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### The Effect of Sulphur upon the Weight and Wool Production of Sheep when Food Intake is not Limited.

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IN a recent article by du Toit *et al* (1935) it was concluded that a daily dose of 5 grms. of sulphur given over a period of twelve months was without significant effect on sheep kept on a productive ration but a limited intake. It follows, therefore, that the sulphur fed was without visible effect on the digestion and utilization of the food given, for neither the weight of nor the wool produced by the sulphur-fed group showed significant differences from that of the control group. It is obvious, however, that the experiment concerned would not have indicated increased food consumption and subsequent increased body weights and wool production should the feeding of sulphur to sheep stimulate appetite. An investigation was therefore begun in May, 1934, in which sulphur was given to sheep under conditions which did not limit the amount of food consumed but merely registered the individual intakes periodically.

#### EXPERIMENTAL DETAILS.

Twenty uniform twelve-months-old Merino ewes, divided by randomization into two groups of ten each were used in the experiment. As in the previous investigation the sheep were fed in individual feeding boxes daily from about 2 p.m. until 8.30 a.m. the following morning. All the food except greenfeed was given in two feeding-boxes, one for the hay and one for the maize. The amount of food given was such that some of it, i.e. both hay and maize, was left over. This procedure ensured maximum food consumption of each individual animal. The food left over was weighed back at intervals which were determined naturally by the poorest eaters whose feeding boxes showed the fastest accumulation of food. Whenever food was weighed back all the boxes were emptied even those in which only a small accumulation of food had taken place.

Greenfeed when given in the individual feeding pens was not taken well, probably partly due to the abundance of food present which necessitated the accumulation of some greenfeed, creating therefore, excellent conditions for deterioration. The sheep showed little inclination to take more than very small quantities of the greenfeed. Hence, shortly after the beginning of the experiment, the sheep were given greenfeed in a common trough replenished daily and to which they had free access when not in the individual feeding pens. This trough was placed in the paddock alongside that in which the feeding pens were built, and was protected from rain and sunshine. Under these conditions the consumption of greenfeed was found to be satisfactory and the practice was continued throughout the course of the experiment.

No special arrangements were made for exercising the sheep, but there was every reason to believe that the daily routine of the experiment, such as letting the sheep into and out of the feeding-pens, daily inspection in the common pen, driving the sheep to the weighbridge at intervals and incidental handling of the animals, provided sufficient exercise. Furthermore, the animals were run in a common pen when they were not in the feeding boxes. The size of this pen (25 by 12 yards) where, incidentally, the sheep always had access to drinking water, allowed the sheep to move about freely which also provided some exercise.

The animals were weighed at monthly intervals, individual food consumption was recorded, wool growth for the full period was registered, 5 grms. of flowers of sulphur made into a paste with water was given daily in a spoon to each animal in one group of ten animals while the remaining animals were kept as controls. The experimental period lasted from 28.5.34 until 27.6.35, when the dosing of sulphur was stopped but both groups kept under the experimental conditions for another four months. The sheep were tested periodically for the presence of intestinal worms and were always found to be practically free.

## EXPERIMENTAL RESULTS AND DISCUSSION.

### *Weights.*

The average weight-curves of the respective groups of sheep are given in the figure below and the individual weights are given in Table I.

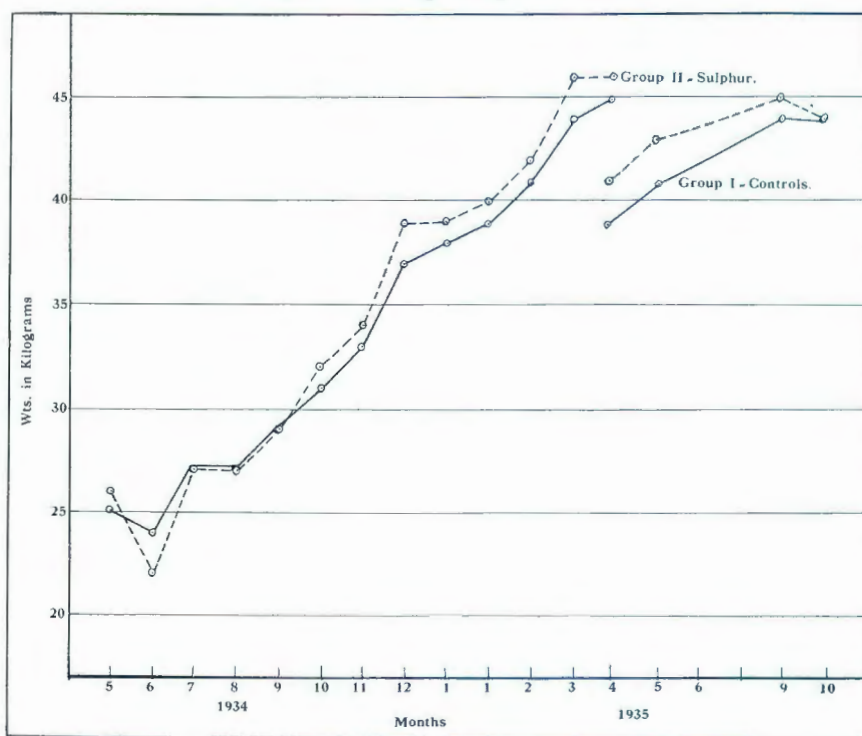
The weight curves given in Figure 1 exclude the possibility of a significant difference in weight between the group of sheep receiving a supplement of sulphur daily and the control group. The greatest average difference in weight between the two groups in the course of the experiment was 2 kgs., which was reduced to 0.3 kg. during the post experimental period. From the individual weights given in Table I it will be seen that apparently not a single sheep in the sulphur fed group reacted to sulphur feeding. As a matter of fact the heaviest sheep at the close of the experiment belonged to the control group and this animal was the heaviest throughout the latter half of the experiment. The sudden drop in weight during May, 1935, was due to shearing and is of course shown in both

curves. All the sheep in the experiment were in excellent condition throughout the course of the investigation as would be anticipated from a study of the weight curves and attained the really remarkable average weight for sheep of this type of approximately 100 lb. at two years of age.

*Food Consumption.*

As already stated food consumption was registered by weighing back periodically the food left over in the feeding boxes. Crushed yellow maize was fed in the one box and lucerne hay in the other while the greenfeed was given in a trough in the common paddock. The amounts of both maize and Hay given were such that some was invariably left over daily by practically all the sheep while the greenfeed was not consumed totally on a single occasion.

Fig. 1.—Average weight curves.



The amount of crushed maize given per sheep per day varied from 450 grms. at the beginning of the experiment to 500 and 600 grms. at later stages, with an average daily consumption of 500 grms. per day in group 1 for the entire period and 520 grms. in group 2. Likewise the hay consumptions per head per day were 160 grms. and 165 grms. respectively for groups 1 and 2. The low consumption of hay is naturally due to the abundance of concentrate given and taken. It would appear therefore that group 2, i.e. the group receiving a daily supplement of sulphur, ate slightly more

TABLE I: GROUP I: CONTROLS.  
Weights in Kg.

D.O.B.	1934.												1935.											
	21/5	22/6	24/7	20/8	21/9	26/10	26/11	31/12	4/1	23/1	23/2	22/3	23/4	28/5	28/5	27/6	28/9	28/10						
40251.....	23.6	23.1	27.2	28.5	26.7	30.3	28.5	31.2	33.0	33.9	35.3	36.2	39.3	40.7	35.7	38.0	39.8	36.6						
40252.....	25.3	22.7	25.8	25.8	26.3	29.4	29.4	36.2	35.7	33.0	36.6	36.2	41.1	41.6	33.9	38.4	38.9	38.4						
40253.....	26.7	25.3	28.5	29.4	30.3	33.9	36.2	40.7	41.6	40.7	42.0	45.8	47.6	51.3	45.4	45.8	49.4	50.0						
40336.....	23.6	22.7	25.8	26.3	30.8	29.9	33.5	37.1	37.5	35.7	18.4	39.8	44.3	45.4	40.2	41.6	45.4	45.4						
40255.....	21.3	18.6	21.8	23.1	24.0	25.8	27.6	30.8	32.1	31.2	32.6	34.8	38.0	38.4	32.6	34.8	36.6	38.0						
40256.....	24.9	22.7	26.7	27.6	29.4	30.3	32.1	34.4	35.3	34.4	34.4	36.2	37.1	39.3	33.5	35.7	38.4	38.0						
40257.....	31.7	29.5	30.8	28.1	31.2	33.0	35.3	36.6	38.0	38.4	40.7	42.0	45.4	45.4	39.3	38.9	40.2	43.4						
40258.....	24.5	24.5	27.6	28.1	30.8	31.7	34.8	38.4	39.8	39.3	42.0	43.8	47.2	50.0	43.8	44.7	47.6	48.1						
40259.....	23.6	23.1	26.3	25.4	28.5	31.7	32.6	38.4	39.3	37.5	38.0	41.1	43.8	42.9	37.1	41.6	43.4	45.4						
40260.....	28.5	23.6	29.9	29.0	33.9	36.2	38.4	42.9	45.4	44.3	46.7	50.9	56.7	56.7	51.8	52.7	55.4	57.5						
TOTALS.....	253.7	235.8	270.4	271.3	291.9	312.2	328.4	366.7	377.7	368.4	386.7	406.8	440.5	451.7	393.3	412.2	435.1	440.—						
AVERAGES.....	25.37	23.58	27.04	27.13	29.19	31.22	32.8	36.67	37.77	36.8	38.67	40.68	44.05	45.17	39.3	41.22	43.51	44.05						

TABLE I: GROUP II.  
Weights in Kgs. 5 grms. S. per day.

D.O.B.	1934.												1935.					
	21/5	22/6	24/7	20/8	21/9	26/10	26/11	31/12	4/1	23/1	23/2	22/3	23/4	28/5	28/5	27/6	28/9	28/10
40261.....	23.6	19.0	20.9	23.1	26.7	28.5	29.0	34.4	35.3	33.9	34.8	37.1	40.7	41.1	34.4	36.6	40.7	38.0
40262.....	28.1	20.4	26.7	26.3	27.2	31.7	32.1	38.9	41.1	39.3	42.5	46.7	50.0	50.9	45.4	47.2	43.8	45.4
40263.....	23.1	21.3	22.7	23.1	23.6	18.6	—	—	—	—	—	—	—	—	—	—	—	—
40343.....	29.9	29.0	32.1	30.8	34.8	37.1	38.9	41.6	42.0	41.1	43.8	45.8	48.5	48.5	44.3	45.4	46.3	47.2
40265.....	29.5	26.7	30.8	30.8	34.4	36.6	37.5	41.6	43.4	43.8	45.8	46.7	52.2	50.9	45.4	49.0	46.7	45.4
40266.....	25.3	20.4	25.8	25.4	27.2	31.7	32.6	41.6	37.1	37.1	38.4	39.3	42.5	41.1	35.7	39.8	40.2	41.1
40254.....	27.2	23.1	28.5	29.0	29.4	32.1	33.0	37.1	35.3	35.3	36.2	38.0	40.7	41.1	35.3	38.0	40.7	42.5
40268.....	25.8	19.5	24.0	25.8	27.6	31.7	33.5	33.9	38.9	37.5	38.4	40.7	44.7	39.8	45.4	45.4	45.4	45.4
40269.....	24.0	23.1	27.6	27.2	29.4	33.9	33.9	38.0	39.3	38.4	38.4	41.1	44.3	45.8	40.2	43.4	44.3	45.8
40333.....	27.2	19.9	28.1	29.4	31.7	34.8	36.2	39.8	40.2	40.2	42.9	46.3	47.6	50.9	45.4	45.8	—	48.5
TOTALS.....	263.7	222.4	267.2	270.9	292.0	316.7	306.7	346.9	352.6	346.6	361.2	381.7	411.2	415.0	365.9	390.6	348.1	399.5
AVERAGES.....	26.37	22.24	26.7	27.09	29.2	31.67	30.67	34.69	35.26	34.66	36.12	38.17	41.12	41.50	36.59	39.06	34.81	39.95

food than the control group. However, on submitting the data on food-consumption to statistical analysis it was found that the difference in intake between the two groups was quite insignificant. It must be concluded therefore that 5 grms. of sulphur given daily, except Sundays, to the sheep did not effect the appetite of the animals significantly and furthermore, that the utilization of food was unaffected by the sulphur in so far as weight increase of the animals could be used as a criterion of food utilization. The sheep consumed on an average about one pound of greenfeed daily.

It should be mentioned that the sulphur was dosed in the form of a paste. Fifty grms. of sulphur were weighed out, transferred to a screw-topped fruit-jar, enough water added to form a paste with the sulphur, the jar closed and the contents shaken vigorously. This method of preparing the paste was very successful, whereas it was exceedingly difficult to moisten the sulphur particles by stirring or gentle shaking in an open container. Dosing the dry powder was not found to be practicable for routine purposes over periods, as the animals easily inhaled the powder, while administering the sulphur through a stomach tube took too long. The paste was dosed in a spoon and with a little practice it was quite easy to transfer ten approximately equal quantities of paste from the common container holding 50 grms. to the animals' mouths.

#### Wool Production.

The sheep were shorn twelve months after the beginning of the experiment. The weights of the grease wool (unskirted) are given in Table II.

TABLE II.  
*Weight of Wool given in Kg.*

Nos. of Animals.	Control Group. (Kg. wool.)	Nos. of Animals.	Group receiving 5 gm. S. daily. (Kg. wool.)
40251.....	4.4	40261.....	5.3
40252.....	4.9	40262.....	5.0
40253.....	4.5	40263.....	—
40236.....	4.5	40343.....	6.2
40255.....	4.7	40262.....	4.8
40256.....	5.3	40266.....	4.3
40257.....	4.4	40254.....	4.5
40258.....	4.9	40268.....	4.5
40259.....	4.6	40269.....	4.5
40260.....	4.4	40333.....	5.4
AVERAGES.....	4.7	AVERAGES.....	4.9

Apparently the total yield of wool (not scoured) was not influenced by sulphur feeding. In view of the negative results of the detailed analysis of the wool of the sheep receiving a daily dose of sulphur in the earlier investigation (du Toit *et al* 1934) only the fleece weights were taken in this experiment. It was conclusively shown in the earlier work (van Wyk *et al* 1935) that sulphur feeding is without effect on the quality and quantity of the wool produced.

## DISCUSSION.

On comparing the weight increases of the two groups of sheep it will be noticed that the mean increases are reasonably equal there being only a difference of .11 kg. in favour of the sulphur fed group which is altogether insignificant. When allowance is made for the difference in food intake it is found that this adjustment does not make an appreciable reduction in the variance and that the adjusted difference of 2.2 kg. in favour of the control group remains quite insignificant.

In short, it may be said that the conclusion is justified that a daily dose of 5 grms. of flowers of sulphur is without effect on the bodyweight, food consumption and wool production of sheep. It seems necessary, however, to review briefly the work on sulphur feeding to sheep that has been published from this Institute in order to state the final conclusions clearly.

Steyn's investigations (1931, 1932, 1934 and 1935) were undertaken, as stated by him, to determine the quantity of sulphur that could be administered to young and full-grown sheep with safety over prolonged periods. Obviously, the body weights of the sheep could be registered with advantage and this was done accordingly. Furthermore, the sheep had to be shorn in the course of the experiment, and hence, the weights of the wool produced were recorded. It is abundantly clear from Steyn's publication (1934) that he fully realizes the unsuitability of his material to determine the nutritional value of sulphur when, naturally, increase in body weight, food consumption, effect on production, etc., are important considerations and if this information had been required his experiments would have been planned differently so as to ensure the registration of these observations for the collection of suitable data for justifiable and definite conclusions. At best, therefore, it can be said that the results of Steyn's original experiment (1931, 1932) seemed to suggest that sulphur when administered to mature sheep at the rate of 5 grms. once, twice or three times weekly, over prolonged periods stimulates increase in body weight and wool yield. In a subsequent experiment (Steyn 1935) 5 grms. of sulphur were administered daily to immature sheep without detrimental effect on body weight and on the wool production of the animals. As a matter of fact the differences in body weight and in the weights of the wool produced are significantly in favour of the sulphur fed animals. All the sheep were fed *ad lib.* as one group, which excludes a consideration of more efficient food utilization or increased food consumption of the sulphur fed when compared with the controls. Again, therefore, it can be said that this investigation suggested that sulphur feeding to sheep affects their bodyweights and wool production beneficially. What is, however, quite definite about this work is that sulphur administered in the doses stated did not affect the animals detrimentally.

Working upon the indications of Steyn's original experiments (1931, 1932) du Toit *et al* (1935) carried out an investigation with sheep to determine the nutritional value of sulphur. Five grms. of sulphur were dosed to each animal in a group of sheep daily while another group was kept as controls. The experiment was planned to satisfy the requirements of a feeding trial. The body

weights of the sheep were registered periodically, a productive ration was fed to the individual sheep in separate feeding boxes and the food consumption of the individual animals was recorded. The animals were kept on the basal ration for a twelve months pre-experimental period after which the sulphur was administered to the one group for a further twelve months. Both groups were of course still kept on the basal ration for the second period of twelve months. Wool was collected from all the animals in both groups, analysed and reported on by van Wyk, Botha and Bekker (1935). In view of the entire absence of any significant difference in body weight, food consumption and wool production of the sulphur fed group when compared with the control group the conclusion appears to be justified that a daily dose of 5 grms. sulphur did not effect the sheep significantly, when they were given a production ration.

The above experiment with sheep on a limited food intake obviously excludes a consideration of increased food consumption which might be an effect of sulphur feeding and hence the investigation reported on in the present paper under conditions of *ad libitum* feeding was undertaken. Again the experiment was planned, primarily with the object of determining the nutritional value of sulphur and fulfills the demands of a feeding trial.

As in the previous work no beneficial effect of sulphur feeding could be determined, nor was the food intake of the sulphur fed group significantly affected.

The main result of the Onderstepoort experiments on the effect of administering sulphur to sheep, could therefore be summarized as follows: Five grms. of sulphur can be given *per os* to sheep over prolonged periods without detrimental effects. The body weights, food consumption and wool production are apparently not significantly affected by the sulphur administered to the sheep.

#### ACKNOWLEDGMENT.

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