The cost to productivity and the potential benefits of 2- and 3-day watering of Boran cattle*

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Summary

A 28-MONTH TRIAL *was conducted under extensive grazing conditions to examine the effects of watering Boran cattle once daily, once every 2 days and once every 3 days, with cattle watered* ad libitum *serving as the control. In the dry season, the weight and condition of lactating cows watered every 3 days declined more rapidly than that of cows watered daily. There were no significant differences in calving rates and birth weights among treatments although birth weights were depressed by 2.5 kg in all treatments compared with the control. Thirty steers showed no treatment differences in 27-month weights despite animals watered every 3 days having a significantly lower DM intake during the dry season. In contrast, 210-day weaning weights were significantly depressed by 9 kg under 2-day watering and by 14 kg under 3-day watering when compared with calves watered daily. The total amount of water consumed was reduced by 5–10% in all classes of stock under 2-day watering and by 25–34% under 3-day watering, compared with cattle watered daily. The results show that watering every 3 days can be carried out indefinitely with all classes of stock with only minor effects on cattle productivity under the climatic conditions in which the trial was conducted. The management implications of 2- and 3-day watering in cattle under extensive pastoralism or ranching are discussed.*

Introduction

The Borana pastoral tribe in southern Ethiopia and northern Kenya water their cattle every 3 days (Dahl, 1979). In the past, the Maasai and other pastoral tribes also adopted this practice, but have discontinued it, presumably due to increased water supplies. In other pastoral regions of Africa, alternate-day watering is resorted to in the dry season (Bailey, 1982; Maliki, 1981; King, 1983; Nicholson, 1985a).

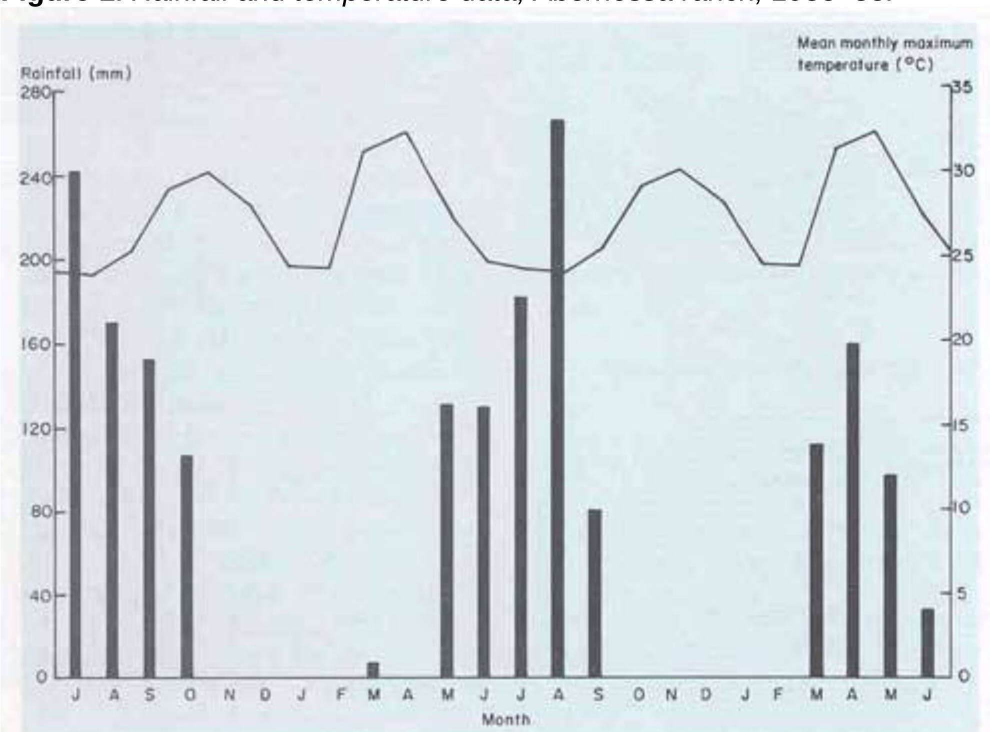
French (1956) studied the effects of 2 and 3-day watering on water and feed consumption and subsequent digestibility of hay in stall-fed *Bos indicus* oxen. However, the trial was of short duration and weight change was not monitored. Payne (1965) examined the effect of 1-, 2- and 3-day watering on 10 sets of identical zebu or zebu-crossbred twins. One of each twin was watered daily and served as the control, and the other was watered intermittently on a 1-, 2- or 3-day cycle and subjected to varying walking distances. After 2 years, the control animals had an average weight of 151 kg, compared with 131 kg for the experimental animals. Payne concluded that the influence of walking on liveweight gain was much less than that of water deprivation, but that the effects of both were small relative to those of seasonal changes in the quality and quantity of grazing.

No experiment has previously studied the effect of infrequent watering on breeding cows and their offspring. This study was conducted to determine whether watering cattle every third day constituted a constraint on productivity in the Borana system. The effects of 2- and 3-day watering needed to be quantified, since it was assumed that there is a trade-off between the expected lower animal productivity and the possible benefits of the practice. The main factors studied were the effects of 3-day watering on cow performance, and on calf and subsequent weaner growth.

Materials and methods

The trial was carried out on the Abernossa ranch in the Ethiopian Rift Valley at an altitude of 1700 m and a latitude of 7°50' N. Average rainfall is between 500 and 700 mm, seasonal in distribution, falling mostly between July and September but with unreliable short rains in April. Rainfall was measured as the average figure from two equidistant rain gauges and was 928 and 681 mm in 1983 and 1984 respectively. The rainfall distribution and mean monthly maximum temperatures during the 28-month trial (July 1983 to September 1985) are shown in Figure 1.

Figure 1. *Rainfall and temperature data, Abernossa ranch, 1983–85.*



Seventy-five Boran cows with male calves were allocated to one of three treatments on the day of calving. One Brahman heifer and three Friesian x Boran crossbred cows were also allocated to each treatment. The treatments comprised daily watering (treatment 1), alternate-day watering (treatment 2) and 3-day watering (treatment 3). Each group was allowed unrestricted grazing in one of three paddocks of 90 ha each, in which the pasture was dominated by *Cenchrus ciliaris, Chloris gayana* and *Hyparrhenia hirta* in a dense acacia woodland. Feed was generally plentiful even at the end of the dry season, although quality was poor. No supplements were given to the cows. Groups were rotated monthly among the paddocks to avoid a confounding effect of paddock condition. Fifty cows from the ranch, watered *ad* *libitum* but otherwise treated identically, served as a control group. However, as these were not under the direct control of the experiment, data on the performance of 2- and 3-day watered cattle are presented in comparison with daily watered cattle unless otherwise stated. In practice, *ad libitum* watering of cattle in pastoral regions is extremely rare in the dry season.

Health control was restricted to spraying against ticks as part of the ranch programme and infrequent vaccination against foot-and-mouth disease. Both were limited by shortages of acaricide and vaccine.

Bulls ran with the cows from late September to December so that calving was seasonal and coincided with the main rains. Suckling was unrestricted and calves had access to all their dam's milk. Calves were weaned monthly at between 210 and 240 days of age. At the end of the first year, 10 weaners in each treatment were castrated and returned to their original treatment to measure post-weaning growth. At 27 months old, these steers were put on *ad libitum* watering for 6 weeks.

All animals were routinely weighed each month before and after watering except during changeable weather during the rainy season when they were weighed twice a month, since water intake, and hence weights, varied according to the weather. At the same time, the condition of lactating and dry cows was recorded using the nine-point scoring system of Nicholson and Butterworth (1985). Heart girth was measured in all stock. Skeletal size was taken as the height from the ground to the dorsal head of the supraspinous fossa on the scapula and the length from the *tuber ischii* to the scapula over the *tuber coxae*.

Animals were given access to water at 11 a.m. for 15 minutes, the difference in body weight before and after drinking representing water consumption. Weight losses due to defaecation and urination during watering were rare, and were therefore ignored.

Dry-matter (DM) intake was estimated in six steers and nine lactating cows per treatment. In steers, intake was estimated indirectly using a combination of a natural marker (indigestible acid detergent fibre (IADF) determined in feed and faeces (van Soest, 1982) after a 96-hour *in vitro* digestion) and 10-day whole faecal collection. Grass was collected during grazing by grab sampling. Samples were bulked during any one grazing period and 10 bulked samples were dried, ground and analysed for each faecal collection period. In cows, DM intake was determined under stall-feeding, where the marker and faecal collection could be validated with direct measurement of feed intake. Tritiated water was used to measure milk intake over 10-day periods in young calves (turnover method), and the measurements were validated by weighing prior to and after suckling (Coward et al, 1982). Measurement of total milk yield is not feasible in *Bos indicus* under field conditions; hence weaning weights were assumed to be a reflection of milk consumed by the calf.

The model used for the analysis of weights included linear and quadratic orthogonal components for treatments. Least-squares means (Harvey, 1982) are given with their standard errors for the analysis of calf and steer weights.

Results

Calving percentage

Although the trial included three calving seasons, July 1983, July–September 1984, and July–September 1985, the first season was independent of the treatment effect; therefore only two calving seasons were considered. There were no significant differences either between years or among treatments, despite 1984 being a particularly dry year.

Birth weights

At the start of the trial birth weights of calves averaged 26.4 kg. For all treatments, 1983 birth weights were significantly heavier (P < 0.001) than those of 1984 or 1985 (Table 1). In the last 2 years there were no treatment, sex or year effects. Calves from *ad libitum*-watered cows were significantly heavier (P < 0.001) than all the treatment calves in both 1984 and 1985.

Table 1. *Calf birth weights (kg ± S. E.), 1983–85*.

Treatment	1983	1984	1985	1984/85
1	$26.3^{a} \pm 0.26$	$24.7^{b} \pm 0.73$	$23.2^{b} \pm 0.76$	$24.0^{b} \pm 0.52$
2	$26.7^{a} \pm 0.38$	$23.7^{b} \pm 0.66$	$23.5^{b} \pm 0.74$	$23.6^{b} \pm 0.54$
3	$26.4^{a} \pm 0.36$	$23.3^{b} \pm 0.71$	$22.9^{b} \pm 0.70$	$23.1^{b} \pm 0.54$
Control	$26.3^{a} \pm 0.24$	$26.1^{a} \pm 0.42$	$25.7^{a} \pm 0.53$	$25.9^{a} \pm 0.51$

Means in the same column with the same superscript are not significantly different at the 5% level.

Month of birth had a significant effect (P < 0.05) on calf weights at birth and at 210 days of age (Table 2). Seventy-four percent of calves were born in July and August. There was no significant interaction between treatment and month. However, the 31 calves from cows in treatment 1 were born significantly later (P < 0.01) than the 68 calves from cows in treatments 2 and 3. This amounted to a difference of between 2 and 3 weeks.

Table 2. *Calf weights (kg ± S.E.) at birth and at 210 days old by month of birth (1984 and 1985 combined for treatments 1, 2 and 3)*.

Month of birth	Birth weight (kg)	n = 99	210-day weight (kg)	n =115
June	$22.0^{a} \pm 0.84$	9	$127.9^{a} \pm 9.82$	3
July	$24.1^{bc} \pm 0.38$	50	$143.7^{ab} \pm 2.74$	44
August	$24.7^{b} \pm 0.49$	27	$135.3^{ac} \pm 2.78$	41
September	$25.1^{bc} \pm 1.27$	4	$132.7^{a} \pm 5.98$	8
October	$21.9^{ac} \pm 1.02$	9	$120.2^{ad} \pm 4.22$	19
Mean	23.5 ± 0.38		136.3 ± 18.37	

Means in the same column with the same superscript are not significantly different at the 5% level.

Weaning weights

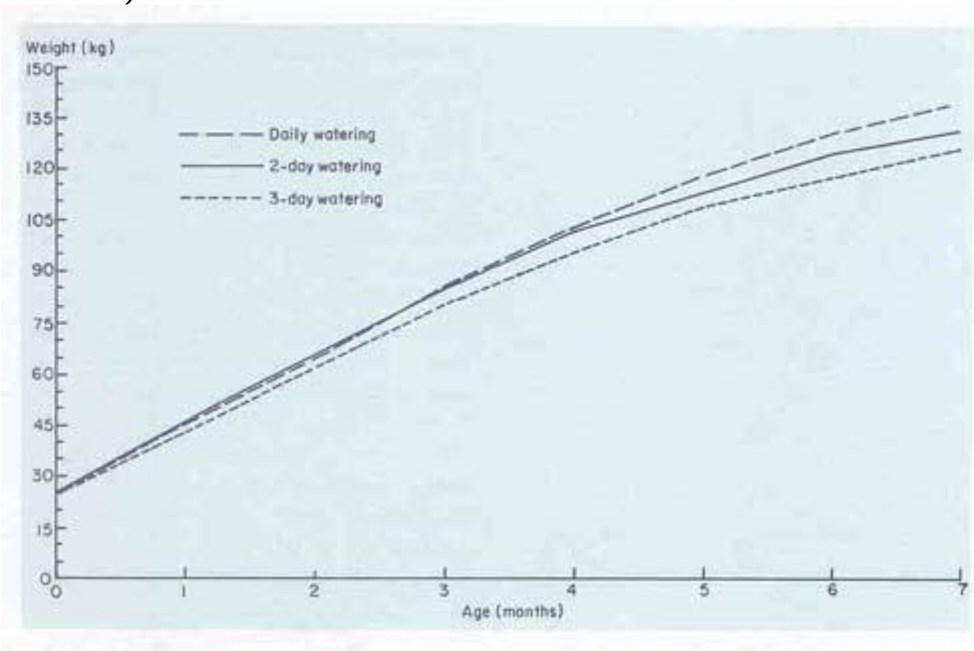
The 210-day weaning weights of calves are shown in Table 3.

Table 3. *Two-hundred-and-ten-day weights (kg ± S.E.) of calves born in 1983 and 1984.*

Treatment	1983 calves (n = 98)	1984 calves (n = 101)	1983 and 1984 calves (n = 199)
1	142.1 ± 3.58	139.8 ± 5.56	139.6 ± 3.40
2	136.5±3.91	133.8±5.20	130 8±3.35
3	132.0 ± 3.80	125.6 ± 6.39	125.5 ± 3.76
Control	147.3 ± 5.82	143.9 ± 6.81	146.2 ± 3.98

The linear effect of watering frequency on calf weight was significant ($P < 0.05$) at all ages over 90 days. Sex, weight at birth and year of birth did not have significant effects but month of birth significantly affected weaning weight (Table 2). Calf growth from birth to weaning at 7 months is shown in Figure 2.

Figure 2. *Effect of watering regime on calf growth from birth to weaning (1983 and 1984 calves combined).*



Mortality

Two-hundred-and-one calves were born in the trial over the three calving seasons. One 19 kg calf died of cutaneous streptothricosis at 2 weeks of age and one 25 kg calf died at 3 days old, apparently from choking on milk. Both calves belonged to treatment 1. Overall calf mortality was therefore 1 %.

Four cows died during the study period. The causes of death were plant poisoning (1), punctured abdomen (1), possible cardiac failure (1) and septicaemia (1). None of the deaths was attributable to treatment.

Post-weaning growth

The weights of 1983 and 1984 weaners were examined separately since the animals in the first group were not significantly different from each other at weaning or at birth. Weights of steers at various ages are shown in Table 4. No data were available on control steers as male calves are either sold or kept for breeding purposes.

Table 4. *Weights of 1984 male weaners (kg ± S. E.) at 12, 15, 18 and 24 months old*.

Treatment	Age (months)			
	12	15	48	24
1	191.4 ± 15.9	218.7 ± 6.1	230.0 ± 6.8	312.8 ± 8.4
2	188.0 ± 15.1	210.2 ± 7.2	216.3 ± 8.0	308.4 ± 9.4
3	209.0 ± 15.1	215.5 ± 7.1	215.5 ± 7.9	306.1 ± 9.2

Watering frequency did not have a significant effect on the weight of steers in 1984 at any age up to 2 years old. In 1985, treatment 3 weaners were significantly lighter ($P < 0.05$) at 1 year old (160 ± 6.9 kg) than those in treatment 1(177 ± 6.9 kg) and treatment 2 (178 ± 5.6 kg). Sex differences in the 1985 weaners were not significant but at 12 months in these animals the treatment linear component was significant ($P < 0.01$). Treatment did not have a significant effect on skeletal size at any age, suggesting that weight differences reflected variations in muscle, fat reserves or gut fill. After 6 weeks of *ad libitum* watering, mean weights were 357, 374 and 371 kg for treatments 1, 2 and 3 respectively. The differences were not significant.

Seasonal change in cow weight

Weight loss in lactating cows during the dry season is shown in Figure 3. Weight gain was confounded with pregnancy. In contrast, dry cows lost a smaller proportion of body weight during the dry season than lactating cows (Figure 4). June and July data are confounded by parturition and subsequent weight changes of about 50 kg per animal. Weight losses of lactating cows during the dry season are shown in Table 5, with October data representing the highest weights.

Figure 3. *Effect of watering regime on weight change in lactating cows, 1984–85*

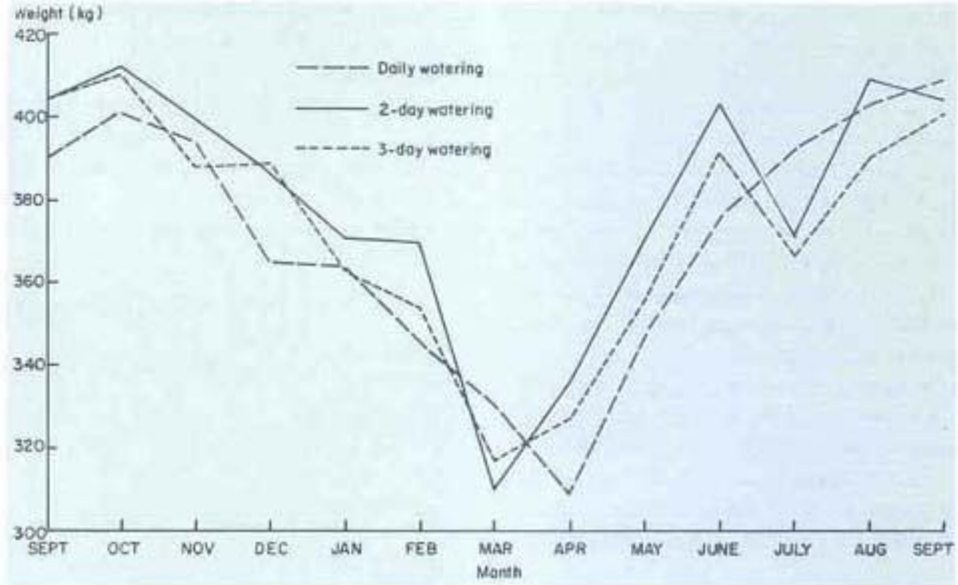


Figure 4. *Effect of watering regime on weight change in dry cows, 1984–85.*

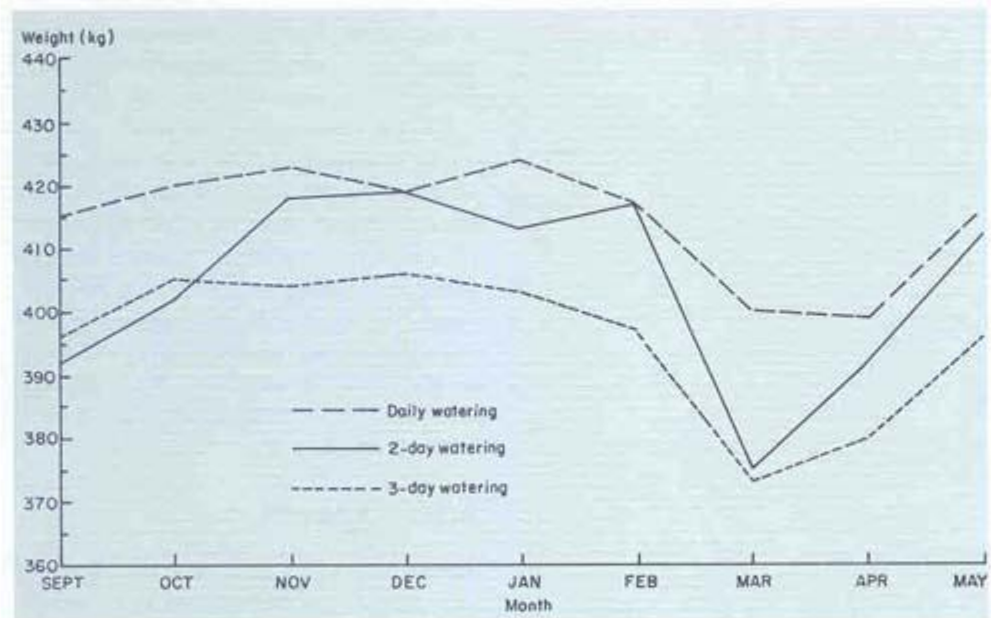


Table 5. *Dry-season weight loss of lactating cows, November 1983–May 1984*.

Treatment	Weight loss (kg)	Percentage of October weight
1	83.4	22.2
2	68.4	18.6
3	111.4	27.0

Seasonal change in condition score

Changes in condition over a 1-year period are shown in Figures 5 and 6 for lactating and dry cows. The data have been analysed in detail by Nicholson and Sayers (1986). Condition scores for individual animals were highly significantly correlated with weight change. One condition point was equivalent to an average weight change of 18 kg and this relationship was linear ($P < 0.001$). Loss of condition in the dry season was marked in lactating cows and varied according to treatment (Table 6).

Figure 5. *Effect of watering regime on monthly condition scores of lactating cows, 1984–85.*

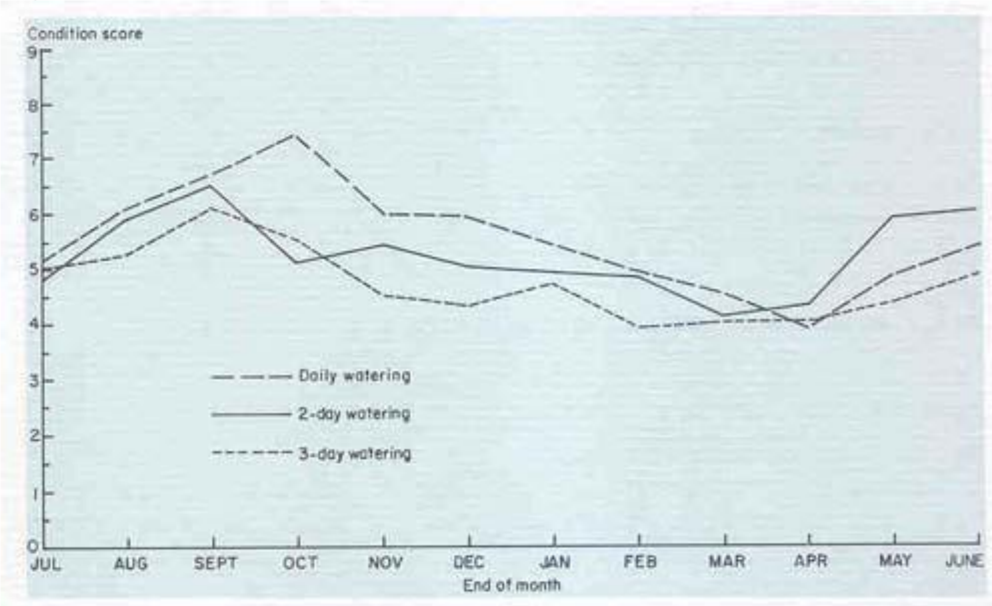


Figure 6. *Effect of watering regime on monthly condition scores of dry cows, 1984–85.*

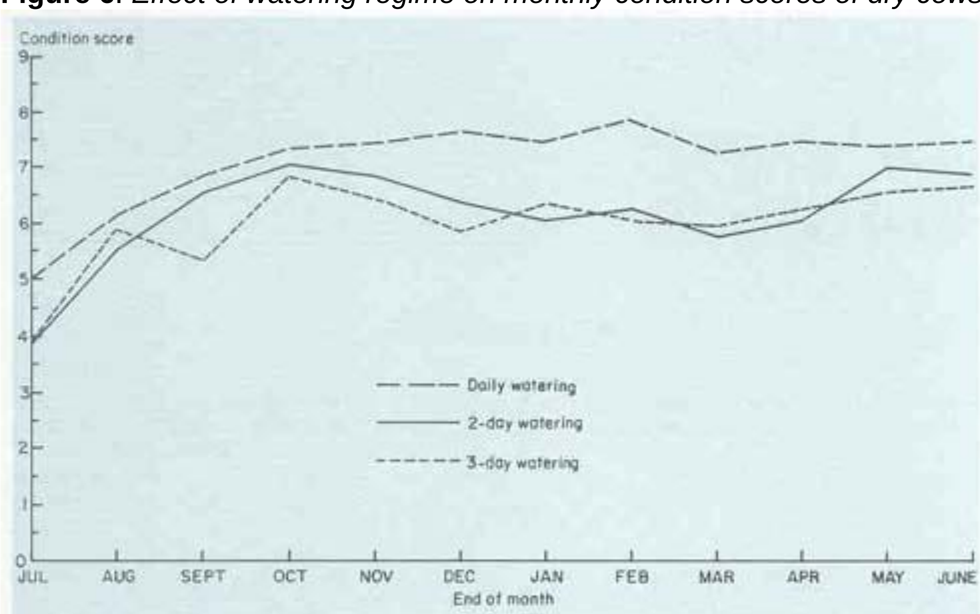


Table 6. *Rate of condition loss in lactating cows over the dry season, October to April (condition score ± S. E)*.

Treatment	October score	April score	Condition loss (points per month)
1	7.4[c] ± 0.27	4.5[e] ± 0.27	0.452[a] ± 0.0039
2	5.1[d] ± 0.26	4.1[e] ± 0.26	0.268[b] ± 0.0040
3	5.5[d] ± 0.26	4.0[e] ± 0.26	0.280[b] ± 0.0039

Means in the same column with the same superscript are not significantly different at the 5% level.

Water intake

There were highly significant (P < 0.001) differences in water consumption between lactating cows and dry cows and between treatments (Table 7). The data refer to the dry season only. Wet-season water consumption was highly variable.

Table 7. *Water consumption (± S. E.), September–March*.

Treatment	Average consumption at drinking (litre)	Consumption (ml/kg)	Consumption (ml/kg/day)	Consumption as % of dehydrated weight
1 LC	28.7 ± 1.3	79.4 ± 2.6	79.4 ± 2.6	7.9
DC	23.3 ± 1.1	57.3 ± 3.2	57.3 ± 3.2	5.7
2 LC	54.6 ± 1.0	151.0 ± 5.7	75.5 ± 2.1	15.1
DC	42.0 ± 1.1	108.2 ± 3.3	54.1 ± 2.6	10.8
3 LC	65.3 ± 1.7	156.7 ± 6.9	52.2 ± 3.3	15.7
DC	49.9 ± 1.6	133.5 ± 4.1	44.5 ±3.0	13.4

LC = lactating cows, DC = dry cows.

Maximum observed intake was 90 litres in a lactating cow with a dehydrated weight of 301 kg. Maximum intake expressed as a percentage of dehydrated weight was 31.4%. Water intake in steers was very similar to that in dry cows when expressed on a ml/kg or a ml/kg/day basis. Treatment 3 cows consumed up to 34% less water than cows watered daily on an intake per day basis, whereas in dry cows intake was depressed by 22%. In contrast, calves of dams in treatments 2 and 3 drank significantly more water in the first 7 months of their life than calves of dams in treatment 1.

Milk intake

During three 10-day sub-periods, milk intake was estimated in young calves of the same age in the third month of lactation. The results (Table 8) show that treatment *3* calves consumed significantly less milk than those in the other two treatments.

Table 8. *Milk intake (kg/day)*.

Treatment	Weighing method	Turnover method
1	$4.93^{a} \pm 0.10$	$5.10^{a} \pm 0.19$
2	$4.82^{a} \pm 0.09$	$4.78^{a} \pm 0.12$
3	$4.19^{b} \pm 0.13$	$4.36^{b} \pm 0.13$

Means in the same column with the same superscript are not significantly different at the 5% level.

Feed intake

Data for faecal output and estimated feed intake of growing lactating cows and steers are given in Tables 9 and 10.

Table 9. *Dry-matter intake of lactating cows (crossover trial, n = 27)*.

Treatment	Feed intake ($g/kg^{0.75}$/day)	Mean weight of cows (kg ± S.E.)
1	68.0	320 ± 7.7
2	65.6	322 ± 8.7
3	61.8	329 ± 9.3

Linear component significant at the 1 % level.

Table 10. *Faecal output and estimated feed intake of steers*.

Treatment	Observed faecal output ($g/kg^{0.75}$/day)	Calculated feed intake ($g/kg^{0.75}$/day)	Mean weight of steers (kg ± S.E.)
1	35.9 ± 0.82	52.9 ± 2.93	248 ± 3.6
2	30.6 ± 1.61	42.3 ± 2.35	238 ± 5.7
3	31.6±0.91	46.1 ± 2.16	231 ± .1

No differences in the digestibility of feed were found between treatments as estimated by the quantity of IADF in the faeces. Faecal output was significantly higher ($P < 0.05$) in treatment 1 steers than in those in the other treatments, and the estimates of DM intake suggest a 12–17% reduction in feed intake by steers in treatments 2 and 3. In the cows, DM intake was depressed by 4% in treatment 2 and by 9% in treatment 3.

Discussion

The overall cost to animal productivity of infrequent watering was small but significant. Calf birth weights were lower in all treatments compared with control calves, and this was probably related to dam condition during late pregnancy and at parturition. When birth weights between treatments were similar as in 1983, treatment 3 calves were 10 kg lighter at weaning than treatment 1 calves, which suggests that milk yield was lower as a result of 3-day watering. However, as total milk yield could not be measured, the lower milk intake by calves of dams in treatment 3 remains indicative only.

Weaning weights were depressed by 4, 12 and 18 kg under 1-, 2- and 3-day watering respectively against controls although there was no significant correlation between birth weight and weaning weight. Month of birth, however, affected subsequent weaning weight and in both 1984 and 1985, treatment 2 and 3 cows calved earlier than treatment 1 cows. When weaning weights were not adjusted for date of birth, there were no significant differences. To the livestock producer this is important, since 1 year after the calving season, the weight of all calves was similar even though treatment 3 calves were older. Since there was no evidence of earlier conception, the gestation period appeared to have been shortened as a result of infrequent watering. This accords with most studies where calf birth weight is significantly correlated with gestation length.

Post-weaning growth in the first year's calf crop suggested that compensatory growth was taking place at differential rates so that the differences at weaning had disappeared by 12 months of age. This was not the case in the second calf crop, in which 12-month weights were 17 kg lower in treatment 3 than in treatments 1 or 2. However, since 27-month weights were similar in all three treatments, it is doubtful whether the lower weaning weights of treatment 3 are sufficient to affect subsequent mature weights or even 2-year weights, provided the animals are put on daily or *ad libitum* watering in order to 'finish' them.

While the lower weaning weights were almost certainly linked to lower milk yield in the dry season, conception rates were unaffected. Presumably foetal demands for energy were small in comparison with lactation demands until the last trimester, at which time lactation had ceased. The lower weaning weights were not reflected in smaller skeletal size. In contrast, calf weaning weights of 50–65 kg that are commonly encountered under pastoral conditions (Nicholson, 1985b) are associated with a much smaller skeletal size, leading to delayed maturity and even the inability of the calf to express its full potential for growth.

Decreasing watering frequency significantly reduced DM intake in both cows and steers, which was reflected in weight loss, condition and, indirectly, in the weaning weight of calves. No differences in digestibility were found among treatments so that although rumen retention time was lengthened, lower rumen water content presumably counteracted any beneficial effects by reducing the efficiency of digestion. Calculated DM intake in steers expressed as $g/kg^{0.75}$ as low due to the overestimation of the IADF% in the feed. If the animals are more selective than the grab sampling technique, the IADF% may be lower in the animals' feed than in the feed obtained by grab sampling. A lower IADF% will raise calculated feed intake but this does not affect treatment differences where the IADF% is constant among treatments.

Since 2- and 3-day watering was continued throughout the rainy season, cows in these treatments were unable to regain the condition of treatment 1 cows and so started the dry season in worse condition.

This seldom occurs under pastoral management where daily or, at worst, alternate-day watering is practised during and immediately after the rainy season when weight gain is greatest. Animals gaining weight need additional water for growth, particularly if they are also lactating, and it appears that 3-day watering during this period is inadvisable despite the additional water in the herbage.

The fact that both Friesian x Boran crosses and Brahman cows conceived, calved and raised calves under all the treatments suggests that 3-day watering can be implemented for *B. indicus* x *B. taurus* crosses. However, the sample size was small and no definite conclusions can be drawn. In practice, *B. taurus* is introduced in order to increase productivity (e.g. milk yield) so that 3-day watering would not be applicable to such crossbreeds except perhaps in times of drought.

Under normal circumstances, 3 days is the maximum watering interval used for cattle in pastoral systems and this is less than for either smallstock (3–5 days) or camels (up to 10 days). Therefore, while cattle are not as good at conserving water as camels or smallstock, they appear to be equally good at tolerating dehydration. On numerous occasions, lactating cows were observed to drink 30% of their dehydrated weight, which is comparable to data on camels (King, 1983; Schmidt-Nielsen, 1964) and desert goats (Choshniak and Shkolnik, 1978). Previous work with African livestock has not distinguished between tolerance of dehydration and ability to conserve water.

When put on 4-day watering, no signs of behavioural stress were apparent, the cattle waiting patiently in the shade for water. The fact that 4-day watering is not practised extensively suggests that pastoralists have arrived at 3-day watering as the optimum trade-off between lower animal productivity and water- and labour-saving.

The benefits of 2- and 3-day watering are fourfold. Firstly, grazing resources further from water can be exploited. On 3-day watering, cattle can graze 21 km away from water, assuming a maximum daily walk of 14 km (42 km *in toto).* This gives access to 1385 km^2 on centrifugal grazing, which is nine times the area available to cattle on daily watering. This is particularly relevant to those areas in Africa where watering points are scarce.

Secondly, where water resources are limiting, a saving of 30% is considerable. With 800 000 cattle in the Borana region of southern Ethiopia, 3-day watering is estimated to save 1.5 million tonnes of water. Since labour is required to raise this water from wells, there would be insufficient labour to water cattle every day. Where machinery and fuel are required to raise water, there is a corresponding saving in fuel.

Thirdly, water intake is normally controlled by DM intake. Under 3-day watering, however, water intake dictates DM intake, resulting in fodder reserves being conserved. Fourthly, since cattle need to trek to the watering point only every third day, the potential erosion in the vicinity of water is lessened.

As a strategy for cattle production in rangeland areas, 2- and 3-day watering may be alternatives to be considered. To the Borana, the strategy is clearly appropriate and it is not as costly as might have been expected. The combined stresses of extensive walking, night enclosures and 3-day watering, all features of pastoralism, are now being investigated in the second part of the trial.

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