The Utilization of Low Quality Roughage by Sheep*

By P. K. BRIGGS†

UNDER semi-drought and drought conditions, large quantities of low-quality standing roughage are usually available throughout much of the pastoral country of Australia. Any economically sound method whereby this roughage can be utilised more efficiently would be of inestimable value to both the sheep and cattle industries.

Over the past four years, investigations have been carried out with large groups of Merino sheep, completely hand-fed under pen conditions, on drought rations comprising low-quality roughage and various supplements*. The work has reached a stage where large scale field studies should be undertaken, but already sufficient progress has been made to indicate methods of feeding large numbers of sheep in confined areas under severe drought conditions.

This paper deals with three of these experiments.

EXPERIMENTAL PROCEDURE.

Experiment 1 (1952-53).

One hundred and eighty well-fleshed six-tooth Merino wethers, averaging 74 lb. bodyweight, in nine matched groups each of 20 animals, were given free access to a cereal straw chaff ration containing 1.2 per cent. crude protein. This ration was fed in open troughs.

In addition to the basal ration, the following supplements were given: Urea, molasses, urea plus molasses, wheat, wheat plus urea, meat meal, a mixture of salt and bonemeal as a lick, and lucerne chaff. One group which served as a control received no supplement.

Experiment 2 (1953-54).

Eighty-seven full-mouthed Merino wethers, in fat condition and averaging 98 lb. bodyweight, were divided into four groups.

All sheep were given free access to a mixture of cereal straw chaff and wheaten chaff in self-feeders. The roughage mixture contained 3.5 per cent. crude protein.

The roughage ration of three of the groups was supplemented with the following mixture: Lucerne chaff 40, whole wheat 30, linseed meal 20, molasses 9, and cobaltised salt 1 part by weight. In addition, Vitamin A concentrate was added to provide 2,400 International Units per pound of mixture.

This concentrate mixture contained 18.9 per cent. crude protein and was fed separately in open trough to the three groups at daily, twice-weekly or weekly intervals at a level equivalent to 4.00 oz. per head per day. The fourth group served as a control and received no supplement.

The experiment was terminated after 26 weeks.

Experiment 3 (1954-55).

Four hundred and forty-eight two-tooth Merino ewe weaners, averaging 46 lb. bodyweight off shears, were divided into 22 groups. Eleven of the groups were given free access to a roughage ration of oaten straw chaff which contained

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*This work has been undertaken as part of co-operative drought feeding studies by the Division of Animal Health and Production, C.S.I.R.O., and the New South Wales Department of Agriculture in the Burdekin Drought Feeding Unit at the Veterinary Research Station, Glenfield, New South Wales. The investigations were supervised by Dr. M. C. Franklin and P. K. Briggs, of McMaster Laboratory, C.S.I.R.O., and Dr. G. L. McClymont, formerly of the Department of Agriculture, New South Wales.

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2.4 per cent. crude protein, and the remaining eleven groups were given free access to a roughage mixture of oaten straw chaff and wheaten chaff, which contained 3.5 per cent. crude protein. All roughage rations were fed from self-feeders.

Ten of the groups on each roughage ration received, in addition, the supplements listed below, whilst the remaining group received no supplement and served as a control. The five supplements fed were linseed meal, 3.14 oz.; lucerne chaff, 6.10 oz.; a concentrate mixture similar in composition to that used in experiment 2, 4.00 oz.; wheat, 3.14 oz. + 1.5 per cent, finely ground limestone; wheat, 3.14 oz. + urea 6.15 g. + sodium sulphate 0.15 g. + 1.5 per cent. finely ground limestone per head per day. In each roughage treatment the supplements were fed daily or twice-weekly.

The experiment was terminated after 24 weeks.

RESULTS

Experiment 1.

With the exception of the group which was given lucerne chaff at a rate of 5.0 oz. per head per day, heavy losses occurred in all other groups, which were then withdrawn from the experiment four weeks after commencement.

The lucerne chaff group continued for 144 days and the data are summarised in Table 1.

TABLE 1

SUMMARY OF PERFORMANCE OF MERINO WETHERS FED A LUCERNE CHAFF SUPPLEMENT

Number of days on experiment	0	32	60	74	88	102	117	130	144
Number of survivors	20	19	18	16	15	13	10	6	6
Mean bodyweight of six survivors (lb.)	76.3	78.1	79.5	76.6	75.2	71.2	69.4	70.6	72.7

The performance of this group indicates that the quantity of lucerne chaff supplied was insufficient for maintenance of bodyweight and the prevention of heavy losses of sheep.

The roughage was fed from open troughs and the considerable wastage which occurred made it impossible to obtain accurate data on the quantity of roughage consumed.

Experiment 2.

The results of the 1953-54 experiment are summarised in Table 2 and Figure 1.

TABLE 2

SURVIVAL RATE, ROUGHAGE CONSUMPTION AND WOOL PRODUCTION OF THE WETHERS IN EXPERIMENT 2

	Control No. Supplement	Interval of Supplementary Feeding		
		Daily	Twice Weekly	Weekly
Number of sheep per group	16	24	23	24
Survival rate per group after 26 weeks—				
Number	12	24	22	23
Percentage	75	100	95.6	95.8
Mean daily roughage consumption per group over 26 weeks (lb.)	0.99	1.58	1.47	1.25
Mean wool production per group (lb.)	5.19	6.69	6.50	6.25
Mean staple length of fleece per group (in.)	2.04	2.71	2.67	2.57

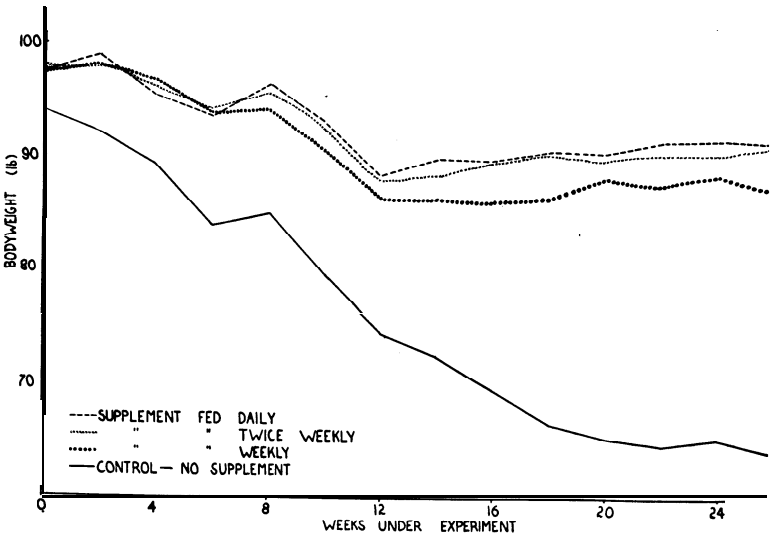

FIGURE 1: Comparative bodyweight performance of adult Merino wethers fed a basal roughage ration which contained 3.5 per cent. crude protein.

Three of the groups were given in addition a concentrate supplement containing 18.9 per cent. crude protein at the rate of 4.0 oz. per head per day.

The addition of the small quantity of concentrate supplement increased the roughage consumption and wool production, and resulted in a greater number of sheep surviving for the duration of the experiment (Table 2). The mean bodyweights of the supplemented groups were maintained at a level within 10 lb. of their initial weight, whereas the bodyweight of the control group fell steadily to a level which was 31 lb. below their initial weight.

The increased wool production of the supplemented groups was largely due to the greater staple length of the average fleece.

Experiment 3.

The results of the experiment are shown in Table 3 and Figures 2 and 3. The results of the daily and twice-weekly fed groups have been combined to give the data in Table 3 and Figures 2 and 3.

The unsupplemented groups on both types of roughage suffered heavy losses. The survivors in these groups lost considerable weight, their roughage consumption declined steadily throughout the experiment and their wool production was significantly lower than that of the supplemented groups.

By comparison, losses were much smaller and roughage consumption and wool production were greater in all supplemented groups. Linseed meal as a supplement gave consistently good results throughout all roughage treatments, and the concentrate mixture and lucerne chaff were also satisfactory.

Wheat grain was not satisfactory as a supplement when fed at the level of 3.14 oz. per head per day. The addition of urea and sodium sulphate to wheat grain inproved the performance of the sheep which were fed this supplement, but the method of feeding the urea-sulphate mixture (mixed with the grain in an open trough) was unsatisfactory. Seven sheep died in the four groups given this supplement in circumstances which suggested that urea poisoning was the principal cause of death.

ECONOMIC CONSIDERATIONS AND GENERAL CONCLUSIONS

The data from Tables 2 and 3 have provided the basis for the economic data in Tables 4 and 5. These data show that the provision of supplements

TABLE 3

THE EFFECTS OF VARIOUS SUPPLEMENTS ON THE UTILIZATION OF LOW-QUALITY ROUGHAGE BY MERINO WEANERS

Supplement	Oaten Straw Chaff **ad lib.** containing 2.4 per cent crude protein						Oaten Straw Chaff — Wheaten Chaff mixture **ad lib.** containing 3.5 per cent crude protein					
	Control No. Supplement	Linseed Meal	Lucerne Chaff	Concentrate Mixture	Wheat	Wheat + Urea + Sulphate	Control No. Supplement	Linseed Meal	Lucerne Chaff	Concentrate Mixture	Wheat	Wheat + Urea + Sulphate
No. of sheep per group	24	38	40	40	39	40	24	40	40	39	40	40
No. of survivors:												
Total	Nil*	36	30	29	21	26	9	39	38	38	29	31
Percentage	Nil	94.7	75.0	72.5	53.8	65.0	37.5	97.5	95.0	97.4	72.5	77.5
Mean bodyweight change over 24 weeks (lb.)	—	+2.7	—0.5	—1.4	—6.8	—3.9	—8.2	+5.5	+2.2	+1.5	—3.8	—0.7
Mean wool production (lb.)	—	3.19	3.00	2.87	2.37	2.56	2.44	3.75	3.12	3.25	2.88	3.19
Mean roughage consumption per day over 24 weeks (lb.)	0.67†	1.06	0.77	0.86	0.71	0.85	0.90	1.21	0.98	1.10	0.92	1.00

*The survivors, totalling 21 per cent. of the control group given roughage containing 2.4 per cent. crude protein, were removed from the experiment after 104 days. All these animals subsequently died before the end of the 24-week experimental period.

†Represents mean daily roughage consumption over first 104 days.

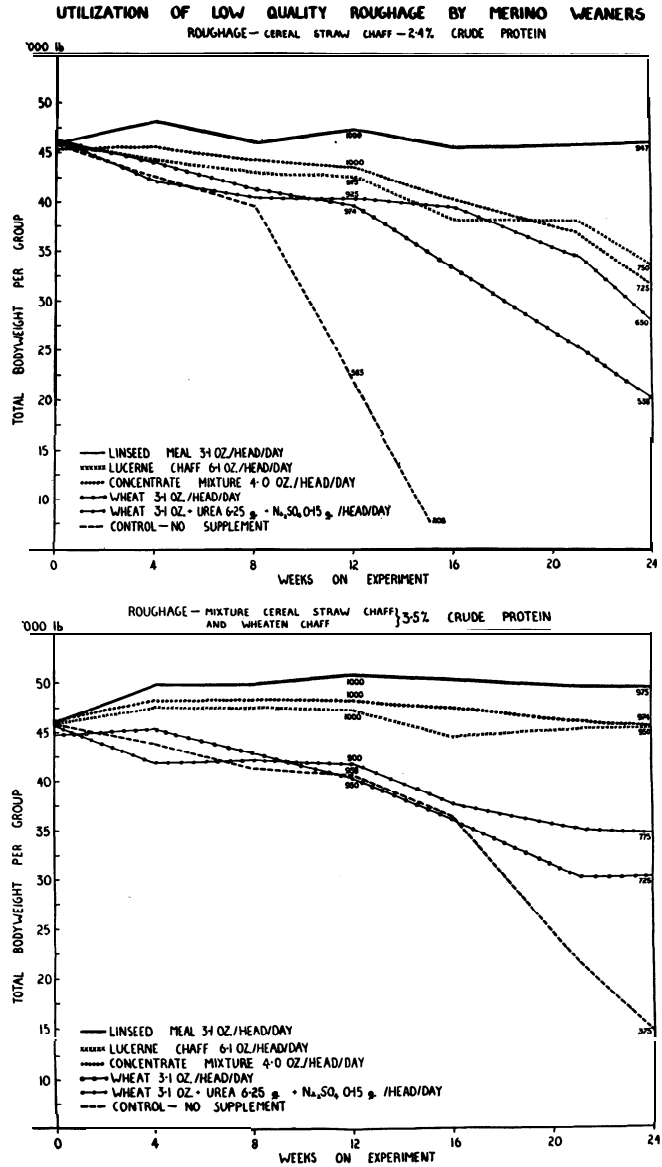

FIGURE 2: The bodyweight performance of merino weaners over a period of 24 weeks when fed various supplements in addition to low-quality roughage rations. The weights are calculated on the basis of 1000 sheep per group and the survivors at 12 and 24 weeks are shown.

(a) Basal roughage ration of oaten straw chaff containing 2.4 per cent. crude protein.

(b) Basal roughage ration of oaten straw chaff and wheaten chaff containing 3.5 per cent. crude protein.

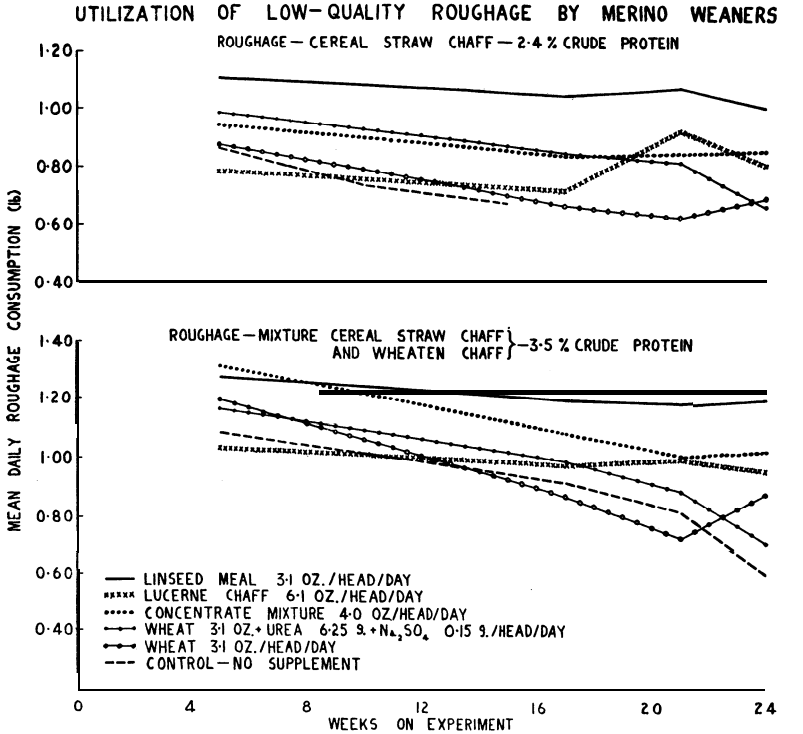

FIGURE 3: Mean daily roughage consumption of two-tooth ewes fed various supplements over a period of 24 weeks.

for both adult and weaner sheep under conditions similar to those used here is economically sound. The alternate approach of giving the sheep no supplements when there is only feed available of similar quality to the roughage used here would result in a heavy economic loss.

When the various supplements were given either at twice-weekly or weekly intervals in experiment 2, and twice-weekly in experiment 3, the results were equally as good as when the supplements were fed daily.

There was some evidence that the age of sheep and the quality ‘of roughage are important factors in determining the ability of sheep to utilise successfully low-quality roughage. The effect of age was evident in the performance of the control groups in experiments 2 and 3 on roughage which contained 3.5 per cent. crude protein, and the effect of quality was evident in the comparative performance of the two-tooth ewes given the two types of roughage in experiment 3. The relatively poor performance of the six-tooth wethers which were given the lucerne supplement in experiment 1 further supports the latter point.

Although these experiments were carried out in a confined area with relatively small numbers of sheep per group, they indicate a series of feeding techniques whereby losses of sheep and production could be reduced appreciably during a severe drought. This can be achieved economically by feeding relatively small quantities of supplements at periodic intervals.

Finally, it is obvious that these studies must be extended into the field where low-quality standing roughage is the only fodder available.

TABLE 4

THE ECONOMICS OF THE EFFECT OF A SUITABLE SUPPLEMENT ON THE UTILISATION OF LOW-QUALITY ROUGHAGE BY MERINO WETHERS

(Calculated on the Basis of 1000 Sheep per Group)

Supplement	Wheaten Chaff-Oaten Straw Chaff Mixture **ad lib.** Containing 3.5 per cent. Crude Protein	
	Control— No Supplement	4.0 oz. Concentrate Mixture per Head per Day*
Survivors after 181 days	750	972
Wool:		
Average weight per sheep (lb.)	5.19	6.38
Total weight per group (lb.)	3892	6201
Gross return at 72.8d. per lb.†	£1180	£1881
Loss from deaths at £3/10/- per head‡	£875	£98
Fodder eaten:		
Roughage (tons)	79.7	123.8
Concentrate mixture (short tons)	Nil	22.4
Fodder costs:§		
Roughage	£797	£1238
Concentrate mixture	Nil	£672
Total	£797	£1910
Total costs (181 days):—Fodder + deaths less wool return	£492	£127
Net cost per head based on survivors	13s. 2d.	2s. 7d.

*Based on composite data from groups given the concentrate mixture daily, twice-weekly and weekly (see Table 2 and Figure 1). The concentrate mixture contained lucerne chaff 40, whole wheat 30, linseed meal 20, molasses 9, cobaltised salt 1 part by weight plus 600 I.U. Vitamin A per 4 oz. of the mixture.

†Based on average Australian wool price for lo-month period ending 30th April, 1955.

‡Actual purchase price.

§Based on roughage £10 per ton; lucerne chaff £30/16/- per ton; wheat 16/- per bushel; linseed meal £45 per short ton; molasses £1/5/- per cwt.; salt 16/6 per cwt.

TABLE 5

THE ECONOMICS OF THE EFFECT OF VARIOUS SUPPLEMENTS ON THE UTILISATION OF LOW-QUALITY ROUGHAGE BY MERINO WEANERS

(Calculated on the Basis of 1000 Sheep per Group)

	Oaten Straw Chaff **ad lib.** Containing 2.4 per cent. Crude Protein						Wheaten Chaff-Oaten Straw Chaff Mixture **ad lib.** Containing 3.5 per cent Crude Protein					
Supplement*	Control	Linseed Meal	Lucerne Chaff	Concentrate Mixture	Wheat	Wheat + Urea + Sulphate	Control	Linseed Meal	Lucerne Chaff	Concentrate Mixture	Wheat	Wheat + Urea + Sulphate
Survivors after 167 days	Nil¶	947	750	725	538	650	375	975	950	974	725	775
Wool—												
Average weight per sheep (lb.)	—	3.19	3.00	2.87	2.37	2.56	2.44	3.75	3.12	3.25	2.88	3.19
Total weight per group (lb.)	—	3021	2250	2081	1275	1664	915	3656	2964	3165	2088	2472
Gross return at 72.8d. per lb.†	—	£916	£682	£631	£387	£505	£278	£1109	£899	£960	£633	£750
Loss from death at £3/8/- per head‡	£3400	£180	£850	£935	£1570	£1190	£2125	£85	£170	£88	£935	£765
Fodder eaten—												
Roughage (tons)	35.9	73.9	57.9	63.7	53.7	63.1	70.1	89.5	73.3	83.9	68.2	74.4
Supplement (short tons)	Nil	16.0	29.3	19.8	14.2	15.8	Nil	16.3	31.2	20.8	14.6	15.1
Fodder costs—§												
Roughage	£359	£739	£579	£637	£537	£631	£701	£895	£733	£839	£682	£744
Supplement	Nil	£720	£806	£594	£379	£487	Nil	£733	£858	£624	£389	£464
Total	£359	£1459	£1385	£1231	£916	£1118	£701	£1628	£1591	£1463	£1071	£1208
Total costs (167 days):— Fodder + deaths less wool return	£3759	£723	£1553	£1535	£2099	£1803	£1911	£604	£862	£591	£1373	£1223
Net cost per head based on survivors	—	15s. 3d.	£2-1-5	£2-2-4	£3-18-0	£2-15-6	£5-1-11	12s. 5d.	18s. 2d.	12s. 2d.	£1-17-11	£1-11-7

*The supplements were fed at the following levels: Linseed meal 3.1 oz.; lucerne chaff 6.1 oz.; concentrate mixture 4.0 oz. (see footnote to Table 4 for composition of concentrate mixture); wheat 3.1 oz.; and wheat 3.1 oz. plus urea 6.25 g. plus Na_2SO_4 0.15 g. per weaner per day.

†Based on average Australian wool price for 10-month period ending April 30, 1955.

‡Actual purchase price.

§Based on roughage £10 per ton; linseed meal £45 per short ton; lucerne chaff £30/16/- per ton; concentrate mixture £30 per ton; wheat 16/- per bushel; urea 9 pence per lb.; sodium sulphate 6/6 per lb.

¶The survivors, totalling 21 per cent. of the control group with access to roughage containing 2.4 per cent. crude protein were removed from the experiment after 104 days. None of these animals subsequently survived the full 167-day experimental period.

DISCUSSION OF PAPERS BY PROFESSOR G. L. McCLYMONT, MR. F. C. SERGEANT AND MR. P. K. BRIGGS.

Dr. FRANKLIN: As a result of his analysis of supplementary feeding experiments, would Professor McClymont advocate that supplementary feeding should not be practised nearly as extensively as is the case at present? This might be a dangerous policy to advocate in Australia where most would agree that supplies of conserved fodder are inadequate, and their conservation and increased use should be encouraged. Also one must not lose sight of the fact that while supplementary feeding may not give significantly greater gains than with unsupplemented animals, the former practice may permit an earlier turn-off of stock from a property. It is often difficult to assess accurately the actual economic gains of supplementary feeding.

ANS.: This paper made special reference to supplementary feeding for production.

Dr. FERGUSON: Referring to Professor McClymont's point that supplementary feeding leads to equivalent decreases in pasture consumption. Some 12 years ago I carried out an experiment on the supplementary feeding of concentrate to dairy cows. Here increasing responses were obtained to increasing levels of concentrate feeding. Under price conditions then ruling the greatest profit was obtained with a level of 2.0 lb. concentrate per gallon of milk. The responses may well have been less if roughage had been used as the supplement.

Mr. BOTT: When feeding stud bulls on lush irrigation pastures a gain of 100-200 lb. at 12 months seems to be obtained by working them up to 6 lb. concentrate per day at 12 months of age. Would Professor McClymont care to comment?

ANS.: I agree it is possible to get a response if one is prepared to feed enough supplement.

Mr. COTSELL: (Professor McClymont). Apart from economics, would the status of the basic grazing material affect the results of the addition of supplement? By basic grazing I refer to (1) rough natural pastures and (2) sown pastures..

ANS.: The answer to this is the reduced intake by sheep from the pastures when they were given supplementary feeding.

Dr. REID: (Professor McClymont). I should like to ask two questions: (1) Sheep tend to chose the constituents of their diet on a physical basis. For example, sheep on concentrates will readily consume sawdust; sheep on purified diets will avidly consume their straw bedding. If supplements were offered in a concentrated form would the physical deficiency induce sheep to eat roughage? (2) Cattle being strip-grazed tend to reduce their grazing time after a period to 75% of their original time. It has been suggested that this is due to the fact that they learn they are to go on to a fresh strip next morning and thus do not work hard for the last of the feed on the strip.

ANS.: Sheep being fed 100 per cent. grain ate less than those fed 50:50 concentrate hay.

Mr. BELL: Has Mr. Briggs or any of the other speakers had any experience with spraying standing roughage or stubble with molasses or molasses and urea? Secondly, would urea used in solution be a dangerous way to employ it?

Mr. BRIGGS: I have had no experience. Some South African workers have claimed some success with roughage steeped in molasses and urea.

With regard to your second question - yes, urea in solution may be dangerous. Investigations at Toorak Field Station, Department of Agriculture and Stock, North Queensland, showed that where high urea sheep nuts were made into a slurry and given to sheep as a drench, losses were quite high and death occurred quite rapidly. Wheat, plus urea, gave wool growth as good as lucerne chaff in the 1954-55 experiments, but the method of feeding the urea was not fully satisfactory.

Mr. SERGEANT: With reference to this last point, when urea was carelessly mixed in stock feeds in U.S.A., there were some losses of stock in dairy herds using the feed.

Professor McCLYMONT: South African investigators fed urea to sheep and got no response. Similarly they obtained no response to the feeding of sodium nitrate. When both urea and nitrate were fed together a significant growth response was obtained.

Mr. C. H. S. DOLLING (Mr. Briggs). Were fibre diameter measurements made or the wool from the sheep in the Burdekin drought feeding experiments?

ANS.: No.

Mr. ROE: (Mr. Sergeant). Work carried out at the Ohio Agricultural Experiment Station, U.S.A., showed that where cattle were given a cobalt supplement when fed low-quality hay their response was equal to that of other cattle on good-quality hay. Would Mr. Sergeant care to comment?

ANS.: There are numerous examples from America on improving the utilization of low-quality roughages. Cobalt was used in the Purdue cattle supplement and I believe that it was considered essential. Molasses and lucerne ash supplements gave the same results.

Mr. de VEAN: (Mr. F. C. Sergeant). Stilboestrol (hormone) treatment by mouth has been associated with more efficient feed utilization and greater gains in weight. This is not apparent in your results. Could you give any explanation?

ANS.: Stilboestrol has given good results in feed-lots with cattle, as for example, at the Iowa Experimental Station, U.S.A., but with high roughage low concentrate rations no response has been obtained.

Mr. KNIGHT: It appears that animal behaviour can be important in the success of supplementary feeding under paddock conditions. To illustrate this the following three instances are given:

1. To offset mis-mothering of young lambs due to ewes rushing to feed, a change to night feeding proved effective — the ewes coming on to the feed with their lambs early in the morning.
2. Grain fed through a superphosphate spreader and broadcast on the ground offset the tendency for sheep to hang about the feeding places and encouraged them to graze the paddocks.
3. Concentrate pellet feeding of the sheep in the paddocks wherever they were grazing at the time of feeding helped to offset the tendency to wait around feeding areas.

Mr. MURPHY (Mr. Sergeant). The low-quality roughage used at Belabula Farms was more "poor type" than "low-quality" — it contained 16 per cent. crude protein and was made up mainly of various weed species with an admixture of considerably less than 50 per cent. lucerne. As a standing crop it was more or less useless and had to be harvested to permit the lucerne to come through. What is important is that this poor type roughage could be put to profitable use.

Would Mr. Sergeant care to comment on the economics of reducing this type of roughage and other similar types to a meal form?

ANS.: The question of economics is bound up with factors other than feed value. Capital costs of machinery to mill this type of feed would be approximately £ 2,000.