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Grass Hay as a Maintenance Ration for Sheep During Winter.

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THE deficiencies of the winter grazing of the summer rainfall areas of the Union have often been stressed in publications from this Institute. Investigations [du Toit *et al* (1940); Smuts and Marais (1940); Louw and van der Wath (1943)] have shown that apart from the well-known phosphorus deficiency there also exists an acute shortage of protein and of energy. These last-mentioned deficiencies, energy probably more than protein, may be considered to be the primary cause of the highly emaciated condition of stock on pasture alone during winter. In this connection it may be of interest to refer to the finding [Louw (1938)] that grass which has grown undisturbed during the season until early in April contained only about 50 per cent. of the available energy present in grass at the grazing stage of growth. Dry winter pasture contains probably less available energy than the grass cut early in April.

As a result of the deficiencies of the winter pasture the animal is forced to draw upon its own body substance in order to provide the nutrients for carrying on a variety of internal processes which are essential to life. According to Smuts and Marais (loc. cit.) sheep husbandry can be established on a sound basis only when this breakdown of tissue which has been synthesized during summer is prevented by applying a judicious and economical method of supplementary winter feeding. If future research should prove this view to be essentially correct then the problem will resolve itself into providing the animal with a maintenance ration during the dry winter months. This object may be achieved by supplementing the available grazing with a feed such as maize, as suggested by Smuts and Marais (loc. cit.). The utilization of the excess summer growth of our grass pastures for the purpose of providing a maintenance ration for stock during winter is an alternative which could with advantage be explored, in view of the fact that this excess growth is in any case wasted if not preserved in a nutritious state. From the results of an investigation previously referred to [Louw (loc. cit)] it was concluded that veld grass should be cut at the flowering stage of growth for the purpose of preserving it in the form of hay to be used as a feed for winter or other times of food scarcity such as drought.

The object of the investigation to be reported on in this paper was to determine the amount of hay, from grass cut at the flowering stage of growth, necessary for the maintenance requirements of sheep during winter.

Experimental Details.

The grass hay used was kindly provided by the Division of Soil and Veld Conservation from its Research Station at Rietondale, Pretoria. It was made from a pure stand of the Zeerust strain of *Digitaria*, harvested at the flowering stage of growth. This hay was fed to a group of six full-grown Merino wethers, as their sole ration, in amounts just sufficient to maintain live weight. The sheep were shorn op April 9, and feeding of the experimental hay commenced on the next day. They were kept for the whole of the experimental period in separate feeding pens with concrete floors and measuring about (16 by 5) square feet, of which a third is under cover. In a preliminary feeding period lasting until May 26, the amounts of hay consumed were varied in accordance with changes in the body weights of the animals with the object of establishing the level of intake which would ensure approximately constant body weights. No difficulties were encountered in getting the animals to consume the required amounts of hay. In fact, the orts were for all the animals at no time more than about 4 per cent. of the total amount of hay offered and consisted of inedible material, such as the coarse woody stems of weeds and grass stubble.

The experimental feeding started on May, 26, and lasted until August, 6—a period of ten weeks. The animals were weighed once a week and a record kept of their food intake. Towards the end of the experimental period five of the sheep were placed in metabolism cages of the Forbes type and their faeces and urine collected for a period of 10 days. In addition to the usual analyses the gross energy contents of the feed, faeces, and urine were determined in a bomb calorimeter. The calorific value of the urine was obtained by evaporating to dryness at room temperature a total of 10·0 c.c. of urine, 2·0 c.c. at a time, on a weighed piece (about 1·5 grams) of filter paper of known calorific value and determining the gross energy content of the paper plus urine after it has been briquetted. These energy determinations and the computation of the methane output of the sheep from Armsby's factor of 4·5 grams of methane per 100 grams of digestible carbohydrates made an estimation of the metabolizable energy of the grass hay possible.

THE RESULTS.

The weekly weights of the individual sheep are given in Table 1. Inspection of the data shows that all the sheep maintained their body weights at an approximately constant level from May, 26, to August, 6.

TABLE 1.

Body Weight Records (in lb.) during Maintenance Experiment.

Date.	Sheep 1.	Sheep 2.	Sheep 3.	Sheep 4.	Sheep 5.	Sheep 6.
1942—						
May 26.....	82·5	75·0	76·0	72·0	74·5	77·5
June 2.....	82·0	74·0	77·0	71·0	74·0	76·0
,, 9.....	82·0	73·0	76·0	71·0	74·5	77·0
,, 16.....	83·0	73·5	75·5	71·0	74·5	75·5
,, 23.....	84·0	76·5	77·5	72·0	75·0	78·0
,, 30.....	82·0	76·0	77·5	72·0	73·0	79·0
July 7.....	83·0	75·0	78·0	71·0	74·0	77·0
,, 14.....	84·5	76·5	77·0	71·5	75·0	78·0
,, 21.....	81·5	74·0	74·5	70·0	75·0	77·0
,, 31.....	83·0	75·0	76·0	71·0	75·0	78·0
Aug. 6.....	82·5	72·0	74·0	70·5	74·0	76·5
Average.......	82·7	74·6	76·3	71·2	74·4	77·2

Small variations in weight did occur from week to week but there was no tendency for the weights of the sheep either to increase or to decrease progressively.

From the average coefficients of digestibility for the grass hay and its average chemical composition the average content of the hay in total and digestible nutrients was calculated, the results being given in Table 2. The computation of the metabolizable energy of the grass hay will be found in Table 3. It will be seen that on an average 41·7 per cent. of the energy consumed was metabolizable. This figure agrees very well with that of 42·6 for timothy hay as determined by American workers with steers in the respiration chamber where the loss of energy due to methane can be actually determined [see Mitchell *et al* (1928)].

TABLE 2.

Average Percentage Composition of the Grass Hay.

	Dry Matter.	Organic Matter.	Crude Protein.	Crude Fat.	Carbohydrates.*	Total Digestible Nutrients	Ash.	P.
Total	93·2	86·2	7·64	2·98	75·6	—	7·01	0·114
Digestible	50·4	47·5	4·33	1·48	41·8	49·46	—	—

* Carbohydrates = crude fibre + nitrogen-free extract.

TABLE 3.

Calculation of the Metabolizable Energy of the Hay.

Sheep No.	Dry Matter Consumed. (lb.).	Energy of Feed Consumed. (Therms).	Energy of Faeces. (Therms).	Energy of Urine. (Therms)	Energy of Methane.* (Therms)	Energy† Correction for Nitrogen Balance (Therms)	Total Metabolizable Energy. (Therms).	Metabolizable Energy as Per cent. of Gross Energy.	Metabolizable Energy per lb. Dry Matter Consumed. (Therms).
1	1·453	2·885	1·416	·121	·173	·003	1·172	40·6	·806
2	1·482	2·941	1·402	·116	·181	·006	1·236	42·0	·834
3	1·491	2·959	1·406	·128	·184	·005	1·236	41·8	·829
4	1·491	2·959	1·379	·125	·187	·006	1·262	42·7	·846
6	1·502	2·981	1·434	·128	·183	·005	1·231	41·3	·819
Average	—	—	—	—	—	—	1·227	41·7	·827

* One gram methane contains 13·34 Calories of gross energy.

† (7·45 × N—balance) Calories.

It is now possible from the figures for the average daily consumption of hay during the maintenance experiment and the data presented in Tables 1, 2, and 3 to make the final calculations of the experiment. This is done in Table 4. The maintenance weight of the individual sheep is simply the average of all the weekly weights in Table 1. The average daily ration given in column 3 of Table 4 refers to the amount of hay consumed during the period covered by the average maintenance weights. The metabolizable energy consumed daily (see column 4) was obtained by using the average result of the metabolism trial with five sheep. In the last two columns of Table 4 the average daily intake of feed and of metabolizable energy has been computed to 100 lb. body weight, using the ratio of the weights to the three-fourths power.

TABLE 4.

Maintenance Requirements of Sheep per 100 lb. Live Weight.

Sheep No.	Maintenance Weight. (lb.).	Average Daily Ration. (lb.).	Metabolizable Energy per Day (Cals.).	Average Daily Ration per 100 lb. Live Weight.	
				Hay. (lb.).	Metabolizable Energy. (Cals.).
1...............	82·7	1·720	1,325	1·984	1,528
2...............	74·6	1·687	1,300	2·102	1,619
3...............	76·3	1·710	1,317	2·094	1,614
4...............	71·2	1·710	1,317	2·206	1,699
5...............	74·4	1·727	1,330	2·155	1,661
6...............	77·2	1·725	1,328	2·094	1,613
Average.........	—	—	—	2·106	1,622

The nitrogen and phosphorus balances were also determined in the 10-day metabolism trial. All the sheep were found to be in positive nitrogen balance; the daily balance in grams nitrogen were 0·40, 0·82, 0·72, 0·81 and 0·62 for sheep Nos. 1, 2, 3, 4 and 6, respectively. In the same order for the 5 sheep the phosphorus balances were in grams P per day −0·072, +0·018, +0·015, +0·003, and −0·031.

DISCUSSION OF RESULTS.

According to the data in Table 4 a full-grown Merino wether weighing 100 lb. require daily 2·106 lb. hay, containing 1622 Calories of metabolizable energy, for maintenance during winter. As stated previously, this figure represents the average daily consumption of hay during a period in which the animals maintained their weight at an approximately constant level. Live-weight as the sole criterion in measuring the nutritive requirement for maintenance may be criticised on the ground that the constancy of weight does not necessarily imply the maintenance of the integrity of the body tissues. However, in the case of adult animals such as those employed in this experiment it may be assumed that a fairly accurate measure directly applicable to the conditions of practice is obtainable by the constant live-weight procedure.

The results obtained in this investigation with the hay from the *Digitaria* species cut at the flowering stage of growth agree well with data secured in experiments on similar lines by Mitchell *et al* (1926, 1928) in which the energy value of lucerne hay for the maintenance of sheep has been investigated. For western ewes, three to four years of age, they found that 1·917 lb. of lucerne hay containing 1864 calories of metabolizable energy were needed for maintenance per 100 lb. live weight. In another trial in which the experimental animals were western lambs, about 10 months of age, and in which a slaughter test was included, the daily requirements for maintenance per 100 lb. body weight were found to be 2·185 lb. of lucerne hay containing 1733 Calories of metabolizable energy. From several live-weight experiments on sheep Armsby (1917) computed their metabolizable energy requirement for maintenance at 1624 Calories per 100 lb. live-weight, a figure which is practically the same as that reported in this paper (cf. Table 4).

An interesting feature emerging from the above comparison of results is that a good quality grass hay such as that used in this experiment has more or less the same energy value as lucerne hay for the maintenance of sheep. This does not mean that lucerne hay may not be superior to the grass hay in other respects. It contains, for instance, more than twice as much protein as the grass hay. However, the non-nitrogenous energy value of lucerne is apparently so low that part of its protein has to serve as a source of energy in a maintenance ration.

Judging from the results of the metabolism trial the grass hay supplied slightly more protein than was necessary for maintenance. In the case of phosphorus the daily balances indicate that the animals were ingesting just about sufficient of this nutrient for their maintenance requirements.

Subject to the conditions under which this experiment has been conducted it may be concluded that hay, from grass cut at the flowering stage of growth, can successfully be used as a maintenance ration for sheep during winter. No supplements such as bonemeal are needed. Mention must, however, be made of the fact that the opportunities for exercise were rather limited as the sheep were confined, as stated previously, to individual feeding pens measuring about 16 by 5 square feet. In addition, the sheep could during cold and windy nights make use of the shelter offered by the feeding pens. Both of these factors may result in a measure which is an under-estimation of the maintenance requirements of sheep which have to roam about on the open veld for their feed supply. On the other hand, it was observed that during the latter half of the experimental period the sheep required about 7 per cent. less hay for the maintenance of constant body weight than during the first half. The explanation for this phenomenon may be somewhat as follows: Exposure of animals to cold air temperatures increases the loss of heat by radiation, especially if they have scanty coats. The heat lost in this way must be made good by the energy of its food if the animal is to maintain its live-weight at a constant level. The sheep used in this experiment were shorn, as stated, under "experimental details", on April, 9, forty-six days prior to the commencement of the experiment. It is conceivable, therefore, that during the latter half of the experiment, when their wool coats were thicker than at the start, the animals were able to maintain live weight on an amount of hay slightly less than the average for the whole experimental period, i.e., slightly less than the maintenance requirement as estimated in this investigation.

In any case, if a grass hay is to be used for the maintenance of sheep during winter it will probably be fed to them under conditions which will, in total effect, not differ markedly from those obtaining during the experiment reported in this paper. The data obtained have shown that from the nutritional point of view it is possible to utilize the excess growth of the summer months successfully for the prevention of weight losses in sheep during winter. The economic feasibility of such a scheme remains to be investigated under practical conditions.

Summary.

Constant live-weight has been used as criterion in measuring the maintenance requirement of adult sheep during winter. It has been found that an animal weighing 100 lb. requires 2·106 lb. of a grass hay, containing 1622 Calories of metabolizable energy, to maintain its weight at an approximately constant level.

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