DROUGHT FEEDING STUDIES WITH CATTLE AND SHEEP

2. The Use of Sorghum Silage With and Without Urea as a Drought Fodder for Cattle.

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SUMMARY.

Four groups each of seven maiden Hereford heifers 15-18 months old were confined in bare yards and fed a basal ration of sorghum silage with and without a urea supplement.

Heifers fed sorghum silage *ad lib.* **with no supplement lost an average of 70 lb. body weight per head over 28 weeks. Over the same period, a group fed the same amount of silage with 1.5 oz. urea per head per day lost an average of 30 lb. body weight. Groups fed silage** *ad lib.* **with 1.5 oz. and 2.5 oz. urea per head per day gained an average of 70 lb. and 117 lb. per head respectively.**

Urea supplementation increased silage consumption. The mean daily consumption of dry matter by animals in each group was: no supplement 5.0 lb.; 1.5 oz. urea 8.2 lb.; 2.5 oz. urea 9.1 lb.

Urea-supplemented animals had a higher plasma protein concentration, did not develop the subcutaneous oedema of the submandibular space which occurred in six of the seven heifers in the unsupplemented group, and showed a greater tendency to shed their winter coats.

When 1.5 oz. urea was added to sorghum silage the rate of body weight increase of the animals when turned out to pasture was greater than that of those fed an iso-caloric amount of silage with no supplement.

Heifers which received *ad lib.* **silage with urea showed normal behaviour; unsupplemented animals on** *ad lib.* **silage became lethargic, apathetic and dejected.**

I. INTRODUCTION.

For many years small quantities of sorghum silage have been conserved annually on some dairy farms in Queensland and northern New South Wales. With the development of satisfactory mechanical forage harvesters and acceptance of the fact that good silage can be made effectively in trenches or pits, interest in silage-making on a large scale has been stimulated in recent years.

Varieties of sweet sorghum have shown their suitability for silage purposes over a wide geographical range in Queensland. In the pastoral areas, many thousands of tons of this form of silage have been made in trenches on sheep properties but little has yet been made on beef cattle properties.

In view of the potential value of sorghum silage for feeding beef cattle in drought, it was decided to include this feedstuff in drought feeding experiments.

The aim of the experiment reported here was to conserve in underground pits a silage which is comparable in composition to that which has been produced in western Queensland, and to investigate its value as a drought fodder for cattle.

The effect of various levels of a nitrogenous supplement on the body weight of animals fed iso-caloric and *ad lib.* amounts of sorghum silage was studied. Observations on the effect of this supplement upon voluntary comsumption of silage, plasma protein and electrolyte concentrations, plasma volume, behaviour and coat of the animals during the experiment were also made.

Urea, because of its suitability for transportation over long distances, its high nitrogen content and its consequent comparatively low haulage cost per unit of nitrogen, provides a nitrogenous supplement which could be fed to cattle in distant inland areas. As it could also be used to prepare iso-caloric rations of various nitrogen contents for ruminants, it was chosen as the nitrogenous supplement in these experiments.

II. METHODS AND MATERIALS.

(1) Sorghum Silage.

The Sugardrip variety of sweet sorghum was grown at the Animal Husbandry Research Farm, Rocklea, Brisbane, on land that had been under cultivation for a number of years. In order to simulate the low level of available soil nitrogen found in western Queensland no fertilizer was applied. The crop was harvested with a single-row forage harvester and chopper 110 days after planting. At this stage it was approximately 10 ft. high and the seed in the soft to hard dough stage.

The chopped material was placed in a hillside pit silo which was built by excavating on the side of a hill a trench 12 ft. wide at the base, with sloping walls and a floor gradient of 2 per cent. in the direction of the mouth. Approximately 100 tons of chopped material was placed in the pit over a period of eight days and consolidated by frequent rollings with a pneumatic-tyred tractor. The material was then covered with a layer of sawdust approximately 18 in. deep and further rolled.

Four months later the pit was opened at the mouth on a vertical face, and silage removed for feeding.

(2) Experimental Animals.

Thirty dehorned Hereford heifers approximately 15 months of age and in store condition were transported by rail to Rocklea from a beef property in the Burnett district. During the next four weeks these animals grazed paspalum (*Paspalum dilatatum*) pastures and were tested and inoculated as described by Morris (1958a).

Seven animals were allotted to each of four groups by a stratified random allocation on a body weight basis.

(3) Body Weight.

All animals were weighed by the procedure described by Morris (1958a).

(4) Experimental Yards and Facilities.

The yards and facilities were those described by Morris (1958a).

(5) Methods of Chemical Analysis.

Analytical methods employed were as follows: proximate analysis of feedstuffs, Association of Official Agricultural Chemists (1955); silage quality tests, Watson and Ferguson (1937); plasma protein, Phillips *et al.* (1950), and Van Slyke *et al.* (1950); plasma sodium and potassium, by flame photometry.

(6) Plasma Volume.

Plasma volume was measured by the dilution of Evans blue (T-1824). Twenty minutes after intravenous injection of 20 ml. of 0·5 per cent. solution of Evans blue, a blood sample was withdrawn from the external jugular vein opposite to that injected. The density of the heparinised plasma in this sample was compared with a pre-injection sample at 620 mμ in a Hilger spectrophotometer. The technical precautions described by Gregersen (1944) were observed.

(7) Hair Cover.

Hair cover was estimated by weighing the hair removed by electric clippers from a measured area over the right eighth intercostal space midway between the vertebral and the sternal attachments.

III. EXPERIMENTAL DESIGN.

(1) Treatments.

The four groups of heifers were confined to bare yards and initially subjected to the following experimental rations:

Group I : Sorghum silage *ad lib.*

Group II : Same quantity of silage as eaten by Group I + 1·5 oz. urea* + 0·14 oz. sodium sulphate per head per day.

Group III: Two-thirds the amount of silage eaten by Group I.

Group IV: Two-thirds the amount of silage eaten by Group I + 1·5 oz. urea + 0·14 oz. sodium sulphate per head per day.

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* The urea used was "Ureafol" brand of "prilled" urea donated by Imperial Chemical Industries of Australia and New Zealand Limited.

After the experiment had been in progress for four weeks it became apparent that restriction of the silage intake below that of Group I (approximately 5 lb. dry matter per head per day) would not be compatible with survival.

The experiment was therefore modified at four weeks to the following treatments:

Group I : Sorghum silage *ad lib.*

Group II : Same quantity of silage as eaten by Group I + 1·5 oz. urea + 0·14 oz. sodium sulphate per head per day.

(Groups I and II: not changed from original treatment.)

Group III: Sorghum silage *ad lib.* + 1·5 oz. urea + 0·14 oz. sodium sulphate per head per day.

Group IV: Sorghum silage *ad lib.* + 2·5 oz. urea + 0·18 oz. sodium sulphate per head per day.

For those groups fed silage *ad lib.* (Groups I, III and IV) the amount of silage fed daily was slightly in excess of the intake. Residues were fed back, the previous day's residue being placed on top of the freshly added silage. This procedure prevented deterioration of the silage residue, always ensured *ad lib.* intake and obviated wastage.

Group II was fed daily the same amount of silage as was added to the trough for Group I.

For Groups II, III, and IV the urea and sodium sulphate supplements were sprinkled on the silage and then mixed in with the upper portion of the silage.

At the conclusion of the experimental feeding period on sorghum silage, all animals were transferred to a paspalum pasture.

(2) Observations and Recordings.

Daily dry matter determinations were made on the silage before feeding. These samples were bulked for chemical analysis. The mean weekly dry matter intake was computed for each group from the daily wet silage consumption and the average of the weekly dry matter percentage. Individual body weights were measured at weekly intervals.

At the conclusion of the sorghum silage feeding the following estimations were performed: plasma protein, sodium, and potassium concentrations; clinical examination by an independent observer for subcutaneous oedema; plasma volume of the animals in Groups I and IV; hair cover at the standard site; faecal worm egg counts; recovery rate using body weight as an index.

At the beginning and the end of the period on silage feeding the permanent incisor teeth eruption was recorded.

(3) Duration of the Experiment.

Sorghum silage feeding commenced on July 2, 1957, and continued for a period of 28 weeks. Thereafter, for a period of 12 weeks, the animals grazed a paspalum pasture and recovery rates were measured.

IV. RESULTS.

The proximate analyses of a sample of silage without preparatory drying and one composite sample of silage resulting from the pooling of daily residues after dry matter determination are given in Table 1. The single sample of silage was the result of sub-sampling the material removed by a post-hole auger from three sites in the pit before the commencement of the experiment. These analyses indicate that the composition of the silage fed is similar to the average of a number of sorghum silages prepared in western Queensland and reported by Skerman (1956).

Table 1.

PROXIMATE ANALYSIS OF TWO SORGHUM SILAGE SAMPLES.

Sample.	Moisture.	Crude Protein.	Ether Extract.	Crude Fibre.	Nitrogen-free Extract.	Ash.	Ca.	P.
	%	%	%	%	%	%	%	%
Single* —As taken ..	73·2	1·4	0·4	7·4	15·6	2·0	0·09	0·07
D.M. basis†	..	5·2	1·6	27·5	58·1	7·6	0·31	0·28
Composite‡—D.M. basis	..	4·9	1·4	33·8	50·5	9·4	0·30	0·33

* Sample taken from the pit by an auger prior to the experiment.
† Corrected for loss of volatile material in drying.
‡ Composite sample prepared by drying and bulking a representative sample of the silage fed daily.

The results of silage quality tests performed on the wet silage were as follows: dry matter, 26·8 per cent.; pH, 3·8; lactic acid, 1·13 per cent.; acetic acid, 0·68 per cent.; lactic acid: acetic acid ratio, 1·7:1; total nitrogen, 0·84 per cent. in the dry matter; amino acids, 0·14 per cent. in the dry matter; volatile bases, 0·05 per cent. in the dry matter; and amino acids: volatile bases ratio, 2·68:1. The light-green silage when exposed to the atmosphere did not develop an unpleasant odour. The results of these tests indicate silage of good quality with a low pH and a favourable lactic acid: acetic acid ratio and amino acids: volatile bases ratio.

All animals survived the experiment. The group mean changes in liveweight and group mean daily sorghum silage consumption over the 28 weeks on sorghum silage, and body weight changes during the 12-weeks recovery period

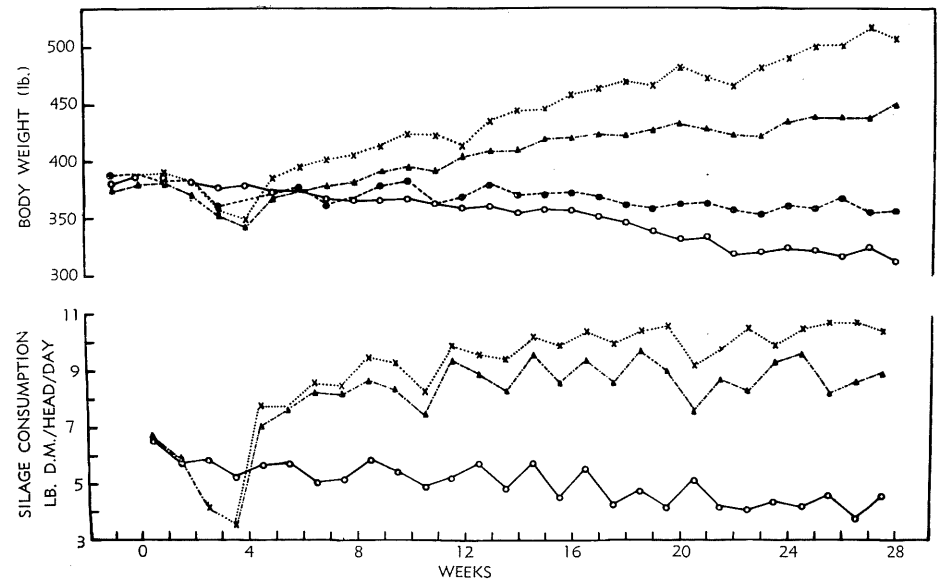

Fig. 1.

Weekly Group Mean Body Weight and Sorghum Silage Consumption of Heifers.

O————O	Group I:	Silage *ad lib.*
●— — —●	Group II:	Same amount of silage as eaten by Group I + 1.5 oz. urea and 0.14 oz. sodium sulphate per head per day.
△ — . — △	Group III:	Silage *ad lib.* + 1.5 oz. urea and 0.14 oz. sodium sulphate per head per day.
× .... ×	Group IV:	Silage *ad lib.* + 2.5 oz. urea and 0.18 oz. sodium sulphate per head per day.

on pasture, are given in Table 2. The weekly group mean body weight and silage consumption are shown in Fig. 1. At five weeks the mean body weights of Groups III and IV were approximately the same as those of Groups I and II. In view of the early restriction imposed on silage consumption by Groups III and IV, the calculation of body weight changes in these groups on the modified experimental design should be taken from five weeks after the commencement.

The urea supplement fed to Groups III and IV resulted in a voluntary intake of silage in excess of that of the unsupplemented Group I. After four weeks on *ad lib.* silage, the dry matter consumption of Groups III and IV steadily increased concurrently with body weight increase. The voluntary consumption of silage by Group I, however, steadily declined and was paralleled by a fall in body weight.

The average daily dry matter consumption of Group I during the 28 weeks of silage feeding was 5·0 lb. per head per day. The dry matter consumption of Groups III and IV in excess of that consumed by Group I was 3·2 lb.

Table 2.

GROUP MEAN BODY WEIGHT CHANGES AND DRY MATTER CONSUMPTION OF FOUR GROUPS OF HEIFERS FED SORGHUM SILAGE AND THE SUBSEQUENT GROUP MEAN BODY WEIGHT CHANGES DURING THE RECOVERY PERIOD ON PASTURE.

Group.	Sorghum Silage.	Supplement/head/day.	Body Weight Group Averages.					Silage Consumption D.M./head/day.
			Initial.	After 28 Weeks' Sorghum Silage.	Change.	After 12 Weeks' Pasture.	Change.	
			lb.	lb.	lb.	lb.	lb.	lb.
I	*ad lib.* ..	Nil	383	313	−70	428	+115	5·0
II	Same as fed to Group I*	1·5 oz. urea; 0·14 oz. sodium sulphate	389	357	−32	516	+159	5·0
III	*ad lib.* ..	1·5 oz. urea; 0·14 oz. sodium sulphate	379	449	+70	543	+94	8·2
IV	*ad lib.* ..	2·5 oz. urea; 0·18 oz. sodium sulphate	390	507	+117	577	+70	9·1

* Feed intake adjusted to the same as Group I.

and 4·1 lb. per head per day respectively. The urea supplements fed to Groups III and IV were in the ratio 3 : 5. Thus, the response of silage intake to urea supplementation was less at the higher level.

Comparisons between Groups I and II show that when silage intake was restricted to the same level the supplement of 1·5 oz. urea gave a relatively small response in terms of body weight change. Table 3 shows that the animals in Group II, which received the urea supplement, were significantly heavier

Table 3.

STATISTICAL ANALYSIS OF THE INDIVIDUAL BODYWEIGHTS OF FOUR GROUPS OF CATTLE FED SORGHUM SILAGE ALONE AND WITH VARIOUS RATES OF UREA SUPPLEMENTATION.

Between Groups.	Body Weight at—				Linear Component of Growth Rate.
	7 weeks.	14 weeks.	21 weeks.	28 weeks.	
IV greater than I ..	†	†	†	†	†
IV greater than II ..	†	†	†	†	†
IV greater than III ..	*	*	†	†	†
III greater than II ..	NS	†	†	†	†
III greater than I ..	NS	†	†	†	†
II greater than I ..	NS	NS	NS	*	†

NS = Not significant.
* = $P < 0{\cdot}05$.
† = $P < 0{\cdot}01$.

than those in Group I ($P<0\cdot05$) only at the 28th week of the experiment. The animals in Group III, which were fed the same level of urea as Group II, were significantly heavier than those in Groups I and II ($P<0\cdot01$) after only 10 weeks on *ad lib.* silage. This indicates that the main mechanism by which urea elevates the value of this silage is by an increase in feed consumption.

The group range and mean of the plasma protein concentration are shown in Table 4. All the heifers in Group I had a plasma protein concentration less than that of any animal in the other groups. The plasma protein concentration of the animals in Group II was significantly greater ($P<0\cdot001$) than that of Group I. Both groups ate the same amount of silage, but Group II was given a urea supplement.

Table 4.

Group Mean and Group Range in Plasma Protein Concentration of Four Groups of Heifers Fed Sorghum Silage and Various Levels of Urea.

Group.	Plasma Protein Concentration (g./100 ml. plasma).	
	Group Mean and Standard Deviation.	Group Range.
I ..	5·2 ± 0·12	4·5—5·6
II ..	6·3 ± 0·12	5·9—6·7
III ..	6·6 ± 0·12	6·2—6·9
IV ..	6·7 ± 0·12	6·4—7·0

Groups II, III and IV greater than Group I ($P<0\cdot001$).
Group IV greater than Group II ($P<0\cdot05$).

Neither the within-group nor the between-group variations in plasma protein concentration could be correlated with the plasma sodium or potassium concentration. The range and group mean concentration of these ions in the plasma are given in Table 5.

Table 5.

Group Mean and Group Range in Plasma Sodium and Potassium Concentration of Four Groups of Heifers Fed Sorghum Silage and Various Levels of Urea.

Group.	Group mean (m-equiv./l.).		Group range (m-equiv./l.).	
	Sodium.	Potassium.	Sodium.	Potassium.
I ..	172	5·3	145–185	4·5–6·0
II ..	152	5·5	140–180	5·0–6·0
III ..	160	5·7	148–180	5·0–6·0
IV ..	183	5·2	150–219	5·0–6·0

Clinical examination of all animals for subcutaneous oedema at the conclusion of the experiment showed that this occurred only in Group I and was confined to the submandibular space. Six of the seven animals in this group had oedematous swellings (bottle-jaw), two being classified as severe, two as moderate, and two as slight. The two severe cases of oedema had the lowest plasma protein concentration.

Faecal samples examined for worm eggs gave a maximum count of 80 eggs per gram of faeces. Of these eggs, 94 per cent. were of *Oesophagostomum* species. This indicates that internal parasitism was not a complicating factor in the production of the oedema.

The group mean and range of plasma volumes (millilitres per kilogram bodyweight) of Groups I and IV were as follows:

——	Mean.	Range.
Group I	52	43–63
Group IV	43	40–48

The plasma volume per unit weight of the heifers in Group I was greater than that of those in Group IV.

The behaviour and the attitude of the four groups of animals were markedly affected by the experimental rations. The animals in Group I initially became more tractable, then lethargic and finally apathetic and dejected. The animals in Group II reacted similarly but were less lethargic than those in Group I, while those in Groups III and IV were bright and alert.

The group mean and range in hair cover (expressed as grams per 100 sq. cm. of skin at the standard site) at the end of the period of silage feeding are shown in Table 6. Hair cover of the animals in Group I was significantly

Table 6.

Group Mean and Range in Hair Cover at a Standard Site of Four Groups of Heifers Fed Sorghum Silage and Various Levels of Urea.

Group.	Hair Cover (g./100 sq. cm. skin.)	
	Mean and Standard Deviation.	Range.
I ..	1·8 ± 0·13	0·9—2·1
II ..	1·2 ± 0·13	0·8—1·9
III ..	0·7 ± 0·13	0·1—1·1
IV ..	0·9 ± 0·13	0·8—1·1

Group I greater than Groups III and IV ($P < 0{\cdot}001$).
Group I greater than Group II ($P < 0{\cdot}05$).
Group II greater than Group III ($P < 0{\cdot}05$).

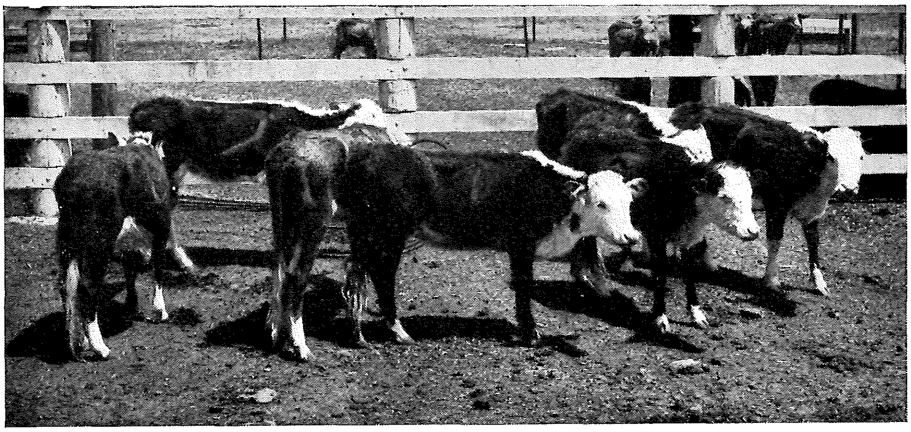

Fig. 2.

Heifers in Group I Fed Sorghum Silage *ad lib.* for 28 Weeks. Note the condition of the animals and the retained winter coat.

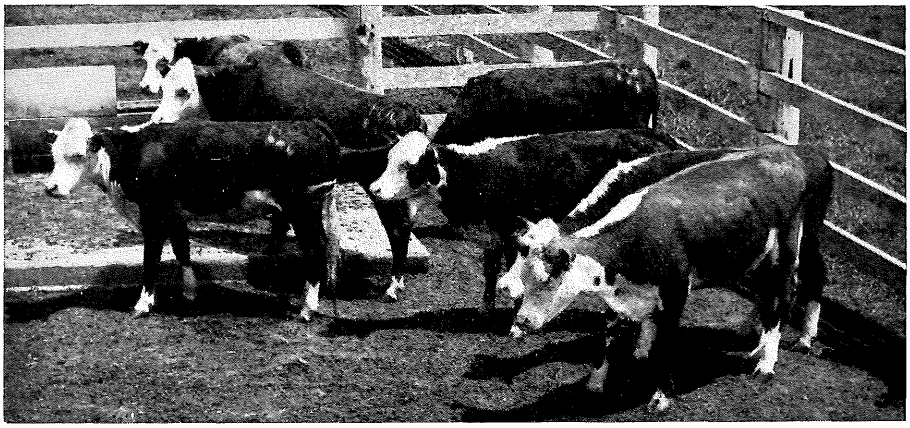

Fig. 3.

Heifers in Group IV Fed Sorghum Silage *ad lib.* plus 2.5 oz. Urea and 0.18 oz. Sodium Sulphate Per Head Per Day. These animals were photographed on the same day as those in Fig. 2. Note the condition of the animals, the short coat and coat shedding over the withers and neck.

greater ($P<0{\cdot}05$) than that of those in Groups II, III, and IV. Figs. 2 and 3 illustrate the difference between the coats of the animals in Groups I and IV at the termination of the experiment. The experiment terminated in midsummer (early January), and the hair cover is therefore an index of retention of winter coat.

The skins of the animals in Groups III and IV were noticeably more elastic than those of the animals in Groups I and II. In addition, the skins of the animals in Groups I and II had a dry and scaly appearance, and venipuncture of the jugular, especially in Group I, was difficult.

Examination of the eruption of the permanent incisors indicated that this was not markedly affected by treatment.

V. DISCUSSION.

This experiment indicates that sorghum silage similar in composition to that which has been conserved in western Queensland is a potentially valuable drought reserve fodder for cattle. Though there was a steady decline in body weight averaging 70 lb. per head over seven months, the experimental animals fed silage alone *ad lib.* were still in a strong condition at the conclusion of the experiment and made reasonable weight gains (1·4 lb. per head per day) when turned out on pasture.

The energy requirements for maintenance of cattle may be computed from conventional feeding "standards." Morrison (1951) allows 7·0–7·9 lb. of total digestible nutrients (T.D.N.) and Woodman (1952) 6 lb. of starch equivalent (S.E.) for the maintenance of a 1,000 lb. bovine. Brody (1945) showed that the basal heat production of all animals is proportional to the 0·73 power of body weight. From the above data the average maintenance allowance for the heifers in Groups I and II as they entered the experiment may be computed as 3·5–4·0 lb. T.D.N. or 3·0 lb. S.E. If values of 56·7 lb. T.D.N. (Schneider 1947) and 35 lb. S.E. (J. M. Harvey, personal communication) are assigned to each 100 lb. dry matter (D.M.) in sorghum silage the energy intake of these groups receiving 5 lb. of D.M. is 2·8 lb. of T.D.N. or 1·8 lb. of S.E. The body weight of the heifers in Groups I and II exhibited a slow continuous decline throughout the experiment, and these animals were probably continually in negative energy balance. However, it is apparent that the allowances for maintenance indicated by either the T.D.N. or the production starch equivalent systems are over-estimations of energy requirements for survival of heifers confined to bare yards for periods of at least 28 weeks. Briggs, Franklin and McClymont (1957) also reported that the maintenance allowance of the starch equivalent system is a too liberal estimation of the energy requirement of Merino sheep under conditions of nutritional stress. Similar results have been reported for cattle by Morris (1958b).

A comparison of the same level of silage intake without and with a supplement of 1·5 oz. urea (Group I and Group II respectively) indicated superior performance of the animals receiving the urea supplement. This was reflected in a slower decline in body weight (32 lb. per head over seven months), an elevation in plasma protein concentration, a superior rate of body weight gain when turned out on pasture (1·9 lb. per head per day) and a greater tendency to shed the winter coat (Tables 2, 4 and 6). As the energy value of urea to ruminants is zero, the superior performance of the animals receiving the same intake of silage with added urea may be explained either by an increased efficiency of utilisation of the energy in silage, possibly by an increase in digestibility, or by a tissue protein sparing effect of urea. The latter explanation appears more acceptable in view of the recorded hypo-proteinaemia of Group I and superior weight gain by Group II during the recovery phase on pasture. This apparent slower rate of body weight increase by Group I during the recovery period may at least be partly explained by the elimination of oedematous fluid. This excessive fluid retention also tends to mask the true decline in body weight during the period of silage feeding. Methods for *in vivo* estimation of total body water of ruminants have inherent difficulties. Blaxter and Rook (1953) have reported that the antipyrine technique is not satisfactory with the bovine. Similarly, Morris (1954) reported that variations in rate of metabolism of antipyrine and its entry into the rumen and abomasum seriously limited the application of this technique to sheep.

The addition of a supplement of urea when silage was fed *ad lib.* greatly increased voluntary silage consumption and permitted body weight increase. The silage consumption by Groups III and IV also exhibited a steady increase throughout the experiment, corresponding to the increase in body weight. Similarly, the *ad lib.* consumption of silage by Group I slowly declined with the corresponding decline in body weight. It is suggested that the supplement of urea increased silage consumption by providing nitrogen which was limiting bacterial growth and hence rate of fermentation in the rumen. Morris (1958a) reported a similar increase in the voluntary intake of native grass hay (bush hay), resulting from the addition of supplements of vegetable protein (lucerne chaff), animal protein (meatmeal), and urea with grain sorghum. Urea has practical advantages as a source of additional dietary nitrogen. These include lower transport costs per unit of nitrogen and high solubility in water which permits application as a spray to the roughage.

The addition of urea to the diet of cattle on a restricted level of silage intake maintained their plasma protein concentration and prevented the development of subcutaneous oedema. Urea also exerted a similar effect at greater levels of silage consumption. Decreased plasma protein concentration as a result of low-protein diets has been reported in rats by Kohman (1920) and Frisch, Mendel and Peters (1929), and in dogs by Weech, Goettsch and Reeves (1935). It is apparent from the reviews of Keys *et al.* (1950) and Gilman and Gilman (1951) that the famine oedema syndrome is not necessarily explicable on the basis of a lowering of plasma protein concentration. In this experiment with cattle, the plasma protein concentration of all animals on the low-"protein" diet (Group I) was less than that of any other animal on the higher "protein" (urea supplemented) diets. The two animals with the severe oedema had the lowest recorded plasma protein concentrations. But there was no correlation between the degree of oedema of the submandibular space and the plasma protein concentration of the other animals in Group I. There was no apparent relationship in any of the animals between oedema and the plasma sodium or potassium concentrations. The products of the mean plasma protein concentration and mean plasma volume per unit body weight for Groups I and IV were similar.

Keys *et al.* (1950) reported that lethargy, reluctance to move except to eat and drink, and a disregard for personal hygiene, are typical reactions of the human subject undergoing dietary restrictions. It is of interest to note the close similarity between this behaviour pattern and that of the animals in Groups I and II. Lethargy and restriction of movement, both voluntarily and by confinement to yards, would minimise energy expenditure. If this was coupled with a similar reduction in basal metabolic rate as observed in humans, it would permit maintenance of life for protracted periods on a low energy intake. These factors may play an important role in the drought feeding of cattle. The virtual absence of normal coat licking by the animals in Groups I and II may be a reaction in bovines similar to the disregard for personal hygiene by humans during semi-starvation.

Hair cover measurements indicate that the animals in Group I did not shed their winter coat. The long hair on the animals in Group I could be readily detached from the skin, indicating that the mechanism causing removal of the hair was defective. The significance of licking and skin movement in the removal of this hair was not investigated.

Yeates (1955) has shown by reversible light experiments that coat shedding in well-nourished bovines is conditioned by length of daylight. The results of this and a similar experiment reported by Morris (1958a) indicate that the phenomenon of coat shedding is modified also by the plane of nutrition. These findings are in agreement with those reported by Yeates (1958).

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