PROVISION OF UREA TO CATTLE IN A SALT/UREA/MOLASSES BLOCK

By R. M. BEAMES, M.Agr.Sc.*

SUMMARY

Six groups of four cattle were selected from 12 pairs of mixed identical and fraternal twins. There were two major age groups, one of mean 25.5 months and the other of mean 14.2 months at the commencement of the experiment. Four animals of each age were group-fed in bare yards on the following rations:—hay *ad lib.*; hay *ad lib.* + molasses; and hay *ad lib.* with free access to a salt/urea/molasses block.

The hay was made from native pasture and had a crude protein content of 3.5 per cent. on an air-dry basis. The salt/urea/molasses block contained 40 per cent. urea and 10 per cent. molasses.

From the 97th to the 103rd day all the younger animals receiving hay and hay treated with molasses were withdrawn from their treatments because of the inability of some to rise and the emaciated condition of the remainder. All the older animals remained in the experiment for the planned duration of 161 days and the younger animals receiving the block were continued for 217 days.

No significant response in either hay intake or body-weight was obtained by treating the hay with molasses.

Provision of the block significantly reduced body-weight loss in both age groups. Over the 161-day period body-weight loss in the older group receiving block was 60 lb less than that in the same age group receiving no supplement. The respective advantage in the younger animals was of the same order but was not significant.

Mean respective block intakes in the older and the younger animals were 6.9 oz and 4.2 oz per head daily over the 0–161-day period. When chromic oxide was added to the block, the faecal chromic oxide percentage in the younger group ranged from 82 to 109 per cent. of the group mean and in the older group from 67 to 113 per cent. of the group mean.

Net air-dry hay intakes were 29 and 45 per cent. greater in the groups receiving block than in the comparable groups with no supplement.

The behaviour of the animals was observed over several 6–7-hr periods during the daylight hours. Calculations made from this data estimated a maximum urea intake per visit to the block of 1.55 oz.

* Husbandry Officer, Animal Research Institute, Yeerongpilly. (Queensland Department of Agriculture and Stock)

I. INTRODUCTION

Many experiments have now been reported on the use of urea as a supplement to ruminants grazing pasture at the standing hay stage. With each method of supplementation there are advantages and disadvantages. Spraying of the standing pasture (Van der Vyver 1954; Kellermann and Groenewald 1956; Bishop 1959; Van La Chevallerie 1959; O'Bryan 1960) involves very little risk from toxicity but has the disadvantage of requiring machinery and labour to apply the spray. Spraying on conserved roughage such as hay or corncobs (Clark and Quin 1951; Clark 1952; Clark and Barrie 1954; Kellermann and Groenewald 1956; Williams and Tribe 1957) also reduces likelihood of toxicity but is more time-consuming.

The simplest method of feeding molasses/urea mixtures is directly from troughs. This has been done successfully both *ad lib.* (Berry, Kunkel, and Riggs 1958; Beames 1960*a*) and on a restricted basis (Clark and Barrie 1954; Kellermann and Groenewald 1956; Beames 1960*a*), but the danger of deaths from toxicity is high.

Adding urea to the drinking water has received little attention. Snook (1958) has given results where sheep both in pens and in the paddock were given urea in this manner. Beames (1960*b*) has devised a method whereby water containing 1 per cent. molasses and 0·125 per cent. urea can be kept in good condition for up to 14 days.

Perhaps the simplest method of supplying a nitrogenous supplement *ad lib.* to cattle is in a lick or block containing salt (Weir and Miller 1953; Riggs, Colby, and Sells 1953). This method was applied to urea feeding in South Africa by Altona, Rose, and Tilley (1960), who fed a salt lick containing 30 per cent. urea to 12-month-old steers grazing summer veld. The daily consumption of the urea/salt lick was approximately 6 oz per head, which was twice the lick consumption of a group provided with salt alone. Over a 40-day period, weight gains in the group receiving the urea/salt lick were significantly greater than in the group receiving a supplement of salt only.

The main aim of the experiment described below was to investigate the response in cattle receiving a low quality hay to unrestricted access to a salt block containing 40 per cent. urea. The effect of spraying the same type of hay with molasses was also studied. Feed intakes, block intakes and body-weight changes were recorded. Biochemical determinations were made on blood and observations were made on animal behaviour.

Duration of the experiment was 23 weeks.

II. MATERIALS AND METHODS

(i) *Animals*.—The experimental cattle consisted of seven sets of identical twins and five sets of fraternal twins. Visual appearance (Hancock 1949) was the criterion for determining the type of twin relationship. There were two major age groups, one being $25 \cdot 5 \pm 4 \cdot 7$ months and the other $14 \cdot 2 \pm 2 \cdot 2$ months of age at the commencement of the experiment. The animals were of *Bos taurus* origin and of mixed breeds.

(ii) *Facilities*.—Each group of four animals was kept in a yard which was 40 ft square and surfaced with decomposed granite. Four covered feed troughs each 7 ft long were provided in each yard.

The block was presented in a covered iron trough 34 in. long and 11 in. deep. For the final six weeks of the experiment this trough was provided with a drain hole through which liquid effluent could be collected.

(iii) *Ration Components*.—The hay was harvested in south-eastern Queensland and had the following composition:—*Bothriochloa intermedia* 78 per cent., *Paspalum dilatatum* 8·5 per cent., *Hyparrhenia filipendula* 2 per cent., *Bothriochloa decipiens* 1·5 per cent., *Aristida* spp. 1·5 per cent., *Cynodon dactylon* 0·5 per cent., mixed species (*Eragrostis parviflora, Digitaria didactyla, Sporobolus elongatus, Chloris* spp., *Heteropogon contortus, Capillipedium* sp., *Fimbristylis* sp.) 2 per cent., and unidentifiable material 6 per cent.

Cane molasses used for spraying the hay was of the following composition.—Moisture 25·3 per cent., sucrose 32·4 per cent., reducing sugars 14·5 per cent., ash 11·3 per cent., nitrogen 0·73 per cent., potassium 2·23 per cent., calcium 0·85 per cent., magnesium 0·72 per cent., and phosphorus 0·09 per cent.

The block, which was prepared and donated by Imperial Chemical Industries of Australia and New Zealand Ltd., consisted of urea 40 per cent., molasses 10 per cent., trisodium phosphate 2·5 per cent., and salt 47·5 per cent., with cobalt sulphate added to provide 0·015 per cent. cobalt. During the period in which individual block intakes were estimated, chromic oxide was incorporated as a marker at a level of 1 g/oz of block.

(iv) *Analytical Methods and Techniques*.—Hay and the nitrogen in the effluent were analysed by the official A.O.A.C. methods (Association of Official Agricultural Chemists 1955), molasses as in Laboratory Manual for Sugar Mills (Bureau of Sugar Experiment Stations, Queensland 1954). The chloride content of the effluent was measured on the ashed material by electrometric titration against a standard silver nitrate solution. Blood inorganic phosphate was determined by the method of Moir (1954), serum proteins by the method of

Gornall, Bardawill, and David (1949) and haemoglobin by the method of Donaldson *et al.* (1951). The technique of measuring packed cell volume was essentially that of Wintrobe (1947), using heparinised blood and a relative centrifugal force of approximately 2067 *g*. Faecal chromic oxide concentration was measured by the method of Schurch, Lloyd, and Crampton (1950).

Copper treatments were given intravenously, using 0·125 per cent. copper sulphate ($CuSO_4 \cdot 5H_2O$) in distilled water.

(v) *Body-weight.*—Cattle-weighing scales with an accuracy of ± 1 lb were used for obtaining body-weights.

(vi) *Meteorological Data.*—Rainfall and humidity were measured at a site approximately 200 yd from the experimental yards.

III. EXPERIMENTAL

Two weeks prior to the commencement of the experiment all animals were removed from pasture and yarded. At this time, in order to ensure an adequate copper status, each animal received an intravenous injection of a 0·125 per cent. copper sulphate solution, the older animals receiving 250 ml and the younger animals 200 ml.

For the first week in the yards the older animals were given 6 lb and the younger animals 5 lb lucerne chaff per head per day in addition to the experimental pasture hay *ad lib.*

At the end of this first week copper therapy was repeated and the feeding of lucerne hay ceased. After a week on a sole ration of pasture hay the groups were allotted to their treatments as under. The design was a balanced incomplete block using twins as blocks.

Groups I and IV—Hay *ad lib.*

Groups II and V—Molasses-treated hay *ad lib.* (12 lb molasses added to each 100 lb air-dry hay).

Groups III and VI—Hay *ad lib.* with unrestricted access to a salt/urea/molasses block.

Mean age of animals in Groups I, II and III was 25·5 months and that of animals in Groups IV, V and VI was 14·2 months.

Before being added to the hay, the molasses was diluted with 0·5 times its weight of water. This mixture was then sprinkled on the hay by means of a watering can. During this process the hay was turned several times.

Hay was fed out twice daily and was before the animals at all times. To facilitate weighing and handling and to minimize wastage, the hay was chaffed in a cutter set to a half-inch cut. Hay residues, which were collected daily before the morning feed, were weighed and fed back. Residues were discarded once per week. Proportionate samples of the hay as fed were collected daily and retained for chemical analysis. Residues were not analysed.

The salt/urea/molasses blocks were weighed weekly. The effluents from the blocks were collected and weighed weekly over the final six weeks and analysed for nitrogen and chloride.

Body-weights were obtained fortnightly at 8·30 a.m. Initial and final body-weights were obtained on a shrunk (18 hr after feed and water removed) and non-shrunk basis. Progressive body-weights at fortnightly intervals were obtained on a non-shrunk basis only.

The behaviour of the animals was observed over periods ranging from 6 to 7 hr on seven days selected at random during the course of the experiment.

On the 98th and the 161st day all animals remaining in the experiment were bled for the determination of haemoglobin, packed cell volume, blood inorganic phosphate, and serum total protein, albumin and globulin.

From the 137th to the 161st day the standard salt/urea/molasses block was replaced by one containing 1 g/oz of chromic oxide on an air-dry basis as a marker in order to assess individual intake of block. On the 11th, 12th, 13th and 14th day after the introduction of these blocks grab faecal samples were taken at 9·20 a.m. from all animals in Groups III and VI. Individual daily samples were analysed for chromium content.

IV. RESULTS

(i) *Hay Analysis*.—Percentage composition of a sample of hay representative of that fed throughout the experiment is as follows:—Moisture 7·7, crude protein 3·5, ether extract 1·3, crude fibre 36·5, nitrogen-free extract 43·6, ash 7·4, calcium 0·15 and phosphorus 0·34.

(ii) *Withdrawals*.—On the 97th day of the experiment two animals from Group IV were unable to rise and were withdrawn from their treatments. On the following day another animal from the same group was unable to rise and on the 99th day an animal from Group V also had to be withdrawn. On the 103rd day the remainder of the animals in Groups IV and V were removed from the experiment because of emaciation. There were no deaths or withdrawals in Groups I, II, III and VI, the first three groups remaining in the experiment for 161 days and the last group for 217 days.

(iii) *Body-weight.*—Body-weight is expressed on both a shrunk and non-shrunk basis in Table 1. These figures are given for the initial weighing, the last weighing before withdrawal of Groups IV and V (85 days) and the final weighing (161 days).

TABLE 1

BODY-WEIGHT CHANGES OVER 85 AND 161 DAYS OF EXPERIMENT†

Group	Body-weight (lb)				
	Initial		Change		
			0–85 day	0–161 day	
	‡Shrunk	Non-shrunk	Non-shrunk	‡Shrunk	Non-shrunk
I	542	560	−32	− 80	− 90
II	530	557	−20	−101	−112
III	553	575	+24	−21	− 30
S.E. of difference of two means	..	..	±10	±18	±15
Difference I—II	..	..	N.S.	N.S.	N.S.
I—III	..	..	**	*	*
II—III	..	..	*	*	*
IV	315	327	−27	§	§
V	319	329	−17	§	§
VI	294	306	+25	− 3	− 8
S.E. of difference of two means	..	..	±15	..	..
Difference IV—V	..	..	N.S.	..	..
IV—VI ..	..	..	*	..	..
V —VI ..	..	..	N.S.	..	..

† Calculated from treatment means after eliminating differences among twin pairs

‡ Weighed 18 hr after feed and water withdrawn

§ Groups withdrawn

* $P < 0{\cdot}05$ ** $P < 0{\cdot}01$ N.S. Not significant

Changes in body-weight recorded at fortnightly intervals are shown in Figure 1.

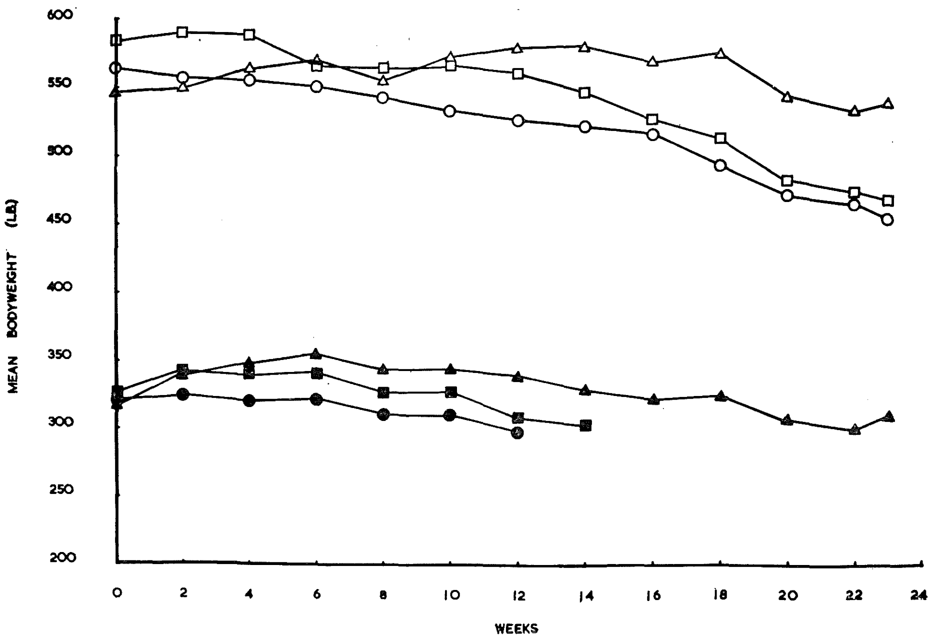

Fig. 1.—Body-weight changes recorded at fortnightly intervals.

Group I	O——O	; Group II	□——□	;
Group III	△——△	; Group IV	●——●	;
Group V	■——■	; Group VI	▲——▲	.

Among the older cattle (Groups I, II and III) spraying the hay with molasses had no significant effect on body-weight loss. On a non-shrunk basis, provision of the salt/urea/molasses block reduced body-weight loss for the 161-day period from 90 lb (Group I) to 30 lb (Group III) ($P < 0 \cdot 05$). The weight loss in Group III was also significantly less than in Group II ($P < 0 \cdot 05$).

In Groups IV, V and VI body-weight changes were −27 lb, −17 lb and + 25 lb respectively over the 0-85-day period. Only the difference between Group IV and Group VI was significant ($P < 0 \cdot 05$). However, the appearance of animals in Group VI indicated that they were in much better condition than the animals in Groups IV and V at this time.

The mean non-shrunk body-weight of Group VI at the 217-day weighing was 8 lb greater than the mean of this group at the 161-day weighing and equal to that at the commencement of the experiment.

TABLE 2

HAY AND SUPPLEMENT INTAKES FOR GROUPS I, II AND III OVER A 161-DAY PERIOD, GROUPS IV AND V OVER AN 84-DAY PERIOD, AND GROUP VI OVER AN 84-DAY, A 161-DAY AND A 217-DAY PERIOD

Group	Period (days)	Mean Feed Intake (lb air-dry/head/day)	
		Hay	Supplement
I	0–161	10·58	. .
II	0–161	9·82	1·18
III	0–161	13·66	0·43
IV	0–84	7·34	. .
V	0–84	7·42	0·89
VI	0–84	10·68	0·32
VI	0–161	10·13	0·26
VI	0–217	9·98	0·25

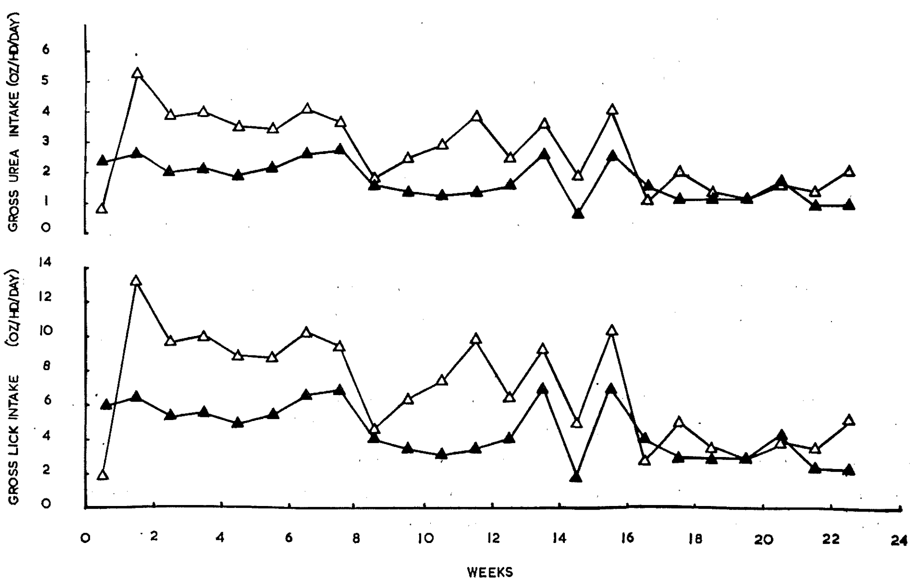

Fig. 2.—Gross lick intake and calculated urea intake of Groups III and VI.

Group III △——△ ; Group VI ▲——▲ .

There was little difference in body-weight loss within treatments between age groups at the 85-day weighing.

(iv) *Block Intake*.—Progressive mean daily block consumption obtained from weekly intake data, together with calculated urea intake, is given in Figure 2. Mean intakes for various periods are presented in Table 2.

Block intake in Group III fluctuated markedly, rising from a mean of 1·88 oz per head per day in the first week to 13·23 oz in the second week. This was the highest intake achieved over the whole experiment. Estimated daily urea intake per beast at this peak was 4·63 oz. In contrast, the block intake of the younger animals (Group VI) stayed within the range of 4·9 to 6·9 oz per head per day for the first 8 weeks.

Over the final six weeks when the block effluents were collected, analysis of the effluents from Groups III and VI showed the mean ratio of nitrogen to chloride to be approximately three times as great in the effluent as in the block. These figures are presented in Table 3 and are used to calculate the net block and urea intakes of both these groups (Table 4). Effluent accounted for more than 34 per cent. of the gross urea intake in three of the six weeks in Group VI but was only a small percentage of the gross intake in Group III for the whole 6-week period. There appears to be some relationship between relative humidity, rainfall, and production of effluent in Group VI, the maximum effluent being produced at the time of maximum humidity and rainfall.

TABLE 3

Mean and Standard Deviation of Nitrogen and Chloride Content of Weekly Effluent Samples Obtained from Blocks Presented to Groups III and VI During Final 6 Weeks

—	Percentage by Weight		N as Urea / Cl as NaCl
	Nitrogen	Cl as NaCl	
Group III effluent	14·21 ± 3·39	12·82 ± 3·22	2·41 ± 0·38
Group VI effluent	13·62 ± 3·40	12·35 ± 3·18	2·46 ± 1·48
Block as supplied	18·6	47·5	0·84

Over the period when the standard block was replaced with one containing chromic oxide and grab faecal samples taken, the mean 4-day faecal chromic oxide concentration ranged from 82 to 109 per cent. of the group mean in Group III and from 67 to 133 per cent. of the group mean in Group VI (Table 5).

TABLE 4

Net Block and Urea Intakes in Groups III and VI over Final 6-Week Period Calculated from Nitrogen and Chloride Analyses of Blocks and Effluents; Plus Rainfall and Relative Humidity

Week	Group III								Group VI								Rainfall (in.)	Mean Relative Humidity (%)
	Gross Intake (oz)		Effluent (oz)		Net Intake (oz)		Effluent/Gross (%)		Gross Intake (oz)		Effluent (oz)		Net Intake (oz)		Effluent/Gross (%)			
	Block	Urea	Block	Urea	Block	Urea	Block	Urea	Block	Urea	Block	Urea	Block	Urea	Block	Urea		
18	5·15	2·06	0·36	0·12	4·78	1·94	7·0	5·8	2·86	1·14	0	0	2·86	1·14	0	0	0	52
19	3·43	1·37	0·07	0·02	3·36	1·29	2·0	1·4	2·86	1·14	0·29	0·11	2·57	1·03	10·1	9·6	0	60
20	2·86	1·14	0·36	0·12	2·50	1·02	12·6	10·5	2·86	1·14	1·14	0·39	1·72	0·75	39·9	34·2	0·07	80
21	4·00	1·60	0·25	0·08	3·75	1·52	6·2	5·0	4·29	1·72	3·14	0·70	1·15	1·02	73·2	40·7	2·06	83
22	3·43	1·37	0·07	0·02	3·36	1·35	2·0	1·4	2·28	0·91	1·57	0·48	0·71	0·43	68·9	52·7	1·02	73
23	5·15	2·06	0	0	5·15	2·06	0	0	2·28	0·91	0·07	0·01	2·21	0·90	3·1	1·1	0·09	71

TABLE 5

FAECAL CHROMIC OXIDE CONCENTRATIONS IN GROUPS III AND VI WHEN RECEIVING BLOCK CONTAINING 1g/oz OF CHROMIC OXIDE

Group	Animal No.	Faecal Chromic Oxide Concentration ($g\ Cr_2O_3/100\ g$ D.M.) Day after Introduction of Marker				Mean
		11	12	13	14	
III	1	0·24	0·19	0·23	0·33	0·24
	2	0·16	0·14	0·22	0·20	0·18
	3	0·21	0·19	0·21	0·22	0·21
	4	0·21	0·23	0·26	0·24	0·23
	Mean					0·22
VI	1	0·17	0·18	0·14	0·16	0·16
	2	0·10	0·09	0·11	0·10	0·10
	3	0·21	0·19	0·18	0·22	0·20
	4	0·17	0·14	0·14	0·18	0·16
	Mean					0·15

(v) *Hay Intake.*—Progressive daily hay intake is shown in Figure 3. The mean data for various periods are presented in Table 2.

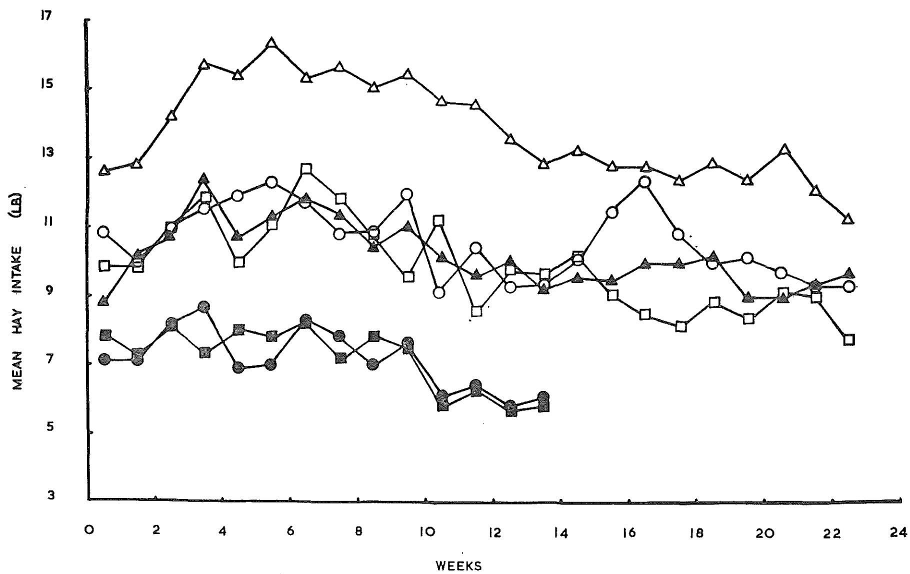

Fig. 3.—Mean daily hay intake calculated from weekly data.

Group I ○—○ ; Group II □—□ ;
Group III △—△ ; Group IV ●—● ;
Group V ■—■ ; Group VI ▲—▲ .

TABLE 6

FEEDING BEHAVIOUR OF CATTLE IN GROUPS III AND VI AT HAY AND BLOCK TROUGHS

Group	Date	Length of Observation (hr)	Feeding at Hay Trough: Mean Time Spent Feeding (hr)	Feeding at Hay Trough: Mean Feeding Time/Total Period (%)	Feeding at Hay Trough: Mean Visits to Trough (No./animal/hr)	Feeding at Hay Trough: Mean Duration of Single Visit to Trough (min)	Feeding at Block: Mean Time Eating Block (min)	Feeding at Block: Mean Block Consumption per Head over Whole Period (oz)	Feeding at Block: Mean Time at Block/Total time (%)	Feeding at Block: Mean Visits to Block (No./animal/hr)	Duration of Single Visit to Block (min): Max.	Duration of Single Visit to Block (min): Min.	Duration of Single Visit to Block (min): Mean	Urea Intake per Visit† (oz): Max.	Urea Intake per Visit† (oz): Min.	Urea Intake per Visit† (oz): Mean	Relationship between Hay Feeding and Block Feeding: End of a Period at Block to Start of Feeding (min): Mean	End of a Period at Block to Start of Feeding (min): S.D.	End of a Feeding Period to Start of a Period at Block (min): Mean	End of a Feeding Period to Start of a Period at Block (min): S.D.	Time Eating Block/Time Eating Hay (%)
III	16.iii.61	7	3·05	43·6	1·43	18·3	10·0	3·5	2·4	0·36	8	1	3·6	0·70	0·09	0·32	10·7	16·2	2·5	1·9	5·4
	30.iii.61	7	3·20	45·7	1·78	15·3	16·5	5·75	3·9	0·64	8	1	3·6	1·11	0·14	0·50	23·4	33·8	2·7	1·4	8·6
	11.iv.61	7	3·76	53·7	1·61	20·0	24·5	—	5·8	0·93	11	1	3·8	—	—	—	18·5	20·5	9·8	9·9	10·9
	19.iv.61	6·5	3·01	46·4	1·42	15·1	5·5	4·25	1·4	0·38	5	1	2·2	1·55	0·31	0·68	33·9	36·2	14·3	32·2	3·0
	12.vi.61	6	3·73	62·2	2·45	15·2	23·5	3·5	4·9	0·83	9	1	4·7	0·54	0·06	0·28	29·4	47·0	3·2	3·9	10·5
	13.vi.61	6	2·98	49·6	2·28	13·1	14·5	3·75	4·0	0·92	7	1	3·2	0·71	0·10	0·32	12·0	23·8	3·6	3·4	8·1
	14.vi.61	6	2·63	43·8	2·0	13·1	19·5	3·25	5·4	0·96	9	1	2·9	0·60	0·07	0·19	25·8	37·8	8·2	15·0	12·4
VI	16.iii.61	7	..	..	..	..	11·5	2·0	2·7	0·42	8	1·5	3·8	0·56	0·10	0·27	..	..	..	..	..
	30.iii.61	7	..	..	..	..	20·4	4·0	4·8	0·53	8	2	5·4	0·78	0·19	0·53	..	..	..	..	..
	11.iv.61	7	..	..	..	..	15·5	3·75	3·7	0·29	13	2·5	7·7	0·92	0·18	0·55	..	..	..	..	..
	19.iv.61	6·5	..	..	..	..	11·1	3·5	2·8	0·31	10	1	3·7	1·26	0·13	0·47	..	..	..	..	..
	12.vi.61	6	3·93	65·5	1·03	38·0	14·5	1·5	4·0	0·37	11	3	6·4	0·45	0·12	0·26	33·7	54·1	5·0	5·4	6·15
	13.vi.61	6	3·88	64·6	1·53	25·4	9·5	0·75	2·6	0·42	6	1	3·8	0·19	0·3	0·12	26	38·5	5·2	4·9	4·1
	14.vi.61	6	3·15	52·5	1·16	27·2	12·0	1·75	3·3	0·50	7	2	4·0	0·41	0·12	0·24	46	37·0	5·8	6·7	6·3

— Block consumption not measured

† Assuming block intake per unit of time spent licking to be constant

.. Data on feeding at hay trough not recorded

There was no marked difference in hay intake between Groups I and II or between Groups IV and V. However, a substantial increase in hay intake within each age group was evident in the groups provided with a block (III > I by 29·1 per cent.; III > II by 39·1 per cent.; VI > IV by 45·5 per cent.; VI > V by 43·9 per cent.).

Residues from the hay troughs in Groups I, II and III were 4·2, 5·3 and 2·7 per cent. respectively of the net daily hay intake for the 161-day period, while the percentages of residues in Groups IV, V and VI were 9·2, 6·7 and 5·6 respectively for the 84-day period.

(vi) *Behaviour Studies.*—Observations on behaviour of the animals over periods each of 6 to 7-hr duration are presented in Table 6. These figures were obtained between 9 a.m. and 5 p.m.

Over these observation periods visits to both the hay trough and the block were frequent, being of the order of 1-3 per hr for the hay and 0·3 to 1·0 per hr for the block. Calculated maximum urea intake per visit (the product of mean intake rate and maximum time) was 1·55 oz in Group III and 1·26 oz in Group VI.

In most cases the time interval between the end of a feeding period and the commencement of licking was short (2·5–14·3 min) whereas the time between the end of a licking period and the start of feeding was long (10·7–46 min).

(vii) *Analyses of Blood and Serum Samples.*—Levels in the blood of haemoglobin, packed cell volume, total serum protein, albumin and globulin are given in Table 7. These figures have been calculated from treatment means after eliminating differences among twin pairs.

There were no significant differences between treatments within either age group in the levels of the various blood components obtained on the 98th day for Groups IV, V and VI and on the 161st day for Groups I, II and III. In Group VI, which remained on its treatment for 217 days and was bled on the 98th day, the 161st day and the 217th day, there was no significant difference in the level of the various constituents between bleedings.

At all times blood inorganic phosphate levels were within the normal range.

TABLE 7

HAEMOGLOBIN, PACKED CELL VOLUME, SERUM TOTAL PROTEIN, ALBUMIN AND GLOBULIN IN GROUPS I, II, III AND VI AT 161ST DAY, GROUPS IV, V AND VI AT 98TH DAY AND GROUP VI AT 217TH DAY†

Time	Group	Haemoglobin (g/100 ml)	Packed Cell Volume (%)	Total Serum Protein (g/100 ml serum)	Serum Albumin (g/100 ml)	Serum Globulin (g/100 ml)
161st day	I	9·78	33·3	6·03	2·94	3·09
161st day	II	9·62	32·3	5·88	2·82	3·06
161st day	III	11·65	39·8	6·68	3·01	3·68
S.E. difference two means ..		± 0·71	± 2·9	± 0·39	± 0·17	± 0·36
98th day	IV‡	8·24	26·2	5·03	2·14	2·89
98th day	V‡	7·26	24·8	5·49	2·40	3·09
98th day	VI	8·02	26·5	5·67	2·18	3·49
S.E. difference	IV–V	± 0·72	± 1·4	± 0·31	± 0·20	± 0·14
	IV–VI	± 0·72	± 1·4	± 0·31	± 0·20	± 0·14
	V–VI	± 0·59	± 1·2	± 0·25	± 0·16	± 0·12
98th day	VI	8·45	27·9	5·52	2·15	3·38
161st day	VI	8·18	27·4	5·12	2·32	2·80
217th day	VI	8·95	27·8	5·50	2·48	3·02
S.E. difference two means ..		± 0·56	± 1·7	± 0·30	± 0·13	± 0·29

† Calculated from treatment means after eliminating differences among twin pairs
‡ Means derived from three animals only

V. DISCUSSION

In the experiment reported in this paper the treatment of a low quality pasture hay with molasses influenced neither hay intake nor body-weight. This agrees with work in South Africa (Clark and Quin 1951), where the spraying of late-cut native grass hay with molasses had no effect on the hay intake or body-weight of sheep. A similar lack of response was obtained by Beames (1959) when molasses was fed as a liquid supplement to cattle on a basal ration of low-protein pasture hay and by Beames (1960*a*), who presented molasses *ad lib.* to cattle grazing a *Paspalum dilatatum* dominant pasture. Thus, serious doubt is cast upon the nutritional value of molasses as a sole supplement to mature pasture or pasture hay, regardless of the level of feeding or method of presentation.

Response to the block in body-weight gains demonstrates that this method of urea supplementation should give results similar to that of molasses/urea either sprayed on the hay (Clark and Barrie 1954) or fed as a supplement in a liquid form (Beames 1959). A comparison between Group VI, which was kept on its treatment for 217 days with no loss of body-weight, and the two groups of comparable age not receiving the lick which had to be withdrawn at 85 days indicates the value of this block as a supplement for survival.

With the small number of animals used in this experiment, the fact that no deaths were associated with the feeding of the block would not necessarily indicate that risks involved in its use were negligible. The detailed observations made to gain information on behaviour under yard conditions (Table 6) produced a calculated maximum urea intake for a single visit to the block in Group III of 1·55 oz and in Group VI of 1·26 oz. This latter intake, equivalent to an intake of 0·26 g urea/kg body-weight, approaches the toxic level of 0·4 g/kg body-weight reported by Dinning *et al.* (1948) and Clark, Oyaert, and Quin (1951). With such high intakes per visit the period between visits to the trough would be critical.

Field observations subsequent to this experiment on the use of a similar type of block containing 35 per cent. urea (K. J. Astill, personal communication 1961) have shown that most stock losses occur within the first 48 hr after presentation of the block. From the mean weekly block intake data presented in this paper it appears that the experimental animals were slow in becoming accustomed to the block. High block intake early in the experiment was evident only in Group III, but this did not occur until the second week of the experiment. At this stage the mean daily urea intake per animal rose to 5·28 oz. With normal fluctuations the daily urea intake by some animals within this week would have been above this figure.

An interesting feature in the behaviour studies was that from a total of 206 observed visits to the block, only in one case was the interval between the end of a feeding period and the commencement of licking of the block over 1 hr. A consideration arising from this observation is that visits to the block might be more frequent and of a lesser duration under grazing conditions if the block were provided in close proximity to feeding areas rather than at the watering point.

During the early part of the experiment a liquid effluent was frequently noticed in the bottom of the trough. In order to obtain absolute consumption figures this was allowed to remain and be consumed by the animals. With the possibility of this liquid causing toxicity if consumed rapidly and also because of the manufacturer's recommendations that the effluent be allowed to run to waste, it was drained from the trough and analysed during the last six weeks. In three of these weeks the effluent accounted for more than 34 per cent. of the loss of weight of the block in Group III. During these weeks, the high humidity resulting from moderate to heavy falls of rain caused these blocks to soften to a depth of up to half an inch. With the low rate of block intake in Group III, the high effluent loss could be attributed to the inability of these animals to consume the block as rapidly as it softened. Fortunately, in commercial usage in dry times, wastage caused by high humidity should be of little importance.

No significant difference between treatments within age groups was found in any of the values determined on blood. On the basis of values obtained on grazing Hereford cattle at the Animal Husbandry Research Farm, Rocklea, the levels of haemoglobin, packed cell volume, total protein and albumin are low at all bleedings for animals in Groups IV, V and VI. In Groups I and II the levels determined at 161 days would appear low for haemoglobin, packed cell volume, total protein and albumin.

During the period when chromic oxide was incorporated in the block there was a considerable between-animal variation in faecal chromic oxide concentration in the younger animals. This concentration, which ranged from 67 to 133 per cent. of the group mean, would be dependent on block intake, hay intake and dry-matter digestibility. The effect of variation in dry-matter digestibility should be small (Forbes *et al.* 1946), while variations in hay intake and thus faecal output should account for less than half the difference between these extremes. Much of this difference, therefore, must result from variation in block intake. Thus, with supplements containing urea, mean intake values may give a very inaccurate estimation of the risk to individual animals.

VI. ACKNOWLEDGEMENTS

The author wishes to express his appreciation to officers of the Biochemical Branch, in particular Mr. R. J. W. Gartner and Mr. K. W. Moir, for chemical analyses, to Mr. S. L. Everist for botanical analyses and to Mr. A. W. Beattie for statistical analyses. Thanks are also due to Mr. M. J. Radel for care of the experimental animals, and to Mr. W. McKellar and Miss K. Scheldt for technical assistance.

REFERENCES

ALTONA, R. E., ROSE, C. J., and TILLEY, T. J. (1960).—Urea as supplementary protein for bulk feeds. *S. Afr. J. Agric. Sci.* 3:69-81.

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. (1955).—"Official Methods of Analysis of the Association of Official Agricultural Chemists." 8th Ed. (The Association: Washington).

BEAMES, R. M. (1959).—Molasses and urea as a supplement to low quality pasture hay for cattle. *Qd J. Agric. Sci.* 16:223-32.

BEAMES, R. M. (1960*a*).—The supplementation of low quality hay and pasture with molasses and molasses urea mixtures. *Proc. Aust. Soc. Anim. Prod.* 3:86-92.

BEAMES, R. M. (1960*b*).—A note on the preservation of a solution of molasses and urea in water. *Qd J. Agric. Sci.* 17:205-6.

BERRY, W. T., KUNKEL, H. O., and RIGGS, J. K. (1958).—A liquid supplement for range cattle. *Texas Agric. Prog.* 4(1):10-11.

BISHOP, E. J. B. (1959).—The value of urea and molasses proved at Dohne. *Fmg S. Afr.* 35(3):27-9.

BUREAU OF SUGAR EXPERIMENT STATIONS, QUEENSLAND. (1954).—"Laboratory Manual for Sugar Mills." (Bureau of Sugar Experiment Stations: Brisbane.)

CLARK, R. (1952).—Use of urea and molasses in winter feeding. *Fmg S. Afr.* 27:453-4.

CLARK, R., and BARRIE, N. (1954).—Winter feeding experiments. *Fmg S. Afr.* 29:135-8.

CLARK, R., OYAERT, W., and QUIN, J. I. (1951).—Studies on the alimentary tract of the Merino sheep in South Africa. XXI—The toxicity of urea to sheep under different conditions. *Onderstepoort J. Vet. Res.* 25(1):73-8.

CLARK, R., and QUIN, J. I. (1951).—Studies on the alimentary tract of the Merino sheep in South Africa. XXIII. The effect of supplementing poor quality grass hay with molasses and nitrogenous salts. *Onderstepoort J. Vet. Res.* 25(1):93-103.

DINNING, J. S., BRIGGS, H. M., GALLUP, W. D., ORR, H. W., and BUTLER, R. (1948).—Effect of orally administered urea on the ammonia and urea concentration in the blood of cattle and sheep with observations on blood ammonia levels associated with symptoms of alkalosis. *Amer. J. Physiol.* 153:41-6.

DONALDSON, R., SISSON, R. B., KING, E. J., WOOTOON, I. D. P., and MACFARLANE, R. G. (1951).—Determination of haemoglobin. VII. Standardised optical data for absolute estimations. *Lancet* 260:874-81.

FORBES, E. B., ELLIOTT, R. F., SWIFT, R. W., JAMES, W. H., and SMITH, Vivian F. (1946).—Variation in determinations of digestive capacity of sheep. *J. Anim. Sci.* 5:299-305.

GORNALL, A. G., BARDAWILL, D. J., and DAVID, M. M. (1949).—Determination of serum proteins by means of the biuret reaction. *J. Biol. Chem.* 177:751-66.

HANCOCK, J. (1949).—Studies in monozygotic twins. II. Recognition of monozygotic cattle twins. *N.Z. J. Sci. Tech.* A31(2):1-41.

KELLERMANN, J. H., and GROENEWALD, J. W. (1956).—Molasses in the feeding of farm animals. *Fmg S. Afr.* 32(2):61-70.

MOIR, K. W. (1954).—The preservation of bovine blood for the determination of inorganic phosphate in the diagnosis of aphosphorosis. *Qd J. Agric. Sci.* 11:143-7.

O'BRYAN, M. S. (1960).—Observations on the utilization by cattle of *Axonopus affinis* following foliar application of urea, molasses and monosodium phosphate. *Qd J. Agric. Sci.* 17:135-46.

RIGGS, J. K., COLBY, R. W., and SELLS, L. V. (1953).—The effect of self-feeding salt-cottonseed meal mixtures to beef cows. *J. Anim. Sci.* 12:379-93.

SCHURCH, A. F., LLOYD, L. E., and CRAMPTON, E. W. (1950).—The use of chromic oxide as an index for determining the digestibility of a diet. *J. Nutr.* 41:629-36.

SNOOK, L. C. (1958).—Supplying urea to stock through drinking water. *J. Aust. Inst. Agric. Sci.* 24:357-8.

VAN DER VYVER, B. J. (1954).—Urea as a source of protein for cattle. *Fmg S. Afr.* 29:286.

VAN LA CHEVALLERIE, M. (1959).—Urea as a nutrient for ruminants. Injudicious use dangerous. *Fmg S. Afr.* 35(9):44-45.

WEIR, W. C., and MILLER, R. F. (1953).—The use of salt as a regulator of protein supplement intake by breeding ewes. *J. Anim. Sci.* 12:219-25.

WILLIAMS, N. M., and TRIBE, D. E. (1957).—The feeding of urea to sheep. *Vict. J. Agric.* 55:769-71.

WINTROBE, M. M. (1947).—"Clinical Haematology." 2nd Ed. (Lea and Febiger: Philadelphia.)

(Received for publication March 8, 1963)