SELENIUM AND EWE FERTILITY

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SUMMARY

Some aspects of the beneficial effects of selenium on a specific nutritional form of lowered reproductive capacity in ewes are described.

The barren ewe problem can be eliminated by a single dose of from 1 to 25 mg Se given one month prior to joining with the rams.

The infertility results from embryonic mortality between three and four weeks post-conception.

Under the conditions of the trial neither the antioxidant, Santoquin, nor the vitamin E preparation, Rovimix E, prevented selenium-responsive infertility.

INVESTIGATIONAL WORK carried out in New Zealand during the last five years has shown that selenium is an essential nutrient for the prevention of certain disease conditions in sheep, cattle, pigs and poultry. One of these entities is lowered reproductive capacity in the ewe. This paper reviews briefly the published work on that subject and outlines the results of recent trials.

A high seasonal incidence of barren ewes, often in association with heavy neonatal lamb losses, has been known for a number of years to occur in parts of inland Otago. In 1958 congenital white muscle disease was widespread in that area and in parts of Canterbury, and a survey showed that there was a positive correlation between the presence of this entity and a high incidence of barren ewes (Grant *et al.*, 1960).

In addition to the areas in which congenital and sometimes delayed white muscle disease were important causes of neonatal lamb losses, a high incidence of barren ewes was also experienced on the pumice soils in the Rotorua-Taupo area. In that area congenital and delayed white muscle disease were of limited importance as a cause of losses. However, selenium-responsive unthriftiness was widespread in lambs.

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Controlled trials carried out in 1959 in both islands clearly showed that selenium administration to the ewes one month prior to joining with the rams and repeated monthly up to lambing dramatically reduced the incidence of barren ewes, thereby substantially increasing lambing percentages (Hartley and Grant, 1961).

The more recent investigations have been designed to:

(1) Ascertain the minimal rate of selenium administration required to prevent the barren ewe problem.
(2) Study the effect of selenium on the lifetime performance of ewes (fertility being one of the factors under observation).
(3) Obtain further information on the nature of the infertility.
(4) Compare an antioxidant and α-tocopherol with selenium in the prevention of the infertility.

DOSE LEVELS OF SELENIUM

During the 1960 and 1961 lambing seasons, trials were carried out in the Rotorua-Taupo area on groups of up to 200 three- to five-year-old Romney ewes that had not received selenium previously.

The selenium was given as a solution of sodium selenite by mouth as follows: (1) Once only — one month prior to joining with the rams. (2) Twice — one month before joining and one month prior to lambing. (3) Three times — one month before joining, one month after joining, and one month before lambing. (4) Monthly — from one month prior to joining until one month prior to lambing. All rams received 5 mg Se orally once one month prior to joining with the ewes. The ewes in each trial were mated together and run together until just before lambing when the various treatment groups were segregated and lambed separately. All dead lambs up to docking were autopsied for evidence of white muscle disease. Tables 1, 2 and 3 give the salient details of these trials.

It can be seen that all selenium treatments increased lambing percentages and decreased the number of barren ewes. A dose as low as 1 mg Se (Table 3) appeared sufficient while 25 mg Se given three times had an apparent slight depressant effect (Table 2).

In all these trials there was a greater percentage of lambs born to ewes lambing in the selenium treated groups as compared with the controls.

TABLE 1: SELENIUM AND EWE FERTILITY 1960 (WAIRAKEI)
(100 ewes per group)

	3 × 5 mg Se	*Control*
Dry dry ewes (%)	10	9
Lambs born/Ewes lambing (%)	134.8	120.0
Lamb mortality (%)	10.8	14.8
Lambs docked/Ewes mated (%)	108.1	92.9

TABLE 2: SELENIUM AND EWE FERTILITY 1960 (TAUPO)
(200 ewes per group)

	3 × 25 mg	1 × 25 mg	1 × 5 mg	3 × 5 mg	5 mg mthly	Control
Dry dry ewes (%)	3.5	3.1	5.1	2.5	4.3	31.7
Lambs born/ Ewes lambing (%)	133.5	151.6	141.6	147.2	147.8	126.4
Lamb mortality (%)	16.1	16.7	9.9	19.4	12.8	8.0
Lambs docked/ Ewes mated (%)	108.1	122.4	121.0	115.6	123.4	79.4

TABLE 3: SELENIUM AND EWE FERTILITY 1961 (TAUPO)
(200 ewes per group)

	1 × 10 mg	*2 × 1 mg*	*2 × 5 mg*	*Control*
Dry dry ewes (%)	5.1	5.0	3.0	15.2
Lambs born/Ewes lambing (%)	155.7	148.9	150.5	118.6
Lamb mortality (%)	15.3	10.3	10.0	10.6
Lambs docked/Ewes mated (%)	125.1	127.0	131.3	89.9

TABLE 4: SELENIUM AND EWE FERTILITY 1961 (BULLS)
(250 ewes per group)

	2 × 5 mg	*Control*
Dry dry ewes (%)	2.6	6.0
Lambs born/Ewes lambing (%)	138.8	128.0
Lamb mortality (%)	11.5	11.6
Lambs docked/Ewes mated (%)	119.6	106.4

An additional trial was carried out in three-year-old ewes at Bulls (Manawatu district). Here the lambing percentages were regularly about 100, there was no barren ewe problem and no known white muscle disease. However, there was a severe selenium-responsive unthriftiness in lambs. A simple selenium trial was carried out (Table 4) and an apparent increase in lambing percentages resulted.

A copper and selenium trial was carried out in ewes on a Rotorua property where there was up to 15 p.p.m. molybdenum, on a dry matter basis, in the pasture, and where selenium treatment had not increased the lambing per-

centage to a satisfactory level. Forty-five milligrams of copper was given subcutaneously as glycinate one month before joining with the rams and one month before lambing. Five milligrams of selenium was given at the same intervals. In this trial (Table 5) copper did not increase the lambing percentage. In fact, the fertility was apparently slightly depressed by the copper treatment.

TABLE 5: SELENIUM AND COPPER AND EWE FERTILITY 1961 (ROTORUA)
(200 ewes per group)

	2 × 45 mg Cu 2 × 5 mg Se	*2 × 5 mg Se*	*2 × 45 mg Cu*	*Control*
Lambing (%)	82.0	90.4	23.3	29.6
Barren ewe (%)	11.9	13.1	52.9	39.1

In some of these trials, and also in previous ones, there was a greater mortality of lambs born from the selenium-dosed ewes as compared with the controls. This occurred particularly when repeated or large levels of selenium were given (Table 2). This increased mortality can be explained in part by the heavier birth weight and consequent greater incidence of difficult births. Only when congenital white muscle disease occurred was the percentage lamb mortality higher in the controls.

SELENIUM AND LIFETIME PERFORMANCE OF EWES

Two small experimental flocks of ewes, one at Bulls and one at Taupo, have been under observation for three and a half years. Approximately half the sheep in each flock have received 5 mg Se as sodium selenite orally at 1 to 4 monthly intervals since docking in 1959. On each property the sheep have been run as one mob except during lambing. The salient details of these two trials are contained in Table 6.

TABLE 6: SELENIUM AND EWE FERTILITY 1961 AND 1962 (LIFETIME PERFORMANCE TRIALS)

	Bulls		*Taupo*	
	Se	*Control*	*Se*	*Control*
No. of ewes at start	*143*	*115*	*200*	*192*
1961				
Av. wt. at first mating (lb)	100	94	126	112
Lambs born/Ewes lambing (%)	121.4	116.7	128.2	111.8
Lambs docked/Ewes mated (%)	89.5	76.1	102.0	48.4
Barren ewes (%)	8.4	22.9	7.7	46.9
1962				
Av. wt. second mating (lb)	126	119	143	133
Lambs born/Ewes lambing (%)	144.7	139.8	127.5	122.2
Lambs docked/Ewes mated (%)	113.8	118.1	104.8	62.1
Barren ewes (%)	10.9	6.7	4.9	37.9

In the Bulls trial the poor fertility of the controls at first lambing can probably be largely explained by the low liveweights at mating rather than from a direct effect of selenium deficiency. As four-tooths there was no difference in the lambing percentage between the selenium-treated and the control group. In the Taupo trial, however, there was a marked reduction in fertility in control ewes in both years.

NATURE OF THE INFERTILITY

Farmers in areas where there was a barren ewe problem stated that the ewes were in good to average bodily condition at mating. They were of the opinion that ewes were served by the rams, apparently conceived, but did not produce a lamb. Several farmers who left the rams out for an additional two months reported a second crop of lambs in November-December.

Controlled trials carried out in the Rotorua-Taupo area using raddled teasers and/or entire rams have confirmed the farmer observations. Selenium-dosed and control ewes had their first heat at about the same time, the intervals between heats were normal, and there was no great difference between the two groups in the percentage of ewes holding to first service. However, more control ewes were marked by the teasers after the entire rams were withdrawn.

To study the nature of the infertility two detailed trials were carried out in 1962, one at Rotorua and one at Bulls, in which groups of selenium-treated and control three-year-old ewes were slaughtered 4 to 8 weeks after raddled rams were joined with them.

In both these trials there was no difference in the incidence of multiple ovulations or in conception rate between selenium-treated and control groups. (There was, however, a great between-property difference.) In the Bulls trial there was no difference between treatments in the incidence of non-viable foetuses or in corpus luteum wastage. However, in the other trial there was a marked increase of non-viable foetuses (Table 7) and corpus luteum wastage in the controls.

TABLE 7: SELENIUM AND EWE FERTILITY 1962 (ROTORUA) — EMBRYONIC MORTALITY

	Selenium	*Controls*
Mortality of twin foetuses (%)	2.3	27.5
Mortality of single foetuses (%)	4.6	23.7
Total mortality %	3.4	25.8

Twenty-one of the 72 ewes in the control group of the Rotorua trial had one or more degenerate embryos in their uteri as compared with 3 out of 74 in the selenium-treated group. The degenerate embryos had a crown-rump measurement of from 13 to 20 mm and probably all had perished between 20 and 30 days post-conception. The incidence of non-viable foetuses did not differ between ewes with multiple and single pregnancies (Table 7). There was no apparent difference in wastage of ova between ovulation and 20 days in the two groups of ewes.

On this property an additional mob of selenium-treated and control ewes was taken through to lambing. The results from this group indicated that there was probably further wastage between 4 to 8 weeks and full term (Table 8).

TABLE 8: SELENIUM AND EWE FERTILITY 1962 (ROTORUA)
(75 ewes per group)

	Slaughtered		*Lambed*	
	Se	*Control*	*Se*	*Control*
Live foetuses/Ewes mated (%)	114.8	91.7		
Lambs born/Ewes mated (%)			124.6	80.8
Not pregnant (%)	9.5	25.0	4.1	34.2

COMPARISON OF ANTIOXIDANT AND VITAMIN E WITH SELENIUM

Harris *et al.* (1958) have shown that vitamin E deficiency gestation-resorption in rats is not preventable by selenium administration. However, it is preventable by some antioxidants. For academic interest a trial was set up to see if the antioxidant ethoxyquin (Santoquin) or a vitamin E preparation DL α-tocopheryl acetate (Rovimix E) would prevent selenium-responsive infertility in ewes. As one dose of selenium given one month prior to mating was sufficient to control the infertility, both the antioxidant and vitamin E were given at that time. (It was not known when this experiment was started that the infertility resulted from early embryonic mortality.)

This trial was carried out at Taupo using four groups of 200 young ewes. One group received 250 mg Rovimix E and one group 200 mg Santoquin orally. Both these were given weekly for four weeks, the last dose being given the day the rams were joined with the ewes. A third group was given 10 mg Se orally once only, one month before the rams were put out, and one group served as a control.

Table 9 lists the salient details. Neither the antioxidant nor the vitamin E preparation had any effect in preventing the high incidence of barren ewes.

It remains to be ascertained whether the weekly administration of either the antioxidant or vitamin E from mating for 4 to 8 weeks thereafter will prevent embryonic mortality.

TABLE 9: COMPARISON OF EFFECT OF VITAMIN E, ANTIOXIDANT AND SELENIUM UPON EWE FERTILITY (TAUPO)
(200 ewes per group)

	Selenium	*Rovimix E*	*Santoquin*	*Controls*
Dry dry ewes (%)	8.4	49.8	43.4	44.9
Lambs born/Ewes lambing (%)	120.0	108.6	112.1	104.9
Lamb mortality (%)	15.2	16.0	14.2	26.2
Lambs docked/Ewes mated (%)	93.2	45.9	54.5	42.7

DISCUSSION

In the dose rate trials reported above, all the levels of selenium treatment used dramatically improved lambing percentages. This resulted from a great reduction in the incidence of barren ewes and to a slightly increased twinning rate. One dose of from 1 to 25 mg Se given one month prior to joining was as effective as 5 mg Se repeated at monthly intervals. It is recommended, therefore, that in responsive areas ewes should be given 5 mg Se two to four weeks before the rams are put out and the dose repeated one month before lambing, this latter dose to control congenital white muscle disease.

The trials carried out to obtain information on the nature of the selenium-responsive infertility clearly showed that oestrus, ovulation, fertilization and early embryonic development had proceeded normally. However, between three and four weeks post-conception — *i.e.*, at about the time of implantation — many embryos from control ewes perished. The reason for this is not known.

The actual cause of the selenium-responsive infertility is not known. Although selenium analyses have not been carried out on tissues from affected ewes, it is probable that the selenium status will be low, as selenium levels are very low in the tissues of selenium-responsive unthrifty lambs on the same properties. The fact that selenium-responsive unthriftiness in lambs is a serious problem in

both the Bulls and the Rotorua-Taupo areas, whereas little or no selenium-responsive infertility occurs in the former area is of considerable interest. It may be that selenium-responsive infertility occurs only where intakes of selenium are particularly low. Alternatively, some other factor or factors that exacerbate the effects of deficient selenium intakes may be required to produce the early embryonic mortality seen in selenium-responsive ewes.

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DISCUSSION

Q: *In view of the variety of symptoms which respond to selenium therapy, and in view of the more or less restricted geographical incidence of each class of symptom, would it be logical to view selenium as a common prophylactic for maladies produced by several distinct causative agents?*

W. J. HARTLEY: Present evidence suggests that all the known selenium-responsive diseases in sheep and cattle are associated with low tissue levels of selenium and that, in some diseases, one or more, as yet unknown, complicating factors are also involved.

Q: *Has the use of selenium eliminated the basic "hogget ill-thrift" problem in the South Island?*

PROFESSOR J. W. MCLEAN: The great majority of outbreaks of "ill-thrift" in lambs in the autumn and winter over the last few years in Canterbury have responded to selenium, much of which has been given with an anthelmintic. There have also been selenium responses in ewes suffering from a related condition in early lactation. To what extent the selenium given prophylactically to pregnant ewes and to lambs at docking has controlled the pre-weaning ill-thrift which used to occur occasionally, we have no way of estimating, but it could be significant. However, for the last few years we have not experienced the seasonal conditions giving rise to lush pasture growth in spring and early summer on which outbreaks of ill-thrift before weaning usually occur.

Q: *Is anything known about breed differences in the response of sheep to selenium?*

MR HARTLEY: No.