observers equipped with two handheld tally counters, a countdown-timer and a notebook.

Focal observations were carried out at 08:00, 11:00, 14:00 and 16:00. On the morning of each observation day, observers were assigned a treatment group to observe. The treatment group assigned to each observer was rotated on a daily basis in an effort to balance any observer effects and to eliminate bias. Each observer recorded the behaviour of each treatment group at least once during the focal observation week.

During each 5 min observation period, the observer would count each bite and step with the aid of the two tally counters. Bites were defined as the actual prehension of food. The sound of prehension, as well as visual criteria, was used to help distinguish when a bite had occurred. Chews and exploratory mouth movements were not counted. A step was defined as a positive movement of the right foreleg, resulting in a forward motion of the animal's body; fidgeting and pest-related movements of the right foreleg were not included.

Step and bites were only recorded when animals were actively feeding. An animal was considered to be actively feeding when it appeared that eating or food-seeking activity were a primary priority. If active feeding did not occur within an hour of the start of a particular observation period, the step and bite measurements were recorded as zero.

Mean bite rate (bites per minute), step rate (steps per minute) and bites per step for each of the observation weeks were calculated for individual animals for each of the daily observation sessions. Mean bite rate, step rate and bites per step were also calculated for the morning and afternoon grazing sessions.

Measurements of LWG, DMI, time budgets, bite rate, step rate and bites per step were analysed statistically with Minitab Release 14.2 using a two-way ANOVA procedure with treatments as the row factors and experimental period as the column factor. Comparisons of the diurnal foraging patterns of the different treatment groups and experimental periods were made using two-way ANOVA (Minitab Release 14.2) of arcsine-transformed measurements of grazing intensity (calculated as the proportion of the total number of observations in which grazing was recorded) during the hours of common grazing (08:00–16:00). In addition, changes in diurnal grazing intensity of group EG during the periods preceding (06:00–08:00) and following (16:00–18:00) the hours of common grazing were compared with the grazing intensity during the period of common grazing (08:00–16:00) using two-way ANOVA (Minitab Release 14.2) of arcsine-transformed data.

Results

The live weight of all three treatment groups increased over the course of the 16-week experiment, but there was no significant effect of treatment. Live weight gain of the TF, EG and TG groups was 11.3 kg (±SEM 4.5), 7.6 kg (±SEM 4.6) and 10.0 kg (±SEM 5.2), respectively.

Table 3 Daily dry matter intake (g per kg $M^{0.75}$) (mean ± SEM) of hay and forage during EP1 and EP2 in cattle given traditional access to pasture for 7 h per day (TG), traditional access plus nocturnal forage supplementation (TF) or extended grazing for 11 h per day (ET) ($n = 4$)

	Grazing access		
	TG	TF	EG
EP1			
Hay	–	13.8 ± 1.2	–
Forage	101.0 ± 8.3	98.4 ± 1.8	106.8 ± 6.0
EP2			
Hay	–	4.5 ± 0.4	–
Forage	97.8 ± 4.0	99.8 ± 3.5	86.6 ± 4.0

Table 4 Time (min) (mean ± SEM) spent eating between 6:00 and 18:00 during EP1 and EP2 in cattle given traditional access to pasture for 7 h per day (TG), traditional access plus nocturnal forage supplementation (TF) or extended grazing for 11 h per day (ET) ($n = 4$)

	Treatment		
	TG	TF	EG
EP1	406 ± 4.8	410 ± 17.4	433 ± 22.5
EP2	450 ± 66.6	409 ± 25.8	497 ± 71.8

The *in vitro* DMD values of the diets were 0.70 and 0.67 for EP1 and EP2, respectively. There were no significant differences in total DMI or DMI at pasture between any of the treatments (Table 3). Overall, animals ate significantly more ($p < 0.05$) during EP1 (102.1 g per kg$^{0.75}$ per day) than during EP2 (94.0 g per kg $M^{0.75}$ per day). This seasonal difference resulted mainly from the TF group eating more hay during EP1.

There was no significant difference between treatments in the total daily time spent grazing despite the EG group having 4 h more per day to graze than the other two groups. Similarly, there were no significant seasonal differences between EP1 and EP2 in the time spent grazing (Table 4). The grazing intensity of group EG during the hours of common grazing was significantly lower ($p < 0.05$) than in the other two groups (Table 5). The grazing intensity of the EG group during the non-common grazing hours (06:00–08:00 and 16:00–18:00) was significantly lower ($p < 0.05$) than

Table 5 Grazing intensity (mean ± SEM) measured as the proportion of total observation in which grazing occurred during three periods of the day between 06:00 and 08:00 (extended grazing hours, AM), 08:00 and 16:00 (common grazing hours) and 16:00 and 18:00 (extended grazing hours, PM), during EP1 and EP2 in cattle given traditional access to pasture for 7 h per day (TG), traditional access plus nocturnal forage supplementation (TF) or extended grazing for 11 h per day (EG). Only EG animals were allowed to graze during the extended grazing hours (AM and PM) ($n = 4$)

	Grazing period		
	Extended grazing hours, AM	Common grazing hours	Extended grazing hours, PM
EP1			
TG		0.72 ± 0.020	
TF		0.76 ± 0.012	
EG	0.44 ± 0.273^{f}	0.68 ± 0.020	0.30 ± 0.031^{g}
EP2			
TG		0.80 ± 0.028	
TF		0.80 ± 0.024	
EG	0.65 ± 0.114^{f}	0.70 ± 0.092	0.73 ± 0.083^{g}
Interaction SED	0.087	0.032	0.087
Treatment means			
TG		0.76^{c}	
TF		0.78^{d}	
EG	0.55^{a}	0.69^{abcd}	0.51^{b}
Treatment SED	0.062	0.016	0.062
Period means			
EP1		0.72^{e}	
EP2		0.77^{e}	
Period SED		0.019	

^{a,b,c,d,f,g}Values that share the same superscript are significantly different ($p < 0.05$)
^{e}Values that share the same superscript are significantly different ($p < 0.001$)

during the hours of common grazing when EG was grazing with the other two treatment groups. There was no significant effect of the TF treatment on either total time spent grazing or grazing intensity.

Diurnal changes in grazing intensity for all treatments during EP1 and EP2 are shown in Figures 1 and 2. During the common grazing hours, the grazing intensities of all the groups at any given hour were statistically

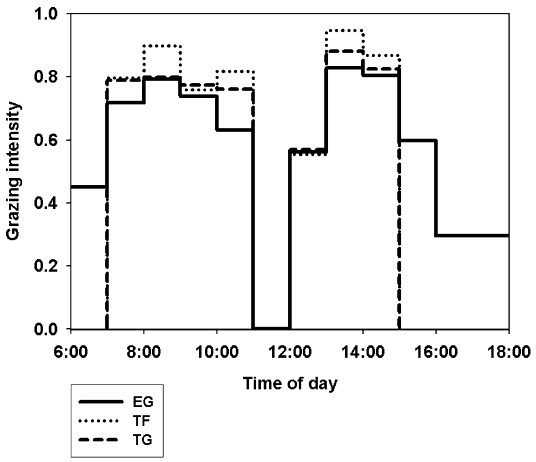

Fig. 1 Diurnal variation in grazing intensity (measured as the proportion of total observation in which grazing occurred) during experimental period 1 (EP1) in cattle given traditional access to pasture for 7 h per day (TG), traditional access plus nocturnal forage supplementation (TF) or extended grazing for 11 h per day (EG) ($n = 4$)

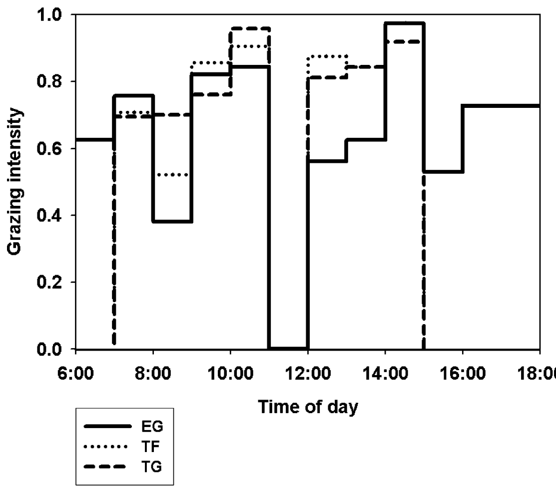

Fig. 2 Diurnal variation in grazing intensity (measured as the proportion of total observation in which grazing occurred) during experimental period 2 (EP2) in cattle given traditional access to pasture for 7 h per day (TG), traditional access plus nocturnal forage supplementation (TF) or extended grazing for 11 h per day (EG) ($n = 4$)

Table 6 Mean (± SEM) bite rate (bites per minute), step rate (steps per minute) and bites per step during EP1 and EP2 in cattle given traditional access to pasture for 7 h per day (TG), traditional access plus nocturnal forage supplementation (TF) or extended grazing for 11 h per day (ET) ($n = 4$)

		Treatment				
		TG	TF	ET	Mean	SED
Bite rate	EP1	47.5 ± 1.00	47.5 ± 0.45	41.1 ± 4.71	45.4	2.02
	EP2	43.8 ± 0.49	44.0 ± 0.21	38.8 ± 0.90	42.2	
	Mean	45.7^{a}	45.8^{b}	40.0^{ab}		
	SED		1.17			
Step rate	EP1	9.8 ± 0.37	9.4 ± 0.41	8.4 ± 0.81	9.2^{c}	0.41
	EP2	7.7 ± 0.12	7.8 ± 0.13	7.6 ± 0.04	7.7^{c}	
	Mean	8.7	8.6	8.0		
	SED		0.23			
Bites per step	EP1	4.9 ± 0.21	5.1 ± 0.23	4.9 ± 0.31	4.9^{d}	0.20
	EP2	5.7 ± 0.16	5.7 ± 0.07	5.1 ± 0.12	5.5^{d}	
	Mean	5.29	5.4	5.02		
	SED		0.11			

^{a,b}Values that share the same superscript are significantly different ($p < 0.05$)
^{c}Values that share the same superscript are significantly different ($p < 0.001$)
^{b}Values that share the same superscript are significantly different ($p < 0.01$)

similar to one another (Figures 1 and 2). The grazing intensity of group EG (0.43 ± 0.042) during the first 2 h after their release to the field (06:00–08:00) was significantly lower ($p < 0.001$) than the grazing intensity of the TG (0.79 SEM ± 0.033) groups and TF (0.84 SEM ± 0.030) groups in the first 2 h after their release (08:00–10:00). The grazing intensity of all three groups became statistically indistinguishable within the first hour of common grazing.

The bite rate of the EG group was significantly lower ($p < 0.05$) than that of the other two treatment groups (Table 6), but there was no significant effect of the treatments on step rate. Step rate of all the treatment groups was significantly ($p < 0.001$) higher during EP1 than during EP2.

Discussion

Access time to grazing had no effect on live weight change during the course of the entire experiment from mid-March to mid-July, indicating that there was no advantage in extending the amount of time available for eating under conditions prevaling in the south-eastern highlands of Ethiopia. In this respect, the results of the present study concur with the work of Smith (1961) carried out in Zambia, who found that restricting grazing time had no effect on live weight gain when pasture quality was moderate. The present experiment was carried out over a period when sward quality was moderate to good, and herbage mass was increasing (Table 1). However, the quality of pasture during EP1 was better than that in EP2 in terms of dry matter digestibility (DMD), crude protein (CP) and ADF content but not NDF content. To some extent this was an unexpected result as EP1 was during the late dry seasons and EP2 during the long rains. The lower quality of herbage during EP2 may account for the lower DMI of animals during this period, perhaps due to gut fill effects (Stobbs, 1973).

Herbage mass was much greater during EP2 than during EP1 (Table 1). The increased availability of herbage may explain the increase in time spent grazing in both the TG and EG treatments and the significant decrease in step rate during EP2 (Table 6); animals had to walk less far between feeding stations. This effect was also reflected in the number of bites per step, which showed that animals took significantly more bites at each feeding station in EP2 than EP1 (Table 6).

Estimates of DMI based on the *in vitro* techniques to estimate DMD and the use of Cr_2O_3 to estimate FO were considerably higher than those predicted by the ARC (1980) intake model (66–77 g DM per kg $M^{0.75}$) for diets with a metabolizability (q) of between 0.4 and 0.5. However, if live weight changes were used as an indication to estimate energy intake, the DMI of cattle fed diets with q-values of between 0.4 and 0.5 would be calculated to be between 68 and 95 g DM per kg $M^{0.75}$ (Lawrence and Pearson, 1999), values close to those estimated by the *in vitro*/FO technique in the current experiment.

Providing additional time for grazing had no effect on total DMI. Dry matter intake of EG animals was not significantly different from that of those with traditional access (TG and TF groups). EG animals spent more time foraging than the TG and TF animals, although this effect was not statistically significant. However, there was no significant change in grazing intensity during the hours of common grazing. The only consistent difference between the feeding behaviour of the EG group and that of the other two treatment groups was in bite rate; this was lower in the group given more time to graze (Table 6). This may indicate that the EG group spent more time selecting forage before prehension.

Animals receiving the EG treatment did not utilize the available grazing very intensely during the hours immediately following turn-out on to pasture (Table 5). The grazing intensity of this group immediately increased when they were joined by the animals in the other treatments (TG and TG). This suggests that the effects of the treatments were possibly confounded by the effect of herd size on the drive to eat, or that the animals in TG were not fully habituated to the increase in pasture access. Grazing intensity of the TG during the extending grazing hours was greater during EP2, during both morning and afternoon (Table 5), possibly indicating that animals were becoming more habituated to the increased pasture access or that the drive to eat was greater.

The data from this experiment indicate that cattle will utilize additional grazing time if it is provided, but this does not necessarily lead to increased DMI or live weight gain because grazing intensity is less. Cattle appear to reduce their rate of intake when they have more time to graze, by decreasing bite rate. Whether this decrease in bite rate was due to an increase in the number of chews per bite, an increase in the bite-to-bite interval (due to more careful selection of forage) or simply a more ‘leisurely attitude’ to grazing cannot be established from the data obtained in this experiment. Whatever the reason for the decline in bite rate, there was no production advantage to increasing the time available for grazing by cattle during the seasons and in the location in which the experiment was carried out.

The greater bite rate of cattle undergoing the TG and TF treatments suggests that these animals were expending more effort to achieve the same levels of DMI as the EG cattle. The extent to which bite rate can be accelerated in response to limited grazing time was not established in this experiment. However, as maximum bite rate is dependent on both the quality and physical structure of the sward, the extent to which increased bite rate can compensate for restricted grazing time is limited (Ungar, 1996)

Providing cattle with low-quality hay during the hours of kraaling did not have any significant effect on DMI or live weight gain. The feeding behaviour of the TF cattle was similar to that of TG cattle. During EP1, a forage supplement tended to depress grazing intake, but not during EP2. Under the sward conditions encountered during this experiment, feeding poor quality hay in the kraal cannot be recommended as a method of improving animal performance. Furthermore, in communal grazing conditions, kraal feeding of hay is disadvantageous to individual farmers because it results in cattle depending on the pastoral resource less and making use of fodder that farmers have made a considerable effort to harvest and store.

In conclusion, it has been established that traditional grazing management systems in the southern-central highlands of Ethiopia provide adequate time for grazing cattle to achieve a DMI that allows a modest daily live weight gain. Under the conditions found at Alemaya, increasing the amount of time or providing supplementary feed did not result in improved productivity. However, the performance of this grazing system under more arduous rangeland conditions has not been established and more long-term studies are required to investigate this under a broader range of environmental conditions.

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Effet d'un temps de pâturage prolongé et d'un complément de fourrage sur l'apport en matières sèches et le comportement fourrager du bétail gardé sous des systèmes de pâturage africains traditionnels

Résumé – Une expérimentation a été menée à l'Université d'Alemaya en Éthiopie pour étudier l'effet du kraaling de nuit sur l'apport en matières sèches (DMI), le gain de poids vif et le comportement fourrager du bétail Ogaden. Trois groupes de quatre animaux ont reçu soit un accès de sept heures à la pâture par jour, simulant une pratique de pâturage traditionnelle (TG); soit un accès à un pâturage prolongé (EG) pendant 11 heures par jour, soit un accès à des pâtures traditionnelles, plus un supplément de fourrage nocturne (TF). Le gain en poids vif (LWG), l'apport en matières sèches et le comportement fourrager ont été mesurés pendant la saison sèche tardive (EP1) et la saison des pluies (EP2). Aucun des traitements n'a eu d'effet significatif, que ce soit sur l'apport en matière sèche ou le gain de poids vif durant la saison sèche ou la saison des pluies. Un temps d'accès prolongé à la pâture de 7 heures à 11 heures n'a pas considérablement augmenté le temps passé à paître mais l'intensité du pâturage a considérablement diminué ($p < 0.05$) pendant les heures de pâturage peu fréquentes. La cadence des pas a été considérablement plus basse ($p < 0.01$) pendant la saison des pluies que pendant la saison sèche et les piqûres par pas ont été considérablement plus nombreuses ($p < 0.001$) pendant la saison des pluies que pendant la saison sèche, ce qui indique que les animaux devaient se déplacer une distance plus courte avant de choisir de quoi manger pendant la saison des pluies (EP2). La fourniture d'un complément de fourrage (TF) n'a pas eu d'effet significatif sur les paramètres mesurés. Dans cette étude, aucune des deux méthodes à bas coût (EG et TF) d'amélioration de l'accès au fourrage n'a eu d'effet bénéfique sur la productivité du bétail. Il en a été conclu que sous les conditions prévalentes, les pratiques de pâturage traditionnelles de cette partie de l'Éthiopie fournissent suffisamment de temps de pâturage pour l'obtention d'un apport alimentaire volontaire journalier.

Efecto del tiempo de apacentamiento extendido y del forraje suplementario en el consumo de materia seca y comportamiento forrajero del ganado mantenido bajo sistemas de apacentamiento africanos tradicionales

Resumen – Se llevó a cabo un experimento en la Universidad Alemaya de Etiopía para investigar el efecto de encerrar al ganado por las noches sobre el consumo de materia seca (CMS), la ganancia de peso vivo y el comportamiento forrajero del ganado Ogaden. A tres grupos de cuatro animales se le dieron, o bien siete horas de acceso a pastos por día, simulando la práctica de apacentamiento tradicional (AT), o bien acceso a un apacentamiento extendido (AE) de 11 horas por día, o bien acceso a apacentamiento tradicional más suplemento de forraje nocturno

(TF, tradicional más forraje). La ganancia del peso vivo (GPV), el CMS y el comportamieno forrajero se midieron durante el final de la estación seca (PE1 o periodo experimental 1) y la estación húmeda (PE2). Ninguno de los tratamientos tenía un efecto significativo en el CMS o la GPV durante el PE1 o PE2. Al extender el tiempo de acceso a pastos de 7 a 11 horas no se incrementaba de modo significativo el tiempo empleado en el apacentamiento, pero la intensidad del apacentamiento se redujo significativamente ($p < 0.05$) durante las horas de apacentamiento no comunes. La tasa de pasos efectuados fue significativamente más baja ($p < 0.01$) durante el PE2 que en el PE1, y los mordiscos por paso fueron significativamente más altos ($p < 0.001$) durante el PE2 que en el PE1, indicando con ello que los animales tenían que viajar una distancia más corta antes de seleccionar el material a comer durante la estación húmeda (PE2). El proporcionar forraje suplementario (TF) no tenía un efecto significativo sobre ninguno de los parámetros medidos. En este estudio ninguno de los dos métodos de bajo coste (AE y TF) de mejoramiento de acceso al forraje tenía ningún efecto beneficioso sobre la productividad del ganado. Se concluye que bajo las condiciones reinantes, las prácticas de apacentamiento tradicionales de esta parte de Etiopía proporcionan el suficiente tiempo de acceso a pastos para lograr un consumo de alimento diario y voluntario.