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An analysis of cattle live-weight changes on tropical grass pasture during the dry and early wet seasons in northern Australia

2. Relations to trends in the pasture, diet and grazing behaviour

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SUMMARY

Cattle grazing buffel grass pastures during the dry season at Katherine lose large amounts of live weight during a short period following first rain. In Part 1 we showed that these losses were due mainly to reduction in gut contents. Part 2 examines the changes in pasture, diet and grazing behaviour to assess the probable change in nutritional status of cattle following rain.

During the dry season the most valuable pasture component, green leaf, was very scarce and had a nitrogen concentration of about 1 %. Diets of oesophageally-fistulated cattle contained less than 0·5 % N. Shortly after first rain diet N doubled owing both to rapidly increasing amounts of green leaf and to the increase in N concentration in young leaf to over 3 %. Although intake was not measured, literature is cited to show that this increase in dietary N would be expected to increase rumen digestion rates with a resultant marked increase in D.M. intake and a reduction in gut contents.

Although availability of high quality herbage increased very rapidly following first rain, a period of increased nutritional stress immediately following rain could not be ruled out. However, any such decline in nutrition appears to be short-lived.

INTRODUCTION

The first paper in this series (McLean *et al.* 1983) reported the trends in live weight and body composition of cattle on buffel grass (*Cenchrus ciliaris*) pasture during the dry and early wet seasons in two years. At least half of the cumulative loss in fasted live weight occurred in the week following first rain, a phenomenon reported earlier in the Northern Territory, Australia as the 'critical period' (Norman, 1967) and in Africa as the 'crisis of July' (Denis, Blancou & Thiongane, 1979). However, body composition data showed that trends in animal well-being were inaccurately portrayed by the live-weight trends. By the time of first rain at the end of the 1976 dry season, cattle had lost only 18 kg live weight, but had in fact lost an estimated 41 kg of fat. Increased body water accounted for most of the difference. In the 'critical period' following first rain, cattle lost 18 kg live weight in 1 week, but in fact most of this loss was gut 'fill'.

The effect of first rain on body composition would have been mediated by the pasture. In this paper we examine the change in pasture and diet composition and in time spent grazing, as a further means of determining whether cattle nutrition on perennial grass pasture gets worse before it gets better following first rain at the end of the dry season.

MATERIALS AND METHODS

Pasture measurements

The yield and botanical composition of the pasture on offer was determined by cutting 20 m^2 quadrats from a 10×2 grid over the paddock using a nested sampling system (McIntyre, 1952). Samples were obtained every 4 weeks from June to September and at fortnightly intervals until December in both 1975 and 1976. Buffel grass was cut to a height of 5 cm and a subsample of 30–50 tillers was separated into green leaf, green stem, dry leaf and dry stem fractions. These and the remaining main sample material were dried for 24 h at 80 °C and the proportions of the various components in the main sample calculated using subsample ratios. All fractions were analysed for nitrogen.

Changes in the moisture and nitrogen content of the youngest green leaves of buffel grass were monitored by plucking leaves along four transects every 4 weeks from June to October and every 2 weeks subsequently. Leaf samples (*ca.* 15 g fresh weight) were sealed in plastic bags to prevent moisture loss. Samples were weighed fresh and after oven drying at 80 °C for 24 h.

Prior to first rain in 1976, four 5 × 5 m areas were fenced to exclude cattle. Within each enclosure a tiller from each of four plants was tagged and measurements of tiller length, number of green leaves, and length of each green leaf were made at approximately weekly intervals until late November.

Diet selection

Samples of the diet selected were obtained using four Brahman × Shorthorn steers fistulated at the oesophagus (Little & Takken, 1970). Extrusa samples were collected on three consecutive days every 4 weeks from June to September and on two consecutive days every 2 weeks from October until early December. Animals were fasted overnight until the commencement of sampling at 08.00 h. Between sampling periods, the fistulated animals grazed similar pastures in a paddock adjacent to the experimental area.

The fistula extrusa obtained from each animal was mixed well and divided into two; one subsample was dried at 60 °C for 24 h for chemical analysis, the other subsample from each animal was frozen for later botanical analysis. Subsamples were thawed and a sample of particles identified as grass, legume, or forb, leaf or stem and green or dry by a microscopic point hit method and adjusted for the weight per unit area of the plant components (Hamilton & Hall, 1975).

Animal measurements

Cattle were weighed late in the afternoon immediately after being removed from the pasture (LW), held overnight without food or water and weighed again in the morning (FLW). In 1975 the group declined progressively from 19 to 4 steers owing to serial slaughtering, whereas in 1976 it contained ten steers.

Grazing time was measured with vibracorders (Stobbs, 1970) attached to the neck of four steers which grazed the pastures continuously from June to December. In 1975, recordings were made for 1 week in each month from June to October and thereafter continuously until early December. In 1976, recordings were made on alternate weeks from September until the end of November.

Body chemical composition in 1976 was estimated using the tritiated water dilution method (McLean *et al.* 1983). In association with this, rumen content total mass and dry-matter fraction were monitored in two rumen-fistulated steers which grazed the pastures continuously with the other experimental cattle.

Weather

Rainfall was recorded daily at the experimental site.

Table 1. *Nitrogen concentration of various pasture components (g/100 g dry matter)**

Pasture component	1975								
	20. vi	23. vii	21. viii	19. ix	16. x	29. x	12. xi	24. xi	2. xii
Plucked leaf	—	1·03	1·52	1·48	2·99	1·82	2·02	1·42	—
Green leaf	0·62	0·79	0·76	0·87	2·54	1·79	2·12	1·40	1·05
Dead leaf	0·30	0·37	0·28	0·35	0·42	0·42	0·43	0·49	0·36
Green stem	0·21	0·25	0·25	0·23	0·25	0·27	0·40	0·31	0·36
Dead stem	0·21	0·24	0·22	0·21	0·27	0·22	0·20	0·24	—

Pasture component	1976						
	10. vi	20. vii	8. ix	20. x	2. xi	18. xi	2. xii
Plucked leaf	1·02	1·00	1·36	1·35	3·33	1·94	1·65
Green leaf	0·97	0·98	1·10	1·34	2·69	1·81	1·51
Dead leaf	0·39	0·39	0·39	0·39	0·39	0·46	0·49
Green stem	0·28	0·29	0·29	0·26	0·34	0·40	0·34
Dead stem	0·33	0·33	0·32	0·32	0·32	0·33	0·22

* First rainfall in 1975 occurred on 1. x and in 1976 on 25. x.

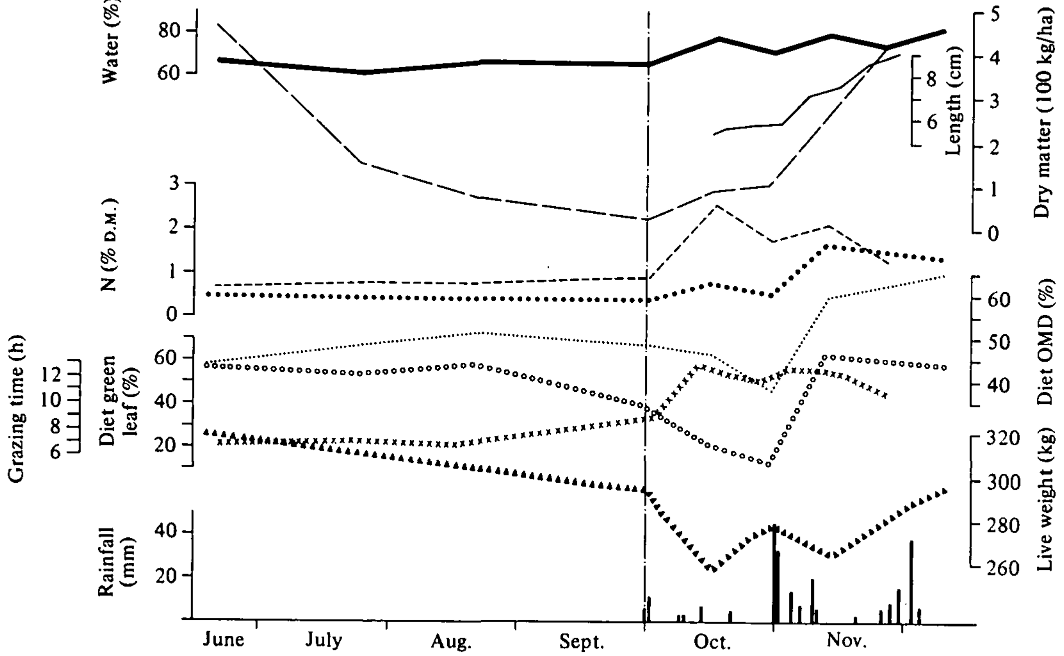

Fig. 1. 1975 trends in youngest green leaf water content (——), average green leaf length (——), green leaf dry matter amount (— —), N concentration of total green leaf (- - -), N concentration of diet (● ● ●), *in vitro* organic-matter digestibility (OMD) of diet (······), green leaf (GL) percentage of diet (o o o), daily grazing time (x x x), fasted live weight (▲ ▲ ▲), and daily rainfall (histogram). (Vertical broken line indicates time of first rain.)

Chemical analysis of herbage and extrusa samples

Dried herbage and extrusa samples were ground and analysed for nitrogen by emission spectroscopy (Johnson & Simons, 1972). Organic-matter digestibilities (OMD) were determined by the *in vitro* technique standardized with samples of known *in vivo* digestibility (Minson & McLeod, 1972).

RESULTS

Pasture quantity v. *quality*

The pasture consisted almost entirely of buffel grass, with only trace amounts of Townsville stylo and forbs. Total herbage available exceeded 5 t/ha at the start of the dry season in both years, and never dropped below 3·6 t/ha in either year, so cattle nutrition was never limited by insufficient herbage quantity. It was rather trends in diet quality which determined the nutritional regime. The patterns of change in three pasture and diet quality variables, i.e. OMD, N concentration, and amount of green leaf, and in others dependent upon them over three relatively distinct periods are considered in detail. Trends in the several variables (Figs 1 and 2) are drawn assuming that the changes in rates during the sampling interval during which first rain fell were initiated by the first rainfall.

The dry season

In 1975 (Fig. 1) the amount of green leaf in the pasture declined exponentially and was less than 100 kg/ha for the last 2 months before rain. Water content of the youngest leaf was very low from the start of the study in June to the last sampling prior to the first rain, indicating that there was no new leaf production during this period. There was a gradual rise in green leaf N, but this was not paralleled in diet N, which remained very constant at about 0·4%. Green leaf in the diet remained constant at 56–58% until August and then fell sharply. Estimated OMD fluctuated in the range between 44 and 52%. Time spent grazing each day rose slightly from 7 to 8 h between August and September. FLW declined only 22 kg/head from June to September.

In 1976 (Fig. 2), trends in pasture green leaf were very similar to those in 1975, dropping to 30–40 kg/ha. Trends in water content of youngest leaves indicate that no growth occurred prior to

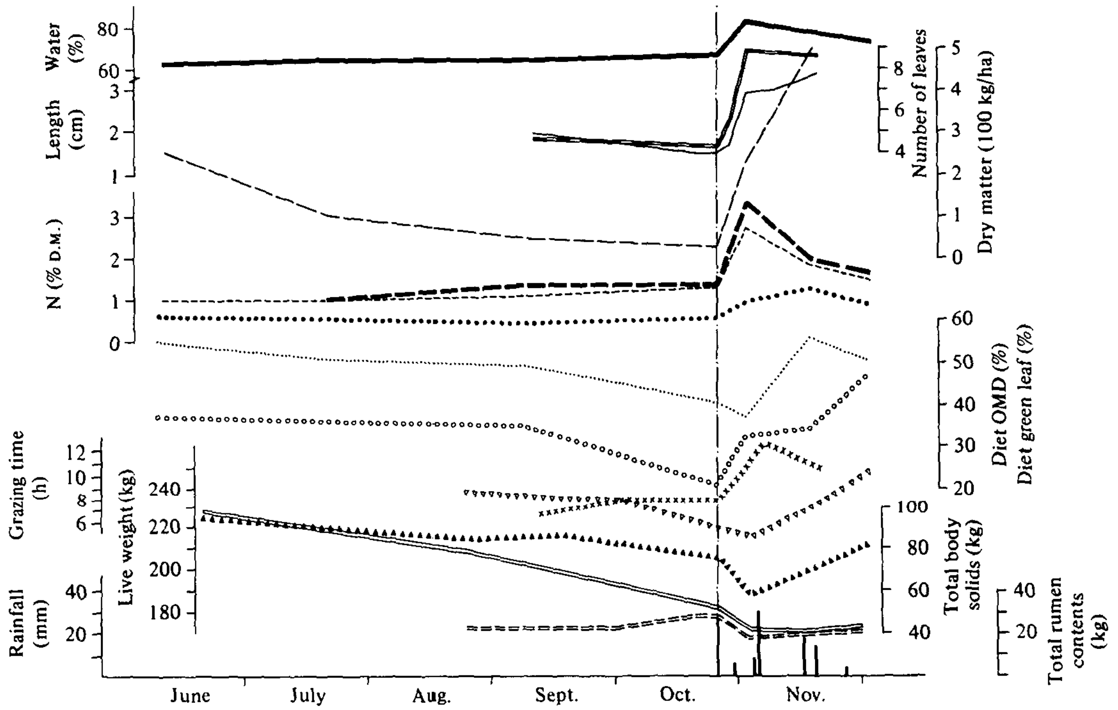

Fig. 2. 1976 trends in youngest green leaf water content (——), number of green leaves per tiller (▬), average green leaf length (——), green leaf dry matter amount (— —), N concentration of youngest green leaf (- -), N concentration of total green leaf (- - -), N concentration of diet (● ● ●), *in vitro* organic-matter digestibility (OMD) of diet (······), green leaf (GL) percentage of diet (o o o), daily grazing time (x x x), unfasted live weight (▿ ▿ ▿), fasted live weight (▲ ▲ ▲), total body solids (═══), total rumen contents (═ ═), and daily rainfall (histogram). (Vertical broken line indicates time of first rain.)

first rain. Nitrogen concentration gradually increased in green leaf, but not in the diet, the latter being stable at 0·6%. Diet green leaf content and estimated OMD declined gradually from June to September, but more rapidly thereafter until first rain. Grazing time rose slightly from 7 to 8 h/day at the last measurement prior to rain. FLW declined fairly steadily at only 0·14 kg/day but total body solids (TBS) declined at 0·32 kg/day.

The effects of first rain

In 1976, the year with the simpler pattern of FLW trends, major changes occurred in the 8 days following the first fall of 24 mm (Fig. 2). Green grass dry weight increased from 30 to over 230 kg/ha. This was associated with an increase in number of leaves per tiller from 4 to 9 and in average length from 1·5 to 3 cm. Water contents of the youngest leaf increased from 66 to 82%. The average N concentration of total green leaf increased from 1·3 to 2·7%, and to 3·3 in plucked youngest leaves. Green leaf in the diet increased from 21 to 32% and N from 0·5 to 1·0%. Diet OMD declined from 40 to 38% in this period, but increased to 56 in the following 2-week period. Grazing time increased from 8 to 12·5 h/day. FLW dropped 18 kg, as much as during the entire preceding dry season. The estimated decline in TBS is shown in Fig. 2 as 10 kg, the approximate mid-point of the range 7–12 kg resulting from different estimates of gut dry matter used in calculation of body solids from total body water (McLean *et al.* 1983).

In 1975, the pattern of weather and its effects was more complex. In the first period of 16 days following first rain, green leaf dry matter increased from about 30 to 90 kg/ha and water content of youngest leaf increased from 65 to 78%. The average N concentration of total green leaf increased from 0·9 to 2·5% and to 3% in plucked youngest leaves. Diet N increased from 0·4 to 0·8%. In contrast diet green leaf percentage and OMD continued to decline at approximately the same rate as before rain. Grazing time increased from 8·5 to 13 h/day. FLW decreased 36 kg, 28 kg in the first 6 days after first rain. The weather in the following period (15–28 October), was dry (5 mm rain; 128 mm pan evaporation). Leaf growth and production rates declined as did water content of the youngest leaf. Nitrogen in both green leaf and diet decreased. Grazing time declined to 11·5 h/day. In spite of all these indications of decline in the plane of animal nutrition, FLW increased 20 kg. The next period (29 October–11 November) was wet, and the status of all the pasture and diet nutritional variables improved markedly. FLW, however, decreased 14 kg.

The early wet season

In 1975 in the well-watered period from mid-November to the end of the study period, the data in Fig. 1 indicate a continued high rate of grass dry-matter production, a stabilizing of concentrations of leaf N between 1·5 and 2%, and diet N at about 1·5%; diet green leaf at about 60% and diet OMD at 60–70%. Average daily live-weight gain exceeded 1 kg/ha.

In the last two measurement intervals of 1976 (3 November–1 December) green leaf dry weight continued to increase rapidly and while green grass N appeared to stabilize at about the levels in 1975 (1·5%), values for diet green leaf, OMD and N were still considerably lower than in the early wet season in 1975. Increases in live weight were less rapid than in 1975. The rainfall data in Fig. 2 suggests that soil water supply during the last half of November may have been inadequate to sustain pasture growth at 1975 rates.

DISCUSSION

Interpretation of the effects of first rain at the end of the dry season on the nutrition of steers grazing these buffel grass pastures is aided by comparing trends in the pasture and the diet during the long dry season with those in the interval just following rain. In the dry season, the quantity of available green leaf was small and the quality of the diet selected by cattle was very low. A considerable loss of live weight over the dry season would therefore be expected. Green leaf yields never exceeded 500 kg/ha and at all times green grass stem was the major pasture and diet component. At the low levels of green leaf availability, intake would have been adversely affected; Chacon & Stobbs (1976) showed with cattle grazing mature tropical pasture swards at different stages of defoliation that total intake declined with decline in the availability of the preferred leaf fraction. The nitrogen (N) content of the diet selected was also low. In the months June–September dietary N did not exceed 0·6% (D.M.). Nitrogen values less than 1% in the diet reduce voluntary intake (Minson & Milford, 1967) mainly through a retarded rate of digestion in the rumen (Weston, 1967) and reduced amounts of protein reaching the small intestine (Egan, 1965).

In spite of the low leaf yield and the poor quality of the diet, live weight declined by only 10% in the dry season. However, when the composition of the live animals was monitored, it was found that although cattle lost 18 kg live weight, the loss in body solids was 45 kg. Much of the loss of solids was masked by an increase in tissue water and gut contents (McLean *et al.* 1983).

Following rain there was a rapid response in the pasture which was reflected in the diet. In 1976, green leaf dry matter increased seven-fold in the 1st week and percentage green leaf in the diet increased from 20 to 30. Nitrogen concentration in young green leaf increased three-fold and in the diet by over 60%. An increased N supply to the N-deficient ruminant increases rate of digestion by bacteria in the rumen and increases rate of passage through the gut (Weston, 1967). This has two major implications: (*a*) increased intake and (*b*) reduced gut contents following overnight fasting. In a pen study in which the cattle, feed, and diet-N changes were very similar to those in our study, increasing N concentration in the diet from 0·68 to 0·92 by adding 10% lucerne resulted in a 37% increase in D.M. intake (Siebert & Kennedy, 1972). In the same study a similar increase was found with sheep. A relationship between intake and crude protein of buffel grass cut and fed to pen-fed sheep was reported by Milford & Minson (1966). In their study an increase in N concentration like the one we recorded would have increased intake 60–80%. After first rain late in the dry season Romero & Murray (1980) found an increase in diet N from 0·62 to 1·2 and an 82% increase in intake with cattle grazing tropical grass pastures; this increase in intake was the mean over a 6-week interval following rain.

There is the possibility that cattle spent a much-increased amount of time (and energy) seeking out small amounts of young high quality, grass leaf with a high water content. In such circumstances, quality of diet samples would tend to increase to a level approaching that of plucked samples, but intake would decrease owing to the inability of cattle to harvest enough D.M. of the highly preferred component. This appears to have been the case in a study of sheep grazing *Astrebla* pastures in N.W. Queensland (Lorimer, 1981). Intake was not measured in our study, but there is evidence that the cattle did not select very strongly for young leaf. Neither dietary N nor OMD of dietary samples increased rapidly to values close to the N and OMD values of the plucked green leaves, even though availability of this preferred component and grazing time did increase dramatically.

The amount of live-weight loss following first rain and the degree to which this constitutes a nutritional crisis must depend greatly on the type of pasture. When desiccated legume is the dominant herbage component live-weight losses following rain are gradual (Norman, 1967). Here, adequate nitrogen nutrition prior to rain obviates large change in gut contents following rain. Losses of live weight on these pastures can be prevented by supplementary feeding (Norman, 1967). The concept of nutritional crisis appears to be unambiguously appropriate on these pastures where relatively high quality dry herbage is spoiled rapidly by rain (McCown, Wall & Harrison, 1981) and new growth is inherently slow (C. J. Gardener and R. L. McCown, unpublished).

On tropical grass pastures, whose nitrogen content is very low during the dry season, abrupt loss of fasted live weight following first rain can be largely attributed to decreased gut contents (McLean *et al.* 1983). Norman (1963) and Walker (1969) found that supplementary feeding did not prevent substantial live-weight losses on such pastures. The degree to which the low nutritional plane persists or declines further following rain depends largely on the capacity of the pasture to regrow quickly. Gardener (1980) found that regrowth of the pasture and live-weight gain of cattle was greatest on treatments with high soil fertility. Similarly, established perennial grass pastures have an inherent regrowth advantage over annual grass pastures and annual grass–legume pastures (Ive, 1976).

The question of whether or not the first rains cause a temporary nutritional crisis for cattle on perennial grass pastures in this environment remains to be answered conclusively. To do so will require very precise short-term measurements of body weight and composition, or of feed intake or some physiological index of nutritional status.

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