

EVIDENCE OF IODINE DEFICIENCY IN DOMESTIC ANIMALS.C.V. DAY-US, M.R.C.V.S.

From the time of the discovery of Iodine in the year 1811, work progressed throughout the century mainly in France and Switzerland resulting in the accumulation of much evidence of the connection between Iodine deficiency and the incidence of goitre in man, and of the use of iodine in the prevention and treatment of goitre.

The next important discovery was made by Baumann in 1895, who found Iodine in the thyroid gland. Since then many investigators have studied the Iodine content of both human and animal thyroids and have demonstrated that this substance is decreased in the glands of man or animals affected with goitre..

During the present century, a great deal of the earlier work has been confirmed and still further progress made in our knowledge of the problem. The application of iodine therapy in the prophylaxis and treatment of goitre was commenced. In America in 1910 Marine found that goitre in brook trout could be prevented by the administration of Iodine, subsequently he found the same result to apply in the case of goitre in school children.

In New Zealand Hercus, Benson and Carter (1925) carried out further extensive work confirming the correlation of goitre in the human subject with a low iodine intake, and the successful treatment of the condition in children by the administration of Potassium Iodide,

It is, therefore, definitely known that the absence of the small quantity of iodine required for the performance of the thyroid function, may give rise to a series of morbid conditions, associated with goitre as the more constant result of this deficiency,

There are, however, other influences which are capable of affecting the incidence of goitre, in areas of low iodine intake, where goitre is more or less endemic, and it seems more than probable that such is the case in certain sporadic epizootic outbreaks of congenital goitre in domestic animals,

It has been shown, for example, that excessive ingestion of calcium relative to Iodine and/or phosphates may be capable of setting up the colloid type of goitre in animals.

Calcium, under certain circumstances, can be looked upon as a goitrogenic factor, and in the case of animals there are possibly several other factors intimately connected with their environment and nutrition, which from time to time show similar activity.

Hercus and Purves (1936) have shown by detailed experiment that certain turnip roots obtained in the Lake Wanaka district of Otago exhibited sporadically a goitrogenic activity comparable with that found for the most active samples of cabbage in other countries, These authorities consider it likely that the sporadic goitrogenic activity of turnip roots would contribute in the production of goitre epidemics in stock.

Presumably in most instances the activity of goitrogenic substances can be controlled by the administration of Iodine. It has been said (McCarrison 1937) there is nothing more certain in regard to goitre than that a sufficient intake of iodine, or more properly a sufficient absorption and utilisation of iodine does counteract the action of all goitrogenic agents at present known to

us with the exception of Vitamin deficiency, In the absence of such agents a low intake of iodine may not by itself cause goitre, while their presence will result in its occurrence; and, if they be present in exaggerated degree they may even overcome the antigoi-trogenic action of a relatively high intake of iodine.

THYROID GLANDS: The thyroid glands in the domestic animals are found in the same relative position as in man; they consist of two lobes situated on either side of the first two rings of the trachea close to the larynx.

In the horse a normal lobe is about the size of a walnut. In the pig the lobes are located close together on the ventral surface of the trachea,

The thyroids are to a great extent responsible for the proper growth of horns, hair and wool, for if they are removed artificially these structures among others do not develop in the normal manner. The glands increase in weight from birth to maturity in proportion to the increase in body weight of the animal.

An iodine containing substance is secreted by the glands, termed thyroxin, which is closely related to carbohydrate metabolism. In the adult human subject deficiency of this secretion, which follows atrophy of the thyroid gland, results in myxocdema. This tends to bring about skin and tissue changes, atrophy of hair follicles, etc., and depression of the nervous system.

This condition is not properly observed in domestic animals.

On the other hand, congenital, defective thyroids are met with in the domestic animals; in the developing foetus and in the new born atrophy of the thyroid gland results in cretinism, which really amounts to foetal myxoedema, the predominate feature being the arrest of physical development.

Several times Cretins have been recorded in the progeny of the Dexter and Kerry breeds of cattle. I have seen examples of cretins in New Zealand cattle, on one occasion in the Waikato in the foetus of a Frieisian cow and again at Burnside in the foetus of a cow of unknown breed. In such cases, the development of the bone structures is arrested, the neck becomes stout and thick and the head is generally larger than normal and in shape somewhat resembles that of a bull dog. The limbs are thick and clumsy and often only two to three inches in length. This picture of a-bovine monstrosity accounts for the popular expression "bull dog calf."

It has been suggested (Crew, 1923), however, that "the bull dog calf" monstrosity so commonly seen in pedigree Dexter cattle is not due to the lack of thyroid function, but it is identical with a human malformation achondroplasia or chondrodystrophia. This is a term for a type of foetal rickets, which is a condition very similar to foetal cretinism. If such is the case there is no satisfactory evidence to explain the mechanism responsible for this irregular development.

Cretinism has been observed in dogs, but it is not a common condition. In the enclosed valleys of the Alps and Pyrenees cretinism in dogs occurs, and it has also been observed in dingos taken from Australia and kept in captivity in zoological gardens.

A condition similar to cretinism may be induced experimentally in young animals by thyroidectomy.

There are two diseases of the thyroid gland met with in domestic animals: -

(1) EXOPTHALMIC GOITRE. Graves' or Basedow's disease. 'In this case there is enlargement of the thyroids and a disturbance of function, the result, it is thought, of increased activity of the glands - hyperthyroidism. The condition, therefore, is just the opposite to myxoedema.

The chief symptoms associated with the gland enlargement, being exophthalmus or protrusion of the eyeballs and nervous and vascular excitability with tachycardia and sometimes glycosuria, the latter owing to the interference with carbohydrate metabolism. This disease is not really important in domestic animals and the reference to it in veterinary literature is not extensive.

Exophthalmic goitre has been recorded in the horse, ox and dog.

(2) GOITRE is the more important disease and is a clinical condition in which there is enlargement of the thyroid gland, and in simple goitre in the adult animal it is unaccompanied by any marked constitutional disturbance. A parenchymatous type is recognised where the enlargement is in the nature of a hypertrophy of the glands with an increased formation of acini, with no increase in the amount of colloid, i.e., stored secretion. There is also a colloid type, in which colloid is stored rapidly and in excessive amount.

As compared with man less attention has been paid to goitre in the domestic animals, but in general following the conditions observed in man the disease in animals is narrowly confined to certain regions with a low iodine content in the food, soil and water.

It has been said (Hercus and Roberts 1927) that a characteristic feature of animals in general, and in particular of wild animals, seems to be that they are capable of remaining non goitrous on a much lower iodine intake than is man. Thus the iodine contents of perfectly normal sheep thyroids were found to range from 0.28 to 2.9 milligrammes per gramme of fresh gland, while the extreme range observed in the case of human beings was from 0.4 to 1.5 milligrammes per gramme.

Goitre occurs in domestic animals over wide areas in many parts of the world, the most serious feature in animals being the incidence of congenital goitre in calves, lambs, pigs and puppies, among which a high mortality is sometimes experienced. It is not uncommon for all the puppies in a litter to be affected or a considerable proportion of the lambs in a flock.

The disease in domestic animals is well distributed throughout the United States of America, the Great Lake region and a large area of the North West from Lake Michigan to the Pacific Coast are noted as goitre territory; it is less frequently seen in the coastal areas. In Canada goitre has been recorded in sheep, pigs and cattle. It occurs in Switzerland and to a lesser extent in England.

In New Zealand goitre has been noted in horses, cattle, sheep and dogs, sporadic cases arise in the Waikato, Manawatu and other parts, but principally it occurs in the snow fed lake districts of Otago and Southland, the Clutha River Valley and the island area of Inchlutha,

In presenting this paper, I do not suggest that Iodine deficiency in domestic animals in New Zealand constitutes a major problem affecting the live stock industry, because as a matter of fact, as far as is known it is not one of very great economic importance. The average domestic animals, with the exception in some cases of horses, dogs and cats, generally do not reach old age, they are slaughtered for food purposes at various periods - large

**numbers** in comparatively early **life**. Domestic animals, other than pigs and some house dogs, although subject to changes in environment, live on a much **more** natural diet than is the case with man,

Nevertheless there **are reasons** which appear to justify some consideration being given to the subject in New Zealand. **Firstly**, on account of the occurrence of goitre in domestic animals in New Zealand and the **material** loss that is often associated with sporadic outbreaks of congenital goitre in puppies and more **particularly in** lambs.

Secondly on account of the **extensive use** of mineral licks in New Zealand, many of which **contain** iodine, in the form of Potassium Iodide, In the **commercialisation** of these materials and also in the case of certain manures, there are claims put forward regarding the Value of **iodine** for livestock, which -in all probability could not be substantiated.

Thirdly the time seems overdue for a commencement to be made to collect and correlate all **the** available evidence dealing with iodine deficiency in the domestic animals in general, and if the information now recorded should provide the necessary initial **stimulus** for further research to be made into the problem as far as New Zealand is concerned, a useful purpose will have been served.

It is desirable to give a brief description of goitre as it affects the common species of domestic animals:

**HORSES:** In several parts of the world, goitre, **characterised** by enlargement of the thyroid gland, is not uncommon in horses. In the State of Washington **it is** estimated (Kalkus **1920**) that from **30** to **50 per cent** of all adult horses have visibly enlarged thyroids. In Europe a **case** of oxophthalmic goitre is recorded in the horse.

*In New Zealand* in the vicinity of Lakes Wakatipu and Wanaka also in the Clutha River valley, it is quite common to find horses, especially young thoroughbreds, with enlarged thyroids. Usually both lobes of the thyroid are enlarged, but the condition in adult **horses** rarely **causes** any symptoms of **note**, **unless** there is very extensive enlargement, when inconvenience may be caused by pressure on the larynx. Goitre, if the swelling is visible, is unsightly and it detracts from the value of **the** animal,

**CATTLE:** In the Northern part of California **in** the valley of a snow fed river calves have been **reported** (Mills **1934**) born **in** the fall **among** range cattle which showed **evidence** of thyroid enlargement when several months old. Calves born in the **extremely** cold weather were premature, weak and small. Many showed evidence of goitre and a few were hairless. Most of these calves were alive at birth and if given good care for a **week or** more they survived, but were much smaller **than normal**.

In the STATE OF WASHINGTON (Kalkus, 1920) it is variously estimated by **stockmen** that from **70 -80** per cent of all calves born in a goitrous district are affected with goitre at birth. In certain districts in Austria goitre is reported to be common in calves. **In** Finland it has **been** stated that with the development of intensive dairy-farming goitre in **calves** became increasingly common,

In New Zealand cases of well marked **goitre** have been seen (Marshall **1937**) in the Waihou district in a yearling bull and heifer, Three young bulls were also seen affected near Hamilton, one case was observed first when the animal was nine months old. In this case the thyroid glands were examined by the CHIEF Chemist of the Department of **Agriculture**.---

<u>Fresh Weight</u> <u>of gland.</u> <u>Grammes.</u>	<u>Percentage</u> <u>of</u> <u>Iodine.</u>	<u>Total</u> <u>Iodine.</u> <u>Grammes.</u>
350	.044	0.1539.

Individual cases occur in calves in the Manawatu. Webster (1937) described two calves seen, one of them with a firm hypertrophied gland weighing approximately 10 ounces. Kalkus (1920) states that the enlargement of the thyroids in new born calves varies with a slight, almost imperceptible swelling, to one of great size. Occasionally the thyroids weigh 500 grammes.

Isolated cases of goitre in calves are seen in Otago, principally in the Inchclutha district,

A comprehensive survey of the thyroid glands from "bobby" calves (approximately five days old) drawn from all parts of the Taranaki Province in New Zealand was undertaken by Webster (1932). Thyroid glands from 2300 calves were examined, a total of 10 per cent appeared abnormal comprising 4 per cent, definitely goitrous, i.e., twice or more the normal size and a further 6 per cent definitely enlarged but less than twice normal,

This method of estimating the incidence of goitre may be open to the same criticism as that sometimes directed against the common practice of estimating the prevalence of goitre by surveys confined to school children. Unless some reliable index of the normal size of the thyroid gland is employed the incidence of goitre may be greatly exaggerated.

McCarrison (1937) states that it is not generally recognised that during early life the thyroid gland normally grows more rapidly than the body as a whole and may exhibit this phenomenon as a visible swelling. Without knowledge of this fact and without some reliable means of measurement of the size of the gland physiological swellings may be mistaken for pathological enlargements.

In the survey carried out by WEBSTER a total of 110 glands were carefully dissected out and the iodine estimation was determined by the Chief Chemist with the following results:

TABLE 1.

NORMAL GLANDS.

<u>District.</u>	<u>Number</u> <u>of</u> <u>Glands.</u>	<u>Average</u> <u>Fresh</u> <u>Weight.</u>	<u>Average</u> <u>dry</u> <u>Weight.</u>	<u>Percentage</u> <u>of Iodine.</u> <u>Fresh Wght.</u>	<u>Percentage</u> <u>of Iodine.</u> <u>Dry WEIGHT.</u>
Stratford	9	6.40 gm.	1.67 gm.	.077	.297
Waitara-Tikorangi	9	7.24	2.53	.083	.304
Eltham	9	7.67	2.06	.084	.311
Inglewood	6	6.67	1.84	.093	.339
Coastal district	8	6.77	2.12	.107	.341
Te Wera	10	7.38	1.91	.095	.368
N.P. Suburbs	11	7.57	1.94	.099	.385
Bell Block	8	7.74	1.99	.101	.389
Hawera	9	7.30	2.04	.109	.390
Waverley	9	7.00	1.75	.100	.400
Uriti	6	8.01	2.16	.108	.404
MEAN:	94	7.44	1.99	.0956	.356.

TABLE 2.

## ABNORMAL GLANDS.

District.	Number of Glands.	Average Fresh Weight.	Average Dry Weight.	Percentage of Iodine Fresh Weight	Percentage of Iodine Dry Weight.
Eltham	1	11.65gm	3.19gm.	.102	.373
Hawera	1	16.53	4.72	.100	.351
South Taranaki	4	22.48	5.83	.100	.388
Coastal District	1	18.97	5.23	.118	.428
Unidentified	3	28.13	8.20	.121	.414
"	5	18.62	5.37	.131	.420.
MEAN:	15	20.97	5.98	.1159	.403
Waverley	1	10.17	2.85	.053	.188.

It will be seen from these tables that the percentage of iodine in the glands was not low, in fact the percentage of iodine in the glands classed abnormal, with one exception, is equal to or higher than the percentage of iodine in the normal glands,

Orr and Leitch (1929) quote Fenger's figures for normal animals in regard to the percentage of iodine and no marked difference with age was shown. Thus in cattle the following percentages of iodine were found in desiccated fat free glands. Foetus 4-5 months 0.25; suckling calves 6 weeks 0.23; non-pregnant cows 0.35; bulls 0.28.

The iodine content of the glands of females is richer than in males.

PIGS: "Foetal Arthyrosor" "hairlessness" in pigs was investigated in 1917, by Ennis Smith, in America, and was associated with thyroid abnormality, which could be prevented by the administration of iodine. This condition is specially prevalent in certain sections of the North West States of America and other goitre areas and caused great financial loss. Pigs so affected are practically hairless have very light coats of hair at birth; they have large necks and as a rule the skin over the shoulders, sides and flanks and the region of the neck is somewhat wrinkled and thickened; In some cases the entire litter may be affected, in others only a portion of the litter will show hairlessness.

It has been stated that "hairless" pigs are most apt to be produced in the spring after a severe winter when the sows do not take much exercise. Also that goitre in young pigs is rare if brood sows are fed well balanced rations neither too low nor too rich in protein and if they get plenty of exercise.

The average weight of the thyroid of hairless pigs is given (Kalkus 1920) as .6466 grams, while that of normal new born pigs is .18 grams.

DOGS: Goitre in dogs, especially in the young animal, has been recorded in several countries. In some instances goitre is congenital and several puppies in a litter or even whole litters of puppies are affected; The enlargement of the glands in these cases may be of sufficient size to interfere seriously with parturition.

In portions of Switzerland it is rare to find dogs free from enlargement of the thyroid glands. In America many adult dogs in goitrous districts are affected with enlarged thyroids and it is reported that many puppies are born with goitre.

The condition is seen from time to time in dogs in New Zealand, especially in known goitrous areas.

I am indebted to Webster (1937) for the following interesting description of a case observed in the Manawatu. Two bitches, mother and daughter, were mated with the same sire and both had litters of healthy pups which they reared successfully. Subsequently both bitches were mated, again with the same sire. The two whelped within four days of each other, the mother having a litter of three, and the daughter a litter of six. On this occasion the pups did not thrive and they were stunted in growth at six weeks of age and all had large palpable goitres.

The pups remained stationary, becoming more obvious cretins, until eight weeks of age, when they began to die rapidly one after the other.

The owner, an experienced and successful breeder, had made no change in the environment or feeding of the two bitches. The food was good, consisting mainly of raw meat, some biscuit and milk and cod liver oil was added regularly.

In the bitches themselves there was no sign of thyroid enlargement.

Cases of a similar nature have been known to occur in the district.

Apart from the congenital form the enlargement of the gland may occur insidiously or in a rapid manner, at different periods in the development of individual animals. Inconvenience is rarely suffered unless the gland is very large, causing compression of the trachea or of the recurrent nerves. Exophthalmic goitre which is of infrequent occurrence in animals, is seen occasionally in the dog.

SHEEP: In America goitre in new born lambs is reported to occur sporadically in nearly all sheep breeding districts and it is endemic in certain areas in the North West and along the Columbia River basin, and has at times seriously interfered with sheep production in those areas. In one year in Montana one flock lost all except one hundred of the lambs from seven hundred ewes because of goitre.

The lambs are born with a small amount of wool, thick necks, and enlarged thyroid glands, which may rapidly increase in size. The majority of lambs so affected are born dead or they die within the first few days after birth.

Congenital goitre in lambs has been known to occur in England.

In New Zealand sporadic outbreaks occur in different parts of the country and Otago provides a centre of interest in this connection.

Marshall (1937) experienced cases where a small number of lambs were affected on two farms in the Waikato situated on fairly deep peat; from one of these cases glands were analysed by the Chief Chemist and the percentage of iodine on dry weight was 0.074 and 0.079. Marshall also noted another outbreak in the Waikato in which a number of lambs were dead or weakly at birth and several had enlarged thyroids. The farm concerned was on the flat, peat was only thin and had

mostly disappeared, as the farm had been in occupation forty years.

In connection with peat soils Orr (1930) quotes the German workers Scharrer and Schwaibold who found that peat binds iodine more readily than any other type of soil examined, fen soils, loam, clay and sand following in that order.

Webster (1937) states that a few cases of goitre in lambs occur in the Manawatu every year.

Cases of congenital goitre in lambs occur in Otago, notably in the vicinity of Lake Wanaka and the Clutha River valley in the Tarras district and the island Inchclutha. Sheep grazing at high altitudes do not seem to be affected. In some instances the mortality has been sufficiently high to constitute a serious loss to the farmers concerned.

In the spring of 1929 Hopkirk and Dayus (1930) investigated a case which occurred among the lambs of a flock of 1400 crossbred ewes running on 600 acres of flat situated at the base of a high range of hills adjacent to the shores of the snow fed Lake Wanaka. This flat was under irrigation with a carrying capacity of four sheep to the acre in addition to a number of cattle, and growing particularly good feed composed mainly of cocksfoot, ryegrass, timothy, crested dogtail and clovers. The cocksfoot and clovers predominated, the ryegrass not appearing to hold so well. The youngest pasture was three years old and the oldest twenty years. There did not appear to be any evidence of lime deficiency, as nearby there are limestone outcrops giving up to 97 per cent carbonate of lime. The clovers do particularly well and the analyses of pastures for lime showed 0.86 to 1.9 per cent.

Orr and Leitch (1929) stated that iodine tends to be leached out of the soil where the soil is deficient in clay colloids, humus or is rich in calcium. They refer to Von Fellenberg's work which determined that iodine absorption by soils is stronger when the reaction is acid rather than basic. They state that calcium rich soils which are likely to be alkaline absorb relatively little iodine and since in addition they are porous the iodine will tend to be removed in the drainage water.

The winter feed of the ewes was also grown on the same plots and consisted of turnips and clover hay. A portion of the ewes, 300 in number, had been removed from the hill country and pastured for one year on the flats, the remainder numbering 1100 had been on the flats two years and it was only in this section that lambs were affected.

The ewes commenced lambing in October, and over 100 lambs were born with enlarged thyroids. Besides enlargement of the glands, many of the lambs showed poor physical development and thinness of wool. The lambs affected were mainly twins, either one or both, and were born dead or died within three days. If any survived this period, the chances of recovery were apparently quite good.

The weight and analyses of some of the glands from these lambs are given by Simpson (1930).

TABLEANALYSES OF LAMB THYROID GLANDS. WANAKA AREA.

No.	Weight of Gland, <u>Grammes.</u>	Percentage Iodine,	Iodine Content, <u>Grammes,</u>
2.	27.0	0.0009	0.0002
3.	103.2	0.0296	0.0001
4.	60.9	0.0005	0.0003.

It has been shown (Orr and Leitch 1929) that the thyroid glands of foetal lambs have about 0.03 per cent. iodine on fresh weight. The glands from the Wanaka lambs are therefore very low in iodine. As far as is known congenital goitre in lambs had not occurred on this station before 1929, and since that year no further trouble has been experienced. Each year since an iodised salt mixture has been in constant use. A similar outbreak had been known to occur previous to 1929 on another station in the Lake Wanaka district and in the Tarris district some thirty miles away a few lambs with congenital goitre are born every year.

One seems justified in expressing doubt that a low iodine supply per se was responsible for this epizootic outbreak of congenital goitre in 1929; it would seem that some factor at present unappreciated precipitated the result, and the available iodine was insufficient to effect control. The ewes themselves were not affected and presumably the low iodine value existed previously, as the area is known goitrous territory,

In October 1933 I had the opportunity to look into another epizootic outbreak of congenital goitre in lambs which appeared on a farm on the right bank of the Clutha River near Clydevale. As has been mentioned, the Clutha River valley is a goitre endemic area and this snow fed river is Iodine free (Hercus, Benson and Carter, 1925).

The farm consisted of 500 acres of flat adjoining the river, with 345 acres of ridged country attached, the soil being rich alluvial mica schist formation. The pasture land, which was in good condition and not more than five years old, consisted of English grasses, mainly cocksfoot, perennial ryegrass, and an abundance of white clover. No topdressing had been carried out, the only manure used being that sown with the turnips.

Approximately 1500 Romney cross ewes, which had all been on the property at least fifteen months were put out with Romney, Border Leicester and Southdown Rams.

At this time, following an exceptionally dry summer and autumn, the sheep were in all the paddocks on the flat and terraces, and the ewes were not grouped together until they were put on turnips on the 9th June. The sheep were entirely on the flat while being turnip fed from this date for a period of three months until the 9th September. The roots consisted of fifty acres of swedes, comprising a heavy crop originally sown out with 2 cwt. of manure mixture per acre (superphosphate, Lime and Guano, equal parts).

Guano is rich in Iodine, Hercus and Roberts (1927) ascertained this fertiliser contained 26,400 per kgm., which among the fertilisers places it second only to Chilean Nitrates in iodine content.

The iodine content of swedes is high, Hercus Benson and Carter (1925) found swedes from the Clutha District containing 480 per kilogram dry weight and that the iodine supplied to the soil in the form of fertilisers is reflected in the roots grown therein.

One paddock approximately fifty acres was used as a run off during the three months the sheep were on the swedes, The paddock was a negligible quantity as regards food value, the ewes being given perennial ryegrass straw, which provided little else but rough fibre.

Lambing began in this flock about the end of September and cases of congenital goitre occurred from the commencement and continued up to the 27th October,

The lambs affected were similar to those previously described having greatly enlarged thyroid glands, many were born dead and others died within an hour or two of birth, In a few cases one twin was affected and the other appeared quite normal. In all 230-240 lambs out of a total of 1800 were lost from congenital goitre.

In the previous year the condition had also occurred on the same farm and about 50 lambs were lost out of a total of 2500.

In past years sporadic cases of congenital goitre have been known to occur in this district but I believe no mortality had previously approached that experienced in the case here recorded.

The thyroid glands from some of the affected lambs in 1933 were examined by the Chief Chemist and the percentage of iodine was found to be low.

TABLE 4.

ANALYSES OF LAMB THYROID GLANDS, CLYDEVALE AREA.

No.	Weight of Gland. Grammes,	Percentage Iodine.	Iodine Content. Grammes.
1.			
2.	18.55	0.0012 0.0030	0.0005 0.0002
3.	20.97	0.0030	0.0006
4.	19.78	0.0013	0.0002.

The iodine content of swedes is relatively high. Guano fertiliser was sown out with the swedes, which amounted to the addition of iodine at the rate of 0.95 grammes per acre. The ewes were not affected.

Here again it seems possible that some unknown factor controlled the incidence of congenital goitre in this particular year. It is possible the swedes were capable of goitrogenic activity. The rather poor nutrition of the ewes for the three months they were turnip fed may have been of some significance or it may have been the fouling of the ground by comparatively heavy stocking for so long a period.

In this latter connection it is of interest to mention an opinion which, however, is not widely held. McCarrison (1937) writes "Insanitary conditions involving the contamination of the food and drinking water by human and animal excreta is a potent goitrogenic agent in localities where the iodine content of the soil is low. In regions (Himalayas) where these conditions prevail

endemic goitre and **its** congenital manifestations are rife..... Goitre in animals and congenital **goitre** and cretinism in their offspring have been produced, under experimental conditions, by the administration to them of extracts of **faccal** material or of bacterial cultures made from **faccs**."

Since 1933, Potassium Iodide has been used on this farm at **Clydevale** and no 'further incidence of Congenital goitre has been recorded, At the **same** time the **ewes** have not again been subjected to such poor management as was the case that year.

In the Inchclutha district sporadic cases of congenital goitre in lambs occur from time to time. In the 1936 season one farmer there lost 50 lambs from this cause; at the **same** time other lambs were affected **but** they ultimately recovered, The farmer concerned is a keen observer and his experience is worthy of **consideration** especially in view of the fact that goitrogenic activity has been observed sporadically in certain substances. He attributes the loss last year to the fact that **after finishing** his lambs on rape he **flushed** the ewes on the remainder of the rape about the time the rams were put out. This same farmer has had previous experience of congenital goitre and he **believes** that the offspring of ewes put on turnip tops have predisposition to congenital, **goitre**.

This opinion is based on the fact that for **two** years running he put old **broken** mouthed ewes on turnip tops and each time **congenital** goitre followed in the lambs.

At any rate, in future outbreaks a close enquiry must be made into the nutrition and management of the ewes throughout the gestation period, and an **attempt** made to correlate the **facts** collected.

In connection with the subject of Iodine **deficiency** in sheep, an iodine survey of sheep and lambs thyroid glands has been carried out in **recent** years in New Zealand by various workers (Mason, 1933; Sykes, 1934; and Mason and Waters 1936).

As far as this Dominion is concerned the work confirmed the previously well known existence of an inverse relationship between the weight of the thyroid glands in sheep and the percentage of iodine they contain. This relationship was found to be negligible until the percentage of iodine has fallen below a certain value 0.03 per cent of the **fresh** weight.

In this **survey** the iodine values were considered from the point of view of certain geological types, and the results obtained in Otago, Southland, Canterbury and the Wairarapa districts were compared. The samples in the alluvial group showed a lower iodine **content** and a higher weight and higher percentage of moisture, though no gross enlargement was recorded than did those of any other district.

The high incidence of goitre in man associated with alluvial soils in New Zealand was demonstrated by Hercus, Benson and Carter (1935); they found a low iodine content in soils associated with river beds and with alluvial flats, where leaching of the soil takes place. In New Zealand this result was later confirmed by Shore and Andrew (1929).

It is interesting to note that an iodine survey of the thyroid glands of sheep in Australia has been carried out (Dawbarn and Farr, 1932). A statistical survey of the dry weight and total iodine content of the thyroid glands of 700 sheep has been recorded. For the districts investigated no iodine deficiency was shown in the animals,

IODINE AND MINERAL SUPPLEMENTS:

Since the war, following publication of the work dealing with endemic goitre and a low iodine supply, many claims have been made regarding the value of iodine in the nutrition of domestic animals and for the prevention and cure of numerous diseases apart from those for which the therapeutic use of iodine has long been recognised. By state propaganda, commercial interests all over the world have not been slow to exploit these claims.

It is impossible here to refer to all the experimental evidence purporting to support the claims made, but it is sufficient to say that the issue is not by any means so clear, as some of the work appeared to make it. Feeding experiments, for example, have been extensively carried out on domestic animals, with the addition of iodine to the diet of certain groups. The conclusions drawn have frequently been conflicting, while information as to the iodine content of the basal rations used was lacking.

In regard to pigs, various recorded work goes to show that the use of iodine stimulated growth and encouraged thriftiness. The accepted opinion now is that there is little evidence to support this view. In experiments at the Rowett Institute (Orr, 1930) it was found that with young pigs on a somewhat restricted experimental ration, the addition of iodine caused an improvement in the assimilation of nitrogen and phosphorus with increased gain in weight. On the other hand, in practical feeding experiments extending over two years, with large groups of pigs which were allowed outside occasionally to graze or root, the results of addition of iodine to the food were negative. No benefit whatever appeared to follow the increased consumption of iodine.

In cattle, the effect of iodine on the milk yield has received attention and it has been suggested that the addition of iodine will increase the milk yield. The evidence in this direction is not convincing. If cattle are receiving well balanced rations, containing the optimal amount of iodine, it seems improbable that the addition of further iodine will increase the milk yield.

In the case of sheep much has been published regarding the value of iodine on wool growth. An experiment dealing with the effect of feeding an iodised lick, on the growth and wool of the Australian Merino sheep was reported by Lines (1933). Increasing the iodine intake by an average of 185 per day for 47 weeks had no significant effect on the growth or wool production of lambs at "Keytch", New South Wales. The amount of potassium iodide in the lick was changed periodically from 1 part in 1000 to 1 part in 7000 but the amount of iodine in the thyroids of the animals hardly varied over the whole period.

The average iodine content of the thyroids of 101 sheep receiving iodised lick at "Keytch" was 0.60 per cent, and of 70 glands from a similar adjoining property where no lick was given was 0.55 per cent. The mean for some 500 glands of Australian sheep analysed by Dawbarn and Parr (1932) was 0.56 per cent iodine.

In South Africa other work is reported (Malan, Du Toit and Groenewald, 1932). In an experiment covering a period of two years the effect of giving 0.02gm. of Potassium Iodide daily per head in the ration of three groups of ewes kept on different levels of phosphorus intake was noted. The iodine was apparently without effect on the growth, food consumption, wool growth and mortality.

The same authorities (1935) reported the results of feeding potassium iodide to Merino ewes over a period of 30 months. The quantities of Potassium Iodide given per sheep daily were 0.002

grammes, 0.02 gm. and 0.6 gm. in three groups respectively, while one group received no Potassium Iodide and acted as controls.

Observations were made on the food, consumption, weight increase, wool production, reproduction and the health of the animals for the full period of the experiment. In addition, observations were also made on the oestrus cycle of the ewes and in the end no significant group differences were recorded. The authors conclude that the addition of Potassium Iodide to sheep licks is unwarranted and is to be discouraged in practical farming unless there is reason for believing that an iodine deficiency exists. The harmful effects, of too high doses of iodine have been recorded (Orr, 1930). The vigour of lambs at birth decreased and the number lost during the suckling period increased when the ewes were fed 394.6 mg. of Potassium Iodide per day for 2½ months.

In view of the widespread practice of feeding iodine, the doses that could be fed to different classes of domestic animals without producing toxic symptoms were worked out at the Rowett Institute, Aberdeen (Orr, Crichton and Middleton 1929). Increasing doses were fed to calves, sheep, pigs and poultry over periods of from three to five months. The results are summarised:

TABLE 5.

	Range of Dosage gms. iodine,	Level at which toxic symptoms appeared. Gms,	Total fed per head, gms.
Calves	0.25 to 5.0	3.5	229.25
Sheep	0.05 to 0.35		37.05
Pigs	0.25 to 5.75		335.00
Poultry	0.01 to 0.31	0.31	14.26.

However, the toxic symptoms disappear as soon as the iodine is eliminated and apparently there is no lasting damage. It is of interest to note that iodine is a specific for ACTINOBACILLOSIS and some cases of actinomycosis in cattle and very large doses of Potassium Iodide are given to adult animals amounting to half an ounce per day for 7 - 12 days. After about a week symptoms of iodism occur, depression, diminished appetite, catarrh of the nasal mucous membrane and conjunctiva, "hidebound," scaly skin, eruption and the hair may fall off in patches. After the administration of iodine ceases, the animal quickly recovers from the toxic effects and as far as is known no permanent defect follows. It has been suggested that heavy prolonged dosage may produce glandular atrophy which in the case of the testicles in male animals results in impotency, though I have never known this to occur in any of the many cases observed under treatment for the above diseases.

As I have stated the experimental evidence of the use of iodine in animal nutrition is still very conflicting, necessitating a conservative outlook in regard to the advocacy of iodine as a constant ingredient of mineral supplements unless in very small quantities, which may be increased in goitre endemic areas, especially on those farms where sporadic epizootic outbreaks of congenital goitre have been known to occur.

Unfortunately the estimation of suitable amounts of iodine to be used for the prevention of goitre in animals remains on a somewhat empirical basis.

For the condition described in young pigs which can be prevented by the administration of iodine, not more than 2 grains of Potassium Iodide should be supplied to the sows daily during the gestation period. It has been suggested that even 2 or 3 grains in the feed twice weekly is sufficient to prevent the occurrence of goitre.

The administration is best effected by dissolving 1 ounce of Potassium Iodide in 1 gallon of water and giving each sow one tablespoonful of this mixture in the food daily.

As a prophylactic measure in the case of goitre in sheep, such quantities of Potassium Iodide as 2 - 3 ounces in one hundred-weight of agricultural salt have frequently been prescribed, but in all probability this amount is unnecessarily high.

Each ewe would not require to take in more than three grains per week, and a suitable iodised mixture could be supplied by the addition of one ounce of Potassium Iodide to 300 lbs. of Agricultural salt,

Such a mixture ought only to be supplied to sheep in quantities sufficient to last a few days.... If a large quantity is put out, there is some loss of iodine due to exposure to light and moisture. For this reason the mixture put out in troughs or boxes is more suitable than the use of iodised block salt.

In cattle the daily intake requirement is approximately 2 grains per day; a suitable mixture could be made by the addition of 1 ounce of Potassium Iodide to 150 lbs. of agricultural salt.

In the actual treatment of goitre in young animals it has been found that small doses of Potassium Iodide gives the best results, Doses of  $\frac{1}{4}$  gr. given once daily for 1-3 weeks in dogs and lambs and for rather longer periods in calves and foals.

Externally colourless tincture of iodine can be applied to the skin over the seat of the thyroid enlargement, daily or every second day.

In order to inhibit the influence of possible factors having some degree of goitrogenic activity, in addition to the more specific iodine therapy in goitre prophylaxis in the case of congenital goitre in sheep, it is essential that adequate attention be paid to the general nutrition of the ewes during pregnancy and that measures be adopted to ensure that they receive plenty of exercise.

A successful lamb percentage is largely bound up with the care and attention which the ewes have received during the previous six months, The value of mating the ewes when they are gradually improving in condition is well established, This means that the ewes should be "flushed" i.e., have access to better feed for three or four weeks before the rams are introduced. Afterwards the standard of nutrition must be kept up to meet the demands of maintenance and advancing pregnancy.

In Otago and Southland sheep farmers depend to a large extent on turnips and swedes used for the winter maintenance of their ewe flocks, the soft turnip being used when commencing to feed sheep on roots in the early winter and swedes in the late winter and early spring. The root crops are the mainstay for winter feeding and must remain so at present in this district, where the pastures are dormant for a long period.

However, not nearly sufficient attention is being paid to the necessity for the utilisation of additional dry feed to balance

the root ration. Both turnips and swedes have a high water content, approximately 90%, carbohydrate 6 - 9 per cent and are low in protein, about 1 per cent.

Often a run off paddock is provided adjacent to the turnip ground, but its value in regard to the provision of supplementary feed is soon negligible. More chaff or hay, with the addition of a little linseed meal or meat meal is required to improve the ration of ewes on roots,

Roots frequently deteriorate in value, owing to dry rot, clubroot, etc., and again if there should be a fresh growth of tops as occurred in many places in the spring of 1936. The food value of roots tends to decline, therefore, as the demand of the ewe for adequate balanced nutrition increases,

At times excessive quantities of roots are fed which should be avoided in ewes prior to lambing, as the distension produced tends to interfere with the normal development of the lamb in utero, and may result in abortion or the birth of weak lambs.

It is certain that the effect of good feeding and management of the ewe flock is reflected in the health, strength and vigour of the lambs produced.

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