OBSERVATIONS ON SELENIUM DEFICIENCY OF LAMBS IN VICTORIA

By K. D. SKERMAN *

Summary

Selenium deficiency in lambs on a farm at Launching Place, Victoria, was demonstrated by significant growth responses to selenium treatment.

The trend in results of subsequent experiments on this farm indicated that the minimum effective dose for lambs dosed each week by mouth was about 0·1 mg Se. This dose also appeared to be close to the optimum weekly dose. Results indicated that for higher doses of 5 • 0 mg Se the interval between doses could be extended to about six to eight weeks.

There was a trend for growth responses to be greatest in late autumn to early winter months.

No adverse effects were apparent in lambs dosed with 1·0 or 5·0 mg Se each week for fifty-four weeks.

I. INTRODUCTION

Selenium has recently assumed importance in animal health with the discovery that selenium supplementation of ewes or lambs effectively prevents muscular dystrophy or white muscle disease in lambs (Muth, Oldfield, Remmert, and Schubert 1958; Drake, Grant, and Hartley 1959). Of further importance to animal production has been the discovery that selenium is essential to normal growth of lambs (McLean, Thomson, and Claxton 1959) and corrects a type of ill-thrift in lambs (Drake, Grant, and Hartley 1959; Oldfield, Muth, and Schubert 1960). Growth responses to selenium have also been demonstrated in calves (Jolly 1960).

This paper reports the occurrence of selenium deficiency of lambs in Victoria, and presents results of studies on selenium supplementation of lambs and their growth responses.

II. INITIAL OBSERVATIONS

Controlled experiments were initiated in April 1959 on three farms in different locations in Victoria to determine whether ill-thrift in weaner lambs was due to selenium deficiency. Lambs in treated groups were dosed with 5·0 mg Se as an aqueous solution by mouth at intervals of one to two weeks. The response was measured by comparing bodyweight gains of treated and untreated lambs. The results (Table 1) showed a highly significant response in the first experiment, a slight but not significant response in the second, and no response in the third experiment. The lambs that showed a significant response were Southdown-Romney Marsh crossbred wethers about eight months of age on a farm at Launching Place, Victoria. These lambs had failed to respond to cobalt treatment in the few months prior to this experiment. The pastures they grazed were

* Nicholas Institute for Medical and Veterinary Research, Sherbrooke, Victoria.

TABLE 1

MEAN BODYWEIGHTS OF LAMBS TREATED WITH SELENIUM AND UNTREATED LAMBS IN THREE EXPERIMENTS

Experiment No.	Treatment	Number of Lambs in Group	Mean Bodyweight (lb) at Week of Experiment					
			Initial	2	4	6	8	16
1	Treated	18	59·6	—	68·3	70·2*	72·9†	—
	Control	18	59·5	—	65·3	66·1	67·9	—
2	Treated	20	55·5	—	58·9	—	63·2	—
	Control	20	55·5	—	57·6	—	61·7	—
3 Rams	Treated	8	50·5	53·1	49·6	52·6	53·7	73 ·4
	Control	8	51·5	53·9	50·9	53·5	54·3	74·7
Ewes	Treated	8	49·2	49·5	47·9	49·7	50·9	64·2
	Control	8	49·9	50·2	48·5	50·4	51·2	64·8

* The difference is significant ($P < 0{\cdot}05$).

† The difference is highly significant ($P < 0.01$).

predominantly perennial ryegrass and white clover that had been established on virgin land of high clay content within two to three years prior to the experiment.

Treated lambs gained 13 ·3 lb per head in eight weeks compared with 8 ·4 lb per head gain by control lambs. Thus the existence of selenium deficiency in lambs in Victoria was demonstrated.

III. OBSERVATIONS ON THE MINIMUM EFFECTIVE DOSE FOR CORRECTION OF SELENIUM DEFICIENCY IN LAMBS

Three weeks after selenium deficiency in lambs was demonstrated at Launching Place, Experiment 4 was commenced on the same farm to obtain data on the selenium requirements of lambs. Previous work in New Zealand has indicated that 1·0 to 5·0 mg Se at intervals of about ten days was effective, and early indications were that frequent dosing was necessary. Four comparable groups each of fourteen wether lambs about 11 months of age and weighing about 64 lb were treated each week with doses of 0·05, 0·1, 1·0, or 5·0 mg Se, and their weight gains were compared with groups given 5 ·0 mg Se once only or no treatment. The results (Table 2) showed that, with the exception of lambs given 0·05 mg Se weekly, treated lambs made better weight gains than untreated lambs. The greatest gains were made bv lambs given 0·1 mg weekly, but gains by these lambs were not significantly better than gains of untreated lambs. The trend of the results indicated that the optimum weekly dose was close to 0·1 mg Se for lambs on this farm. Doses of 5 ·0 mg Se given each week were not superior to a dose of 5·0 mg Se given once only, suggesting that dosing at weekly intervals was unnecessarily frequent. Overall, the responses were less rapid and less substantial than the response in Experiment 1 on this farm. It was suspected therefore that the deficiency was marginal or seasonal.

TABLE 2

INITIAL MEAN BODYWEIGHTS AND PROGRESSIVE MEAN GAINS (lb) OF LAMBS DOSED WITH SELENIUM AT DIFFERENT RATES AND INTERVALS AND OF UNTREATED LAMBS (EXPERIMENT 4)

Treatment	Initial Mean Bodyweight	Mean Gain at — Week of Experiment					Difference* from Controls
		1	5	8	12	18	
Controls	65·2	1·8	8·7	16·1	32·9	51·7	—
0·05 mg Se weekly	63·6	2·1	8·0	16·3	31·6	50·8	—0·9
0·1 mg Se weekly	63·4	2·1	9·6	18·5	36·3	56·5	+4·8
1·0 mg Se weekly	64·1	2·2	9·6	18·1	33·9	55·6	+3·9
5·0 mg Se weekly	64·1	3·3	10·0	17·3	34·3	54·3	+2·6
5·0 mg Se once	64·1	3·2	10·5	17·7	34·1	54·4	+2·7

* None of the differences reached statistical significance.

IV. OBSERVATIONS ON SEASONAL VARIATIONS IN RESPONSES OF LAMBS TO SELENIUM

Experiments 1 and 4 at Launching Place were done between April and December 1959. Experiment 5 was commenced in January 1960 on the same farm. Treated lambs showed an immediate response, but after some weeks it became apparent that the response was of about the same magnitude as that recorded in the second experiment. It was suspected that untreated lambs might have been obtaining a significant portion of the minute amount of selenium required for growth through contamination of the pastures with selenium excreted in the urine of treated lambs. Experiment 6 was therefore commenced in May 1960, using lambs grazing pastures on a different watershed on the opposite side of a stream traversing the farm. Experiments 5 and 6 done between January and November 1960 resulted in non-significant growth responses similar to those in Experiment 4. A dose of 5·0 mg Se once appeared to be as effective as 5·0 mg monthly in these experiments.

In January 1961 a controlled experiment was commenced on the same farm to measure the growth responses of lambs treated with two different anthelmintics in comparison with growth of untreated lambs. In the first thirteen weeks the overall growth of lambs was poor, even though the worm burdens of lambs treated with anthelmintics were greatly reduced. Selenium deficiency was suspected as the cause of retarded growth. The groups were subdivided, and half of each group was dosed with 5·0 mg Se at intervals of four and a half weeks (Experiment 7). An immediate and significant growth response occurred within nine weeks in the lambs receiving one anthelmintic, but no response occurred in the other groups (Table 3). This response was recorded between April and June 1961.

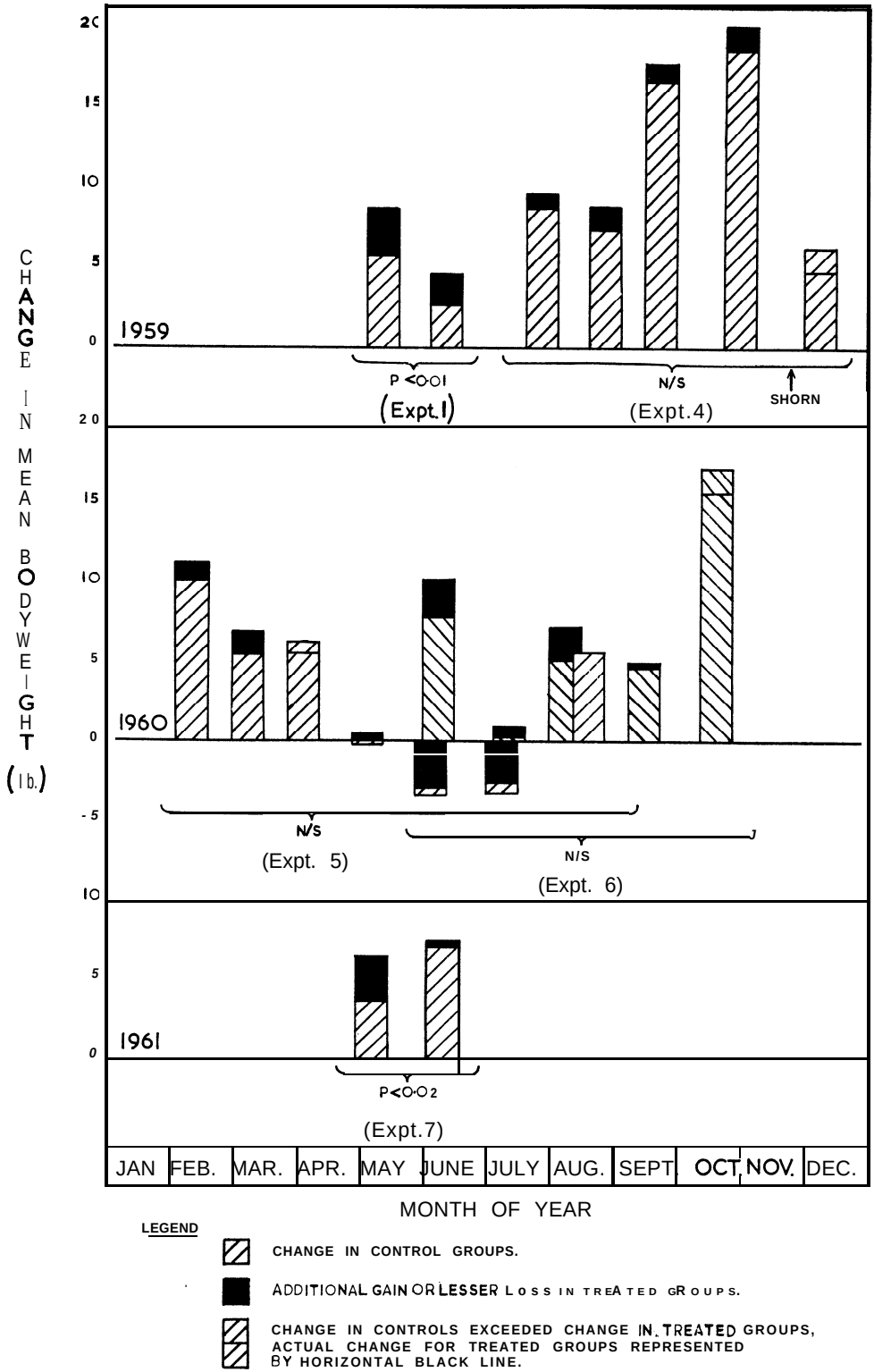

Fig. 1—Seasonal trends in growth responses of lambs to selenium in five experiments on one farm. Each column represents the mean change in bodyweight for periods of about four weeks. In Experiment 4 the treated group that showed the greatest response is recorded here. Note different cross-hatching to differentiate Experiments 5 and 6.

TABLE 3

MEAN BODYWEIGHTS AND GAINS OF LAMBS TREATED WITH SELENIUM AND UNTREATED LAMBS IN AN EXPERIMENT ORIGINALLY DESIGNED TO MEASURE GROWTH RESPONSES TO ANTHELMINTIC TREATMENTS

(EXPERIMENT 7)

Original Treatment	Treated with Selenium	Number of Lambs	Mean* Bodyweight (lb)	Mean Gain (lb) at — Weeks 4½	9
Nil	—	17	59·0	3·8	11·0
	+	18	56·8	4·5	10·5
Anthelmintic A	—	17	56·6	4·6	11·5
	+	18	56·6	5·2	11·0
Anthelmintic B	—	17	59·3	3·6	10·6
	+	18	58·9	6·5†	13·9‡

* At commencement of selenium investigation.

† The difference in favour of selenium treatment is significant ($P < 0·05$).

‡ The difference is of increased significance ($P < 0·02$).

The results of all experiments on this farm are shown in Fig. 1. There is a strong suggestion that deficiency on this farm is seasonal, the greatest responses occurring in late autumn to early winter. The lack of a significant response at this time in 1960 may be ascribed to particularly inclement weather, during which all lambs lost weight. Also of interest is the fact that in three of the five experiments the response was most marked in the first month of the experiment.

V. THE TOXICITY OF REPEATED DOSES OF SELENIUM FOR LAMBS

Six lambs from each group that had been dosed with 0·1, 1·0, or 5·0 mg Se each week in Experiment 4 were brought to the pastures at the laboratory at conclusion of the experiment. The weekly dosing of treated groups was continued for a total of fifty-four weeks for toxicity observations. In this period no clinical abnormalities or adverse effects on growth resulted from repeated doses. All of the lambs were then slaughtered. No visible pathological lesions were seen in treated lambs. On histopathological examination of tissues, a periphero-lobular fatty metamorphosis in livers of treated lambs, not present in livers of control lambs, was the only change that could be attributed to repeated dosing with selenium.

VI. DISCUSSION

Selenium deficiency in lambs was demonstrated on one of the first three farms in Victoria on which its existence was investigated. This suggested that investigation of its existenc in other States was warranted, especially in areas where weaner lambs fail to thrive. Also, because of the association of selenium and muscular dystrophy in other countries, it appeared that muscular dystrophy might also be encountered here.

Muscular dystrophy has not yet been demonstrated at Launching Place, Victoria, but it has recently been recorded in lambs in New South Wales (Walker, Harris, Farleigh, Setchell, and Littlejohns 1961) , in Victoria (Christie 1961) , in

Western Australia (Gardiner 1961), and in Queensland (M. D. McGavin, I. D. Baynes, and B. A. Woolcock, personal communication, 1961). Lambs in affected flocks have shown significant growth responses to selenium in New South Wales and Queensland, and an initial temporary response was recorded in Victoria. Thus, selenium is assuming importance in animal health and production in widely separated areas in Australia.

In all of our experiments the selenium was given in aqueous solution by mouth. It is also effective given by subcutaneous injection (McLean et *al.* 1959; Drake *et al.* 1959; Oldfield *et al.* 1960).

Experiments were done to determine the minimum weekly dose of selenium effective for growth promotion in lambs, and to determine whether larger doses given less frequently would be equally effective. In these experiments the additional gains due to treatment did not reach significance. However, the trend in results indicated that 0·1 mg Se was close to both the minimum and the optimum weekly dose, and a single dose of 5 mg Se gave comparable results for about six to eight weeks. These trends agree closely with results of similar studies in New Zealand, in which the lowest dose reported as effective, namely 0·63 mg Se given at fortnightly intervals was equal to higher doses, and a single dose of 5 mg was regarded as effective for two to three months (Hartley 1961) .

Overseas workers have used sodium selenite or sodium selenate as the source of selenium. At Launching Place selenium dioxide was used. Thus these three selenium compounds have been shown to be effective for growth of lambs. In toxicity trials (unpublished data) oral doses, as expected, were less toxic than subcutaneous injections, and selenium dioxide was less toxic than sodium selenite or sodium selenate when administered either orally or by injection. The chronic toxicity study reported briefly here indicates that no untoward effects are likely to result from the doses of selenium currently recommended for sheep by New Zealand workers (Hartley 1961) .

VII. ACKNOWLEDGEMENTS

The author is indebted to owners who made sheep and facilities available for these studies, particularly to Mr. S. Ricketson of Launching Place, Victoria. Histological examinations were done by Mr. J. M. Bourke, B.V.Sc., and technical assistance was given by Messrs. R. M. Deacon and P. W. Versteege.

VIII. REFERENCES

CHRISTIE, B. R. (1961).—Paper presented at 182nd General Meeting, Victorian Division, Australian Veterinary Association, Melbourne, September, 1961.

DRAKE, C., GRANT, A. B., and HARTLEY, W. J. (1959).—*Proc. Ruakura Farmers Conference. Week,* Hamilton, New Zealand.

GARDINER, M. R. (1961).—*J. Agric. Western Aust., 2* (4th series): 497.

HARTLEY, W. J. (1961).—*Proc. Ruakura Farmers Conference Week,* Hamilton, New Zealand.

JOLLY, R. D. (1960).—*New Zealand vet. J. 8:* 13.

MCLEAN, J. W., THOMPSON, G. G., and CLAXTON, J. H. (1959).—*New Zealand vet. J. 7: 47.*

MUTH, O. H., OLDFIELD, J. E., REMMERT, L. F., and SCHUBERT, J. R. (1958) . - *Science.* **128** : 1,090.

OLDFIELD, J. E., MUTH, O. H., and SCHUBERT, J. R. *(1960).-Proc. Soc. Exp. Biol. and Med.* **103**: 799.

WALKER, D. J., HARRIS, A. N. A., FARLEIGH, E. A., SETCHELL, B. P., and LITTLEJOHNS, I. R. *(1961).-Aust. vet. J. 37:* 172.