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EFFECT OF GRAIN AND UREA SUPPLEMENTS FED WITH MAIZE FORAGE FOR FATTENING CATTLE

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SUMMARY

Twelve groups each of five steers with a mean body-weight of 742 lb were group-fed *ad lib.* on six rations for approximately 100 days and then slaughtered. A further two groups of comparable steers were slaughtered at the commencement of feeding.

The rations were green maize forage harvested daily and green maize forage with grain fed at the rate of 0·65 and 1·3 lb dry matter per 100 lb body-weight. All rations were fed with and without a supplement of 85 g urea per head per day.

A urea supplement with or without added grain led to an increase in dry-matter intake and efficiency of feed conversion. On both grain-forage rations, the addition of urea resulted in a significant increase in body-weight gain, carcass gain and dressing percentage.

Body-weight gain and dressing percentage were not significantly influenced by the higher grain ration in comparison to the lower.

Observations made during the experiment suggest that, with once-per-day feeding, fermentation of the green forage may be a problem in the tropics.

I. INTRODUCTION

The comparatively high beef prices realised in recent years have led to an increased interest in intensive finishing of beef cattle in Queensland. This has come at a time when increased emphasis is being placed on irrigation development. One possible use of the expanding irrigation facilities would be to provide green forage for intensive finishing.

This paper gives the results of a feeding experiment with beef cattle using rations based on green maize grown under irrigation and supplemented with grain and urea.

II. MATERIALS AND METHODS

Location.—The project was undertaken at the Cattle Field Research Station, Ayr, North Queensland. A description of the property is given by Cowdry (1954).

The annual average rainfall for Ayr is 41·54 in., 75% of which is received during the summer months from early in December to the end of March. Temperatures are equable and only a few light frosts are likely to be experienced each year.

Experimental animals.—Seventy Hereford steers, approximately 3 years of age and in forward store condition, were selected for the project. They were bred and reared in the Einasleigh district in northern Queensland.

Experimental yards and facilities.—The experiment was conducted in 12 adjacent open yards (each 30 ft x 20 ft) each holding 5 steers. Outside the yards a strip approximately 5 ft wide was maintained bare of vegetation. Each yard was provided with a feed trough, 12 ft in length, protected from weather by a roof 12 ft wide.

Ration components.—The roughage fed was maize (hybrid Q739) forage. For the first half of the trial period, cracked sorghum grain was fed; thereafter cracked maize grain was used. The changeover was accomplished in 3 days, and no effects of digestive upsets were observed. The sorghum and maize grain were purchased as single consignments. Urea (feed grade, 46% N) was fed as solid prills.

Sampling and analyses.—Samples of harvested maize were taken daily for moisture determinations and the dried samples were bulked on a weekly basis for crude protein analyses. Calcium and phosphorus determinations were made on bulked samples collected over intervals of 5 weeks. One analysis of each grain for calcium, phosphorus and crude protein was made on bulked weekly samples. Methods of analysis were those of the Association of Official Agricultural Chemists (1960).

Weights.—Each animal was weighed on a cattle-weighing scale with an accuracy of ± 1 lb at weekly intervals at 9.30 a.m. prior to feeding. Initial and final body-weights were the mean of 3 days' consecutive weighings (unfasted).

Carcass weight was determined after a 24-hr chilling period. Weighings were made on a scale with an accuracy of ± 1 lb. Weights of the rumen and reticulum contents were determined on all cattle at slaughter.

Forage weights were taken on a clock-face scale with an accuracy of ± 1 lb.

Slaughter data.—A mean dressing percentage based on chilled carcass weight and liveweight prior to slaughter was calculated on the pretreatment slaughter group. This dressing percentage was applied to the experimental groups to estimate their initial carcass weights. This allowed an estimation of carcass gain over the experimental period.

III. EXPERIMENTAL

Maize (hybrid Q739) was planted at approximately weekly intervals from July to October. The crops were irrigated but unfertilized.

Seventy steers were allocated on the basis of body-weight by stratified randomization into 14 lots. These lots were then randomly assigned to seven treatments with two replications each of five head per treatment.

All animals were fed solely on maize forage for 13 days. During the last 3 days of this period the initial weights were determined.

At the end of this period, two groups of five animals were slaughtered to provide pretreatment slaughter data and the remaining 12 groups were allocated to the following six treatments:—

Treatment 1: Groups 1 and 8: Maize roughage to appetite.

Treatment 2: Groups 2 and 9: Maize roughage to appetite, plus 85 g urea per head per day.

Treatment 3: Groups 3 and 10: Maize roughage to appetite, plus 0·65 lb grain (on a dry-matter basis) per 100 lb body-weight per day.

Treatment 4: Groups 4 and 11: Maize roughage to appetite, plus 0·65 lb grain (on a dry-matter basis) per 100 lb body-weight per day plus 85 g urea per head per day.

Treatment 5: Groups 5 and 12: Maize roughage to appetite, plus 1·3 lb grain (on a dry-matter basis) per 100 lb body-weight per day.

Treatment 6: Groups 6 and 13: Maize roughage to appetite, plus 1·3 lb grain (on a dry-matter basis) per 100 lb body-weight per day, plus 85 g urea per head per day.

The mean crude protein percentage of the forage on a dry-matter basis was 6·0% (range 4·6–6·9). Calcium and phosphorus levels were virtually constant at 0·28 and 0·22% respectively. Crude protein percentage averaged 9·7 in the maize and sorghum grains, while the calcium and phosphorus contents were 0·03 and 0·33% respectively. The mean weekly dry-matter percentages of the maize forage generally increased with time (Figure 1).

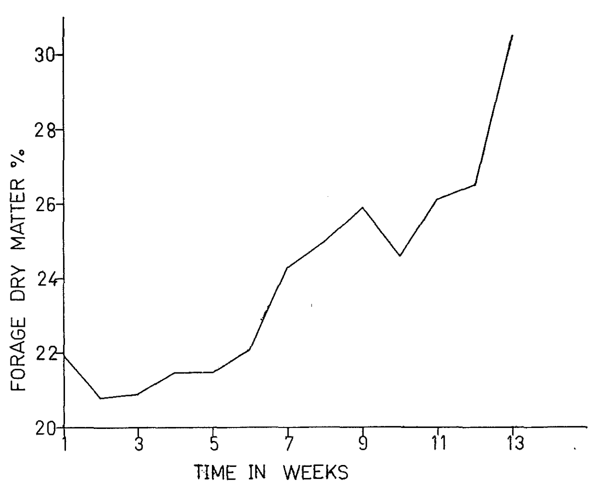

Fig. 1.—Mean forage dry-matter percentage.

Because of slaughtering limitations imposed by the local abattoir, the duration of the feeding period varied from 92 to 102 days for different groups.

IV. RESULTS

Dry-matter intake.—Groups fed grain and/or urea in addition to maize roughage had higher dry-matter intakes than those fed only roughage (Table 1). This was so whether dry-matter intakes were expressed as actual intakes or as percentage of body-weights. There were similar increases in the dry-matter intakes of the groups fed urea or grain at either level and an additive effect was produced when grain and urea were fed together.

TABLE 1

DRY-MATTER INTAKE OF ANIMALS IN THE DIFFERENT TREATMENTS FOR THE WHOLE EXPERIMENTAL PERIOD

Item	Treatment*					
	1	2†	3	4†	5	6†
Total DM intake (lb)	13,593	15,505	15,468	17,417	16,043	18,268
Total DM feed rejected (lb)	173	202	155	134	396	439
Percentage DM rejected of DM offered	1·3	1·3	1·0	1·0	2·4	2·3
Total amount of grain (DM) offered	..	..	4,306	4,361	8,604	9,134
Grain offered (DM)(lb/100lb body-weight)	..	..	·65	·65	1·3	1·3
Mean DM intake (lb/head/day)	14·5	16·5	16·0	18·0	16·3	17·9
Mean DM intake/day/100lb body-weight	1·8	1·9	1·9	2·2	2·0	2·3
No. of days fed	94	94	96	96	99	102
No. of steers	10	10	10	10	10	10

* Each item represents the mean results for the two replicates within each treatment.

† Treatments receiving 85 g urea/head/day.

During the feeding period, all treatments showed a gradual increase in their dry-matter intakes for the first half of the feeding period (Figure 2). During the later part of the feeding period, the intake of all forage groups continued to rise, the groups fed grain at the lower level tended to reach a steady level of intake, while those fed the higher level of grain showed a declining level of intake. In this period there was a slight rise in maximum temperature and a marked reduction in the diurnal variation in temperature (Figure 3). The increased intake associated with urea ingestion was constant throughout the trial in all treatments except those not receiving grain. In these, the difference between the treatments receiving no urea and urea appeared to lessen as the experiment progressed.

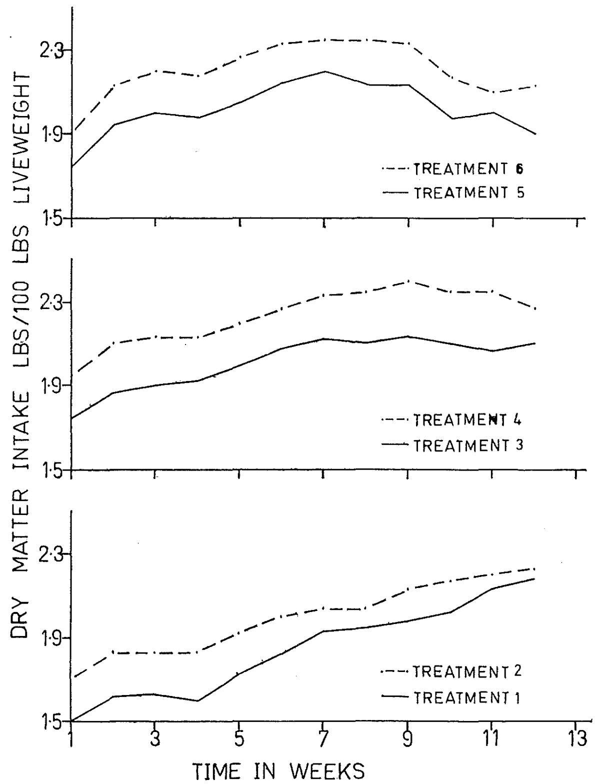

Fig. 2.—Mean feed consumption.

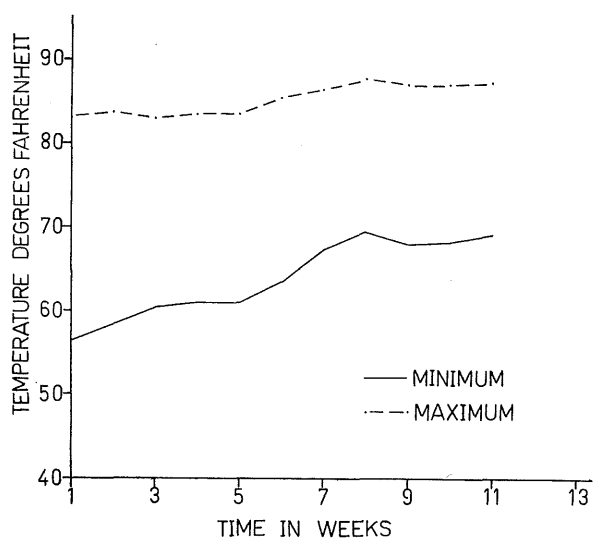

Fig. 3.—Mean temperature range.

Body-weight.—The groups receiving grain gained significantly more weight ($P<0\cdot01$) than the forage groups (Tables 2 and 3). Similarly, the addition of urea significantly increased ($P<0\cdot01$) the liveweight gain of the animals in those groups. There was no significant difference in liveweight gain between the animals receiving the lower level of grain and those receiving the higher level of grain, with or without urea.

TABLE 2

EFFECT OF RATION ON MEAN LIVEWEIGHT, FEED CONVERSION AND CARCASSES OF THE ANIMALS

Item	Treatment						
	1	2	3	4	5	6	S†
Initial body-weight (lb)	741	751	742	724	756	738	724
Final body-weight (lb)	803	857	845	863	853	884	..
Total gain (lb)	62	106	103	139	97	146	..
Mean gain/day (lb)	0·6	1·1	1·1	1·5	1·0	1·4	..
Feed conversion*	21·9	14·6	15·0	12·5	16·5	12·5	..
Estimated initial carcass weight (lb)‡	384	389	384	375	392	381	375
Final carcass weight (lb)	417	454	457	474	463	493	..
Estimated carcass gain (lb)	33	65	73	99	71	112	..
Carcass gain/day (lb)	0·4	0·7	0·8	1·0	0·7	1·1	..
Dressing percentage	51·9	53·0	54·0	54·9	54·3	55·8	51·8
Dressing percentage (less rumen weight)	62·9	63·4	63·3	64·2	63·6	64·7	60·8
Carcass gain as % of body-weight gain	54·1	59·1	70·2	71·2	73·2	76·7	..
Lb carcass gain/100 lb DM consumed	2·4	4·2	4·7	5·7	4·4	6·1	..

All carcass data are on chilled weight basis.

* Unit feed intake per unit body-weight gain.

† Initial slaughter groups.

‡ Initial carcass weight computed from group S data.

TABLE 3

SIGNIFICANCE LEVEL OF THE DIFFERENCE BETWEEN THE TREATMENTS FOR EACH PERFORMANCE CHARACTERISTIC

Treatment	Liveweight Gain	Carcass Gain	Dressing Percentage	Dressing Percentage (minus rumen)
Main Effects—				
Urea *v.* No urea	1%	1%	5%	N.S.
Grain *v.* No grain	1%	1%	1%	N.S.
Grain (·65) *v.* Grain (1·3)	N.S.	N.S.	N.S.	N.S.
Individual Treatments—				
Grain (·65) *v.* No grain (No urea)	1%	1%	5%	N.S.
Grain (·65) *v.* Grain (1·3) (No urea)	N.S.	N.S.	N.S.	N.S.
Urea *v.* No Urea (No Grain)	1%	1%	N.S.	N.S.
Grain (·65) and Urea *v.* Grain (·65) and No urea	1%	1%	N.S.	N.S.
Grain (1·3) and Urea *v.* Grain (1·3) and No urea	1%	1%	N.S.	N.S.

Slaughter data.—Rations containing grain produced significantly greater carcass gains and dressing percentages than those without grain ($P<0 \cdot 01$) but there was no significant difference between the two levels of grain feeding (Table 3). The addition of urea produced a significant increase in carcass gain ($P<0 \cdot 01$) and in dressing percentage ($P<0 \cdot 05$). When the chilled carcass weight was expressed as a percentage of the liveweight less the contents of the rumen and reticulum, the differences in dressing percentage between all treatments became non-significant (Table 3).

The ratios of carcass gain to body-weight gain were higher in the groups fed grain than in the groups without grain. This is due to the differences in the amount of ingesta in the rumen as indicated by the dressing percentage and dressing percentage collected for full rumen weight.

The efficiency of dry-matter conversion to carcass and body-weight was improved with both urea and grain supplements.

V. DISCUSSION

Body-weight response to varying grain/roughage ratios has been investigated by various workers. Black *et al.* (1943), Keith, Johnson, and Lehrer (1955), Pahnish, Stanley, and Shillingburg (1956) and Pope *et al.* (1957) found that the average daily gain of steers and heifers was not greatly influenced by different ratios of grain to roughage. Richardson *et al.* (1961) found that the rate of gain of heifers increased as concentrate percentage in the ration increased, but the reverse occurred with steer calves. Morris and O'Bryan (1965) found that the rate of gain and dry-matter intakes of steers increased with increasing percentages of grain in the ration. In the experiment reported here, there were no significant differences in body-weight gains between the two levels of grain feeding. Body-weight gains and dry-matter intake were significantly higher in the groups fed grain compared with those fed only roughage, but similar increases in body-weight gains and dry-matter intakes were obtained from urea without added grain. This suggests that the response from grain may have been due to the digestible protein of the grain rather than to the additional digestible energy supplied by the grain.

The response from urea could be expected because of the low protein content of the maize roughage. Under various conditions Williams *et al.* (1959), Campling, Freer, and Balch (1962), Coombe and Tribe (1962), Hemsley and Moir (1963) and Hemsley (1964) demonstrated a similar effect when roughages of low protein content were supplemented with urea. Morris and O'Bryan (1965) found that urea also has the ability to increase the feed intake and body-weight gains of steers fed rations containing a roughage with large amounts of grain. The results of the present investigation are in agreement with this finding and they indicate a limitation of dietary nitrogen in the rations consisting of roughage and grain.

Dry-matter intakes per 100 lb body-weight were generally below optimum levels, as defined by the National Research Council, U.S.A. (1958), in all groups. The continuous rise in dry-matter intake in the all-roughage groups with length of feeding was associated with an increase in the dry-matter percentage of the maize crop. Duckworth and Shirlaw (1958) found that on a herbage diet maximum dry-matter intake was achieved only when the dry-matter percentage was above a critical figure which lay between 24 and 28%. Holmes and Lang (1963) reported dry-matter intakes of 2·0 lb per 100 lb body-weight of freshly cut herbage from two treatments averaging only 16·6 and 19·7% dry matter. In this work, herbage was cut and fed once per day and the dry-matter intake of the all-roughage groups averaged 1·8 lb per 100 lb body-weight. With the wettest forage, the heavy bulk of material placed before the animals had to be compressed to fit a day's feed into the trough. This enhanced the possibility of fermentation, which may have resulted in a lower intake. Fermentation may also have been partly responsible for the decline in intake of the high-grain fed groups when maize was used in the second half of the feeding period. Unlike sorghum, the maize when hammermilled contained a large proportion of powdery material and this when mixed with the forage appeared to hasten fermentation. In these groups there were large amounts of feed residues containing a high proportion of grain.

Apart from the possible effects of fermentation on dry-matter intake, the frequency of feeding has been found to have a direct effect on feed utilization. Increasing the frequency of feeding has been shown to increase dry-matter intake, dry-matter digestibility and nitrogen retention (Gordon and Tribe 1952; Moir and Somers 1957; Mohrman *et al.* 1959; Campbell and Merilan 1961) and to increase body-weight gains of sheep (Gordon and Tribe 1952), of beef cattle (Mohrman *et al.* 1959) and of dairy cattle (Thomas and Mochie 1956; Hardison *et al.* 1957; Campbell and Merilan 1961). It appears that better body-weight gains would have been achieved by more frequent feeding than was used in this experiment.

High climatic temperatures have been shown to adversely affect feed utilization and body-weight gains of cattle. Lundgren and Johnson (1964) reported that environmental temperatures of 88°F significantly depressed feed intake. Sharma and Kehar (1961) demonstrated with Zebu-type cattle fed "concentrates and poor roughage" that intake and digestibility of feed were depressed by high temperatures. During the course of our experiment maximum temperatures increased from about 83 to 87°F, with a concomitant rise in the mean daily temperature, but in spite of this there was a continuous rise in the dry-matter intake in the all-roughage groups. However, high temperatures may have indirectly and adversely affected the intake of the high-grain fed groups by favouring fermentation of the feed.

The efficiency of feed conversion to body-weight or to carcass gain was considerably improved when both urea and grain were fed with maize roughage, but the food conversion ratios were not satisfactory. This could be largely attributed to low rates of gain resulting from sub-optimum feed intakes. In addition, the body-weight of the steers at the commencement of feeding was higher and their condition better than would normally be expected of steers entering yards for intensive finishing. It could reasonably be expected that the carcass change in these cattle involved more fat deposition and less muscle development than in younger cattle. Blaxter (1962) has stated that the energetic efficiency with which a food is used for growth of the protein mass of the body will be greater than the energetic efficiency with which the same food is used to lay down body fat in the adult animal.

The ratios of carcass gain to body-weight gain for the grain-fed groups were higher than those reported by Morris and O'Bryan (1965) and by Marlow, Arbuckle, and Alexander (1962). However, in our experiment there was a depression in body-weight during the last days of feeding when the water intake of the steers dropped sharply following rain. This depression in body-weight was sufficiently large to markedly affect these ratios. The lower ratios of the all-roughage groups compared with the grain-fed groups can be explained mainly on the basis of differences in gastro intestinal fill. At the time of slaughter, the weight of the rumen contents of the all-roughage groups was approximately 20 lb in excess of the mean of the grain-fed groups.

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