GOITRE AND NEONATAL MORTALITY IN LAMBS

E. D. ANDREWS AND D. P. SINCLAIR*
Wallaceville Animal Research Station, Wellington.

SUMMARY

The experimental production and prevention of goitre in new-born lambs from ewes grazing thousand-headed kale, turnips, perennial ryegrass dominant pastures, or clover dominant pastures during pregnancy, is described.

On all fodders, lamb thyroid size was reduced by giving the ewes extra iodine during pregnancy. Iodine supplements also prevented the high neonatal mortality sometimes associated with kale feeding.

There was no evidence that death rates associated with goitrogenic feeds other than kale were reducible by iodine. However, there is some evidence from other sources that mortalities in excess of normally accepted rates may sometimes occur in association with goitrogenic ryegrass clover pastures.

It is thought possible that goitre-producing factors in pasture might contribute widely to lamb neonatal mortalities, the underlying causes of which are still largely conjectural.

INTRODUCTION

GILRUTH (1901) first noted the occurrence of goitre in calves and lambs in New Zealand. Since that time the disease in farm stock has been recorded on numerous occasions and associated environmental factors have been described. While a number of feeds, including pasture plants, have shown goitrogenic activity, severe outbreaks of goitre in the new-born have commonly been associated with the consumption of brassica crops by the dams during pregnancy.

Figure 1 shows those areas within which goitre is liable to occur. The map is based on a survey of iodine content of lamb thyroid glands integrated with the distribution of recorded cases of the disease (Cunningham, 1955). Goitre in calves and lambs in the Rotorua-Taupo district has recently been reported but the information available is not yet sufficiently detailed for mapping purposes. No clear association between

*Manutuke Research Station, Box 18, Manutuke.

soil types and the distribution of goitre has been noted, but the disease tends to occur in more southern districts where brassica crops are widely grown for winter feed.

Although a dietary deficiency of iodine has commonly been regarded as a cause of goitre there is increasing evidence that substances which interfere with the utilization of iodine *via* the

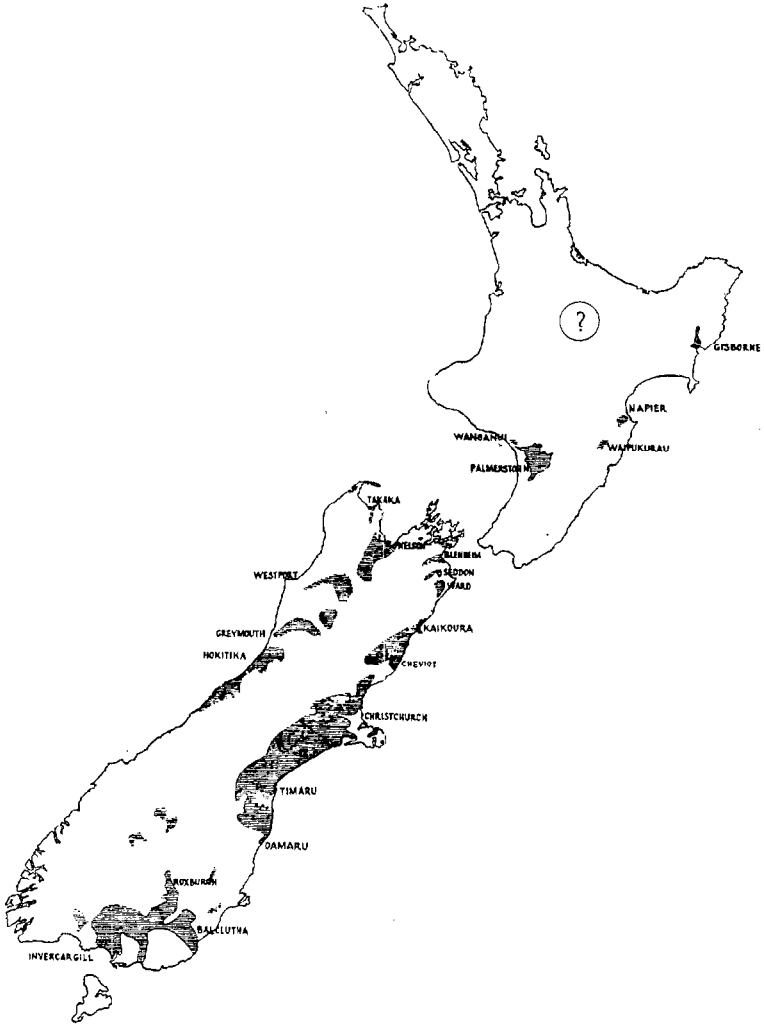

Fig. 1: Goitre-producing areas in New Zealand.

thyroid gland occur in many animal fodders, and that consumption of these so-called goitrogens is an important cause of the disease (Wright and Sinclair, 1958; Allcroft and Salt, 1961). Goitrogens can be classed as belonging either to the "thiocyanate" type or the "thiouracil" type. The goitrogenic effect of thiocyanate is reversible by giving extra iodine whereas that due to thiouracil is either not reversible or only partly so. Present experience suggests that goitre in farm stock is largely if not wholly preventable by giving extra iodine, though, in the Brassicae at least, a goitrogen of the "thiouracil" type may play some subsidiary role in the aetiology of the disease (Sinclair and Andrews, 1961).

Although goitrous adult cattle and sheep are sometimes seen, there is at present no definite evidence that the disease is of significant importance in animal production provided affected animals survive the first few days of life. In experiments conducted at Massey College (Flux *et al.*, 1960) iodine supplements prevented goitre in ewes and lambs grazing goitrogenic pastures, but had no apparent effect on reproduction, wool production, or lamb growth. Manutuke experiments showed that, although in some instances the disease was associated with increased gestation periods of ewes and decreased birth weights of lambs (Sinclair and Andrews, 1954; 1958), goitrous lambs grew as well as did their flock mates in which the disease had been prevented (Sinclair and Andrews, 1954; 1959). In practice, outbreaks of severe goitre in new-born lambs are sporadic. Nevertheless, there is much field evidence to show that, on individual farms, accompanying death rates can be disastrously high.

The main aims of this paper are to record the experimental production of goitre in new-born lambs from ewes grazed before lambing on various feeds, to report on methods of preventing the high neonatal death rate, sometimes associated with the feeding of thousand-headed kale (*Brassica oleracea* var. *acephala*) and to discuss the possibility that goitre-producing factors in pasture may contribute widely to lamb mortality rates at present accepted as normal.

EXPERIMENTAL

Investigations into goitre and associated neonatal deaths in lambs were prompted by an outbreak of the disease at Manutuke in 1952. In succeeding years the goitrogenicity of thousand-headed kale and other feeds, and the effects of iodine

supplements were examined under controlled experimental conditions using groups of 20 to 25 presumed-pregnant ewes. In each year, an aim, not always realized, was to graze the ewes on experimental feeds for at least two months immediately preceding lambing. With few exceptions the glands of all lambs born were examined by palpation and classified as not palpable, slightly enlarged, moderately enlarged, or greatly enlarged. In earlier experiments (1953-56) the glands of lambs which died were weighed and analyzed for iodine content. In later trials (1960-61) these observations were supplemented by killing lambs at birth so that glands were available from at least six animals in each group.

Criteria on which a normal or abnormal thyroid condition can be judged are necessarily rather arbitrary. A figure of 0.10% of iodine on a dry weight basis was used as the best available estimate of the critical iodine concentration below which hyperplastic changes may occur (Underwood, 1956). In later experiments (1960, 1961) thyroid status was considered normal if glands weighed less than 1.3 g, doubtful if weights ranged between 1.3 and 2.8 g and hyperplastic if weights exceeded 2.8 g (Sinclair and Andrews, 1961). Within groups goitre was judged to be mild, moderate or marked according to the proportion of animals showing thyroid enlargement as judged by palpation, thyroid iodine concentrations, and sizes or weights of glands.

In this paper, only an outline of experimental procedures and results can be presented. Except for the 1961 work which is unpublished, details, including statistical evaluations where appropriate, are given elsewhere (Sinclair and Andrews, 1954; 1958; 1961).

OBSERVATIONS AND RESULTS

1952 Observations

For two months toward the end of pregnancy, 40 two-tooth Romney ewes had been grazed continuously on kale. As lambing progressed it soon became evident that the death rate among new-born lambs was abnormally high. Most early lambs showed some oedema of the head and neck and had swollen tongues. Many died or were dead, at birth. Others survived the birth process but were unable to suckle, and succumbed within one or two days, presumably as a result of starvation. Post-mortems carried out by R. Crawford and D. McFarlane, then of the Gisborne Veterinary Club, showed that all lambs examined had some thyroid enlargement. In some later-born

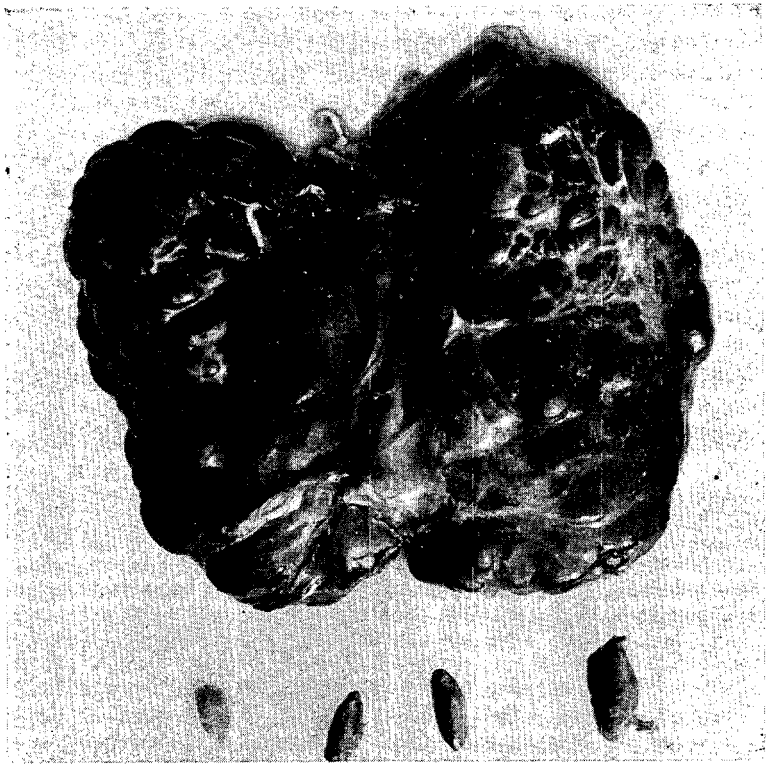

Fig. 2: Goitrous gland compared with a range of normal sizes.

lambs this was so gross that it was apparent at a glance, the gland being approximately as large as the animal's head. Figure 2 compares the largest gland observed, with a range of normal sizes.

The main station flock had been carried throughout pregnancy on perennial and short-rotation ryegrass and white clover pasture, supplemented with lucerne hay. Following the diagnosis of goitre in lambs from the kale-fed ewes, the thyroid glands of all lambs subsequently born in the main flock were examined by palpation. Only a few cases of thyroid enlargement were found.

In the pasture-fed main flock 16% of the total lambs born (317), died. Of the 42 lambs born in the kale-fed flock, 76% died.

From these observations it was provisionally assumed that, although some lambs from pasture-fed ewes were probably

goitrous, the goitre-producing effect of the kale was much greater than that of the pasture and that among lambs from the kale-fed ewes the high mortality rate was a concomitant of the disease.

1953 Trial

A controlled trial carried out in 1953 gave confirmatory evidence that although some thyroid enlargement resulted from pasture feeding, kale was more goitrogenic. There were indications that weekly oral doses of potassium iodide (140 mg per ewe) reduced thyroid enlargement and increased iodine concentrations in the thyroid glands of lambs from kale-fed ewes. Results for lambs which died in the kale-fed groups are shown in Table 1.

Table 1: Weights and Iodine Contents of Lamb Thyroid Glands (1953 Trial)

Ewe Treatments	*Ewe No.*	*Thyroid Glands*	
		Weight (g)	*Iodine (% D.W.)*
Kale: Control	46	14.3	0.009
	96	20.5	0.005
	202	7.2	0.020
	257	25.0	0.003
Kale: Dosed KI	1	2.5	0.148
	217	2.8	0.130
	237	2.5	0.123

A feature of this trial was that despite marked goitre among lambs from control kale-fed ewes, the death rate (18%) was much lower than in the previous year and did not differ significantly from death rates for other groups. However in this experiment kale feeding could be continued for only 6 weeks and ewes were returned to pasture 12 days before the start of lambing.

1953-1956 Trials

Further kale-feeding trials carried out in 1954 and 1955 showed that potassium iodate was as effective as potassium iodide in preventing goitre and suggested that doses of either salt given two months before lambing and again one month before lambing was a reasonably effective and practicable method of controlling the disease. However, in these years the amount of kale available again failed to last for the whole of the two months between first treatments and lambing. Goitre among kale-fed control groups (not receiving iodine) was mild and obviously high mortality rates were not experienced.

In 1956 experimental procedures were modified to ensure that sufficient kale would be available to carry ewes for the full two months until lambing commenced. Iodine-supplemented ewes each received two doses of 360 mg of potassium iodate, approximately two months and one month before lambing. Results are summarized in Table 2.

TABLE 2: EFFECTS OF INORGANIC IODINE ON LAMB THYROID GLANDS AND NEONATAL MORTALITY (1956 TRIAL)

Ewe Treatments	*Thyroid Glands* *Mean Weight (g)*	*Mean Iodine (% D.W.)*	*Mortality (%)*
Kale: Control	16.7	0.011	78
Kale: KIO_3 twice	2.7	0.041	14

It appears that iodine treatment at least in some cases did not result in normal thyroid weights or iodine concentrations. However, as indicated by palpation and weights of glands from lambs which died, thyroid enlargement was greatly reduced. More importantly the iodine supplements greatly reduced the death rate associated with the disease. An ancillary finding from analyses kindly carried out by Dr G. W. Butler was that the goitrogenic activity of the kale was not associated with a dietary deficiency of iodine (Wright and Sinclair, 1958).

1960 TRIAL

In 1960 the effect of a single injection of Neohydriol (an organic iodized poppy-seed oil preparation) in preventing kale-induced goitre and in reducing death rate was examined. When ewes were injected (1 ml per ewe) at the start of kale feeding (*i.e.* two months before lambing) iodine concentrations in lamb thyroid glands were raised to normal levels, and marked goitre and high neonatal mortality were again prevented. Injections given one month later only partially prevented thyroid enlargement but were similarly effective in raising iodine concentrations to normal and in preventing a high death rate (Table 3).

TABLE 3: EFFECTS OF ORGANIC IODINE (NEOHYDRIOL) ON LAMB THYROID GLANDS AND NEONATAL MORTALITY (1960 TRIAL).

Ewe Treatments	*Thyroid Glands* *Mean Weight (g)*	*Mean Iodine (% D.W.)*	*Mortality (%)*
Control	10.3	0.013	59
Neohydriol: 1 month before lambing	5.5	0.45	14
Neohydriol: 2 months before lambing	1.9	0.40	10

An ancillary result from this trial confirmed a suggestion from other observations that among goitrous lambs from unsupplemented ewes there is no apparent association between the increased size of thyriod glands and the ability of lambs to survive (Table 4).

TABLE 4: THYROID SIZE AND SURVIVAL OF GOITROUS LAMBS FROM CONTROL EWES (1960 TRIAL)

*Thyroid Enlargement**	*No. of Lambs*	
	Total	*Survived*
Slight	5	1
Moderate	15	7
Great	7	2

*Assessed by palpation.

1961 TRIAL

A trial carried out in 1961 was designed to compare goitrogenic effects of clover dominant pasture, perennial ryegrass dominant pasture and turnips. Iodine was again given as a Neohydriol injection to the ewes, in each case at the start of the experimental feeding regime. At lambing there was little evidence of goitre as judged by palpation, and for all groups death rates were low. However, examination of glands from lambs that died or were killed showed that for all groups not given Neohydriol some glands were low in iodine. Moreover, as shown in Table 5, mean weights of glands from groups in which the iodine supplement was given were lower than corresponding weights for control groups.

TABLE 5: MEAN WEIGHTS (G) OF LAMB THYROIDS (1961 TRIAL)

Ewe Treatment	*Feed*		
	Ryegrass	*Clover*	*Turnips*
Control	3.1	1.5	1.8
Neohydriol	0.8	0.8	1.2

From the evidence it appears that all three feeds were slightly goitrogenic.

DISCUSSION

The Manutuke trials show that feeding pregnant ewes on thousand-headed kale for two months before lambing is liable to produce marked goitre in their lambs. The condition may be accompanied by a death rate grossly in excess of normal.

The high death rate can be greatly reduced by giving extra iodine to the pregnant ewes under conditions which can be simply and effectively applied in farm practice.

Wallaceville records, and other experience, show that goitre, sometimes accompanied by apparently higher than normal death rates, has been associated with the feeding of other brassica crops, notably choumoellier and turnips. Consequently the very slight indication of goitre in lambs from turnip-fed ewes in the 1961 trial was rather surprising. It is clear that the goitrogenicity of turnips and other Brassicae as compared with that of kale will require further examination under controlled experimental conditions.

The nature of the relationship between goitre and ability of the lamb to survive is not clear. Ewes that produce goitrous lambs, themselves show evidence of hypothyroidism (Wright and Sinclair, 1958) and lamb viability may be partly dependent upon the state of thyroid activity in the dam. Australian workers (Setchell *et al.*, 1960) have suggested that in extreme cases of goitre death may result through obstruction of the trachea. Results of Manutuke trials show that marked thyroid enlargement is not associated with high death rates if iodine is given a month before parturition (Table 3). If iodine is not given, lambs in which the glands show only slight enlargement are as liable to succumb as those with greatly enlarged thyroids (Table 4). All that can be said is that thyroid enlargement beyond an imprecisely defined threshold value is evidence of an unknown degree of foetal hypothyroidism during pregnancy (though not necessarily at parturition) and that hypothyroidism probably results in impaired ability of the lamb to survive.

While it can be accepted that kale is much more goitrogenic than pasture, the ability of ryegrass dominant and clover dominant pastures to produce enlarged thyroid glands has been demonstrated both in the Manutuke experiments and at Massey College (Flux *et al.*, 1960). From what has been said it could be inferred that hypothyroidism as evidenced by the mild goitre produced by pasture plants would tend to make some contribution to neonatal death rates. However, the situation is by no means clear. No measurable effect of iodine treatments on mortality rates could be demonstrated from the Manutuke or Massey College experiments, but this might be accountable, in whole or in part, to the small numbers of animals used in these trials. On the other hand, an apparently abnormally high number of neonatal deaths among goitrous calves has been reported from the Rotorua district although no Brassicae were

fed to the cows during pregnancy (Hartley, W. J., pers. comm.). Also, Australian workers (Setchell *et al.*, 1960) have reported a 30% mortality rate among goitrous lambs on improved subterranean clover, perennial ryegrass pastures. The pregnant ewes did not have access to brassica feeds and no cruciferous weeds of known goitrogenicity were found.

Results from surveys carried out by the Gisborne Veterinary Club (McFarlane, 1955) and by Wallaceville (Hartley and Boyes, 1955) suggest that between 10 and 15% of all lambs born die at or near birth, resulting in a loss to the sheep industry of several million lambs each year. It appears that, while infective processes play an important part in this immense wastage, their full effects are unknown. Perhaps a quarter to a half of the losses include those that cannot be accounted for and others classifiable only under general headings such as exposure, dystokia and starvation—terms that give no clue to the underlying causes of death. In the writers' experience the size beyond which glands can be regarded as definitely enlarged is not easily assessed even by skilled observers and a widespread incidence of mild to moderate goitre might largely pass unrecognized. While the evidence is at present fragmentary, there is a distinct possibility that goitre-producing factors may account for an economically important fraction of normally accepted neonatal losses on ryegrass, white clover pastures.

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