1-1-1965

Clover disease of sheep in Western Australia

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Clover disease of sheep

SUBTERRANEAN CLOVER is truly the Dr. Jekyll and Mr. Hyde plant of Western Australian agriculture. It has been responsible for enormous increases of agricultural production over the past 25 years and yet some strains have caused more trouble than many poison plants.

If your pastures contain subterranean clover you should know the following facts:

Signs of Clover Disease . . .

1. A progressive loss of fertility of ewes which is more or less permanent.
2. Difficult lambing, with frequent loss of lambs and often of ewes.
3. Heavy loss of lambs in the first two or three days after birth. (This may also be due to other causes. A loss of 15 per cent or more of lambs is usual even in the absence of clover).
4. Prolapse or turning inside-out of the uterus or womb.
5. "False bladder" in wethers.
6. Milk secretion in virgin ewes and wethers. This is probably harmless but indicates the possibility of more serious aspects developing.

Cause of Clover Disease . . .

The disease occurs in sheep grazing on pastures consisting mainly of Dwalganup and Yarloop strains. The Dinninup strain is also suspect. The predominance of clover is usually a feature of newly developed land and clover disease generally decreases in severity on older pastures where grasses and other non-clover species predominate. The dangerous strains are potent throughout the growing period and become harmless when they wilt and dry. Hay, as usually prepared, is safe.
Recommended Practices for Minimising Clover Disease . . .

(1) DON'T sow Dwalganup or Yarloop strains unless absolutely necessary. Avoid using the Dinninup strain until further information is available.

(2) DON'T graze breeding ewes on green pastures dominated by Dwalganup, Yarloop or Dinninup strains. If possible, avoid prolonged grazing of breeding ewes on dominant stands of any strain of subterranean clover during the growing period.

(3) DON'T mate ewes on green subterranean clover of the potent strains. It is good practice to avoid mating on any green subterranean clover.

(4) SOW either Mt. Barker, Woogenellup or Geraldton strains according to your rainfall and district requirements. Alternative strains are Bacchus Marsh and Clare. Rose clover, cupped clover, serradella and lucerne appear to be non-potent and should be useful substitutes in some areas.

(5) Try to shorten the period when subterranean clover is the dominant pasture species by heavy dressings of superphosphate and by oversowing with oats or grass.

(6) EWES not intended for breeding are preferable to wethers for grazing on dominant stands of the potent strains. Wethers should only be allowed limited access to such pastures. Cattle appear to be unaffected.

Further information is given in the following article.
ANIMAL DISEASES

CLOVER DISEASE OF SHEEP IN WESTERN AUSTRALIA

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DURING the past five years there has been a marked increase in the incidence of breeding abnormalities of sheep associated with the grazing of subterranean clover pastures. This complex of diseases first became a major problem in Western Australia in the years following 1940 and eventually became known as “clover disease”.

Clover disease was first defined by Dr. H. W. Bennetts to include the following signs:

- infertility in ewes;
- dystocia or difficult lambing;
- uterine prolapse;
- lactation in virgin ewes and in wethers; and
- the so-called “false bladder” in wethers.

Subsequent investigations have suggested that, in addition, to these, there is usually a heavy loss of lambs during the first few days after lambing.

Clover disease in its severe form is essentially a disease occurring on new country sown with certain strains of subterranean clover. These strains rapidly become the dominant pasture species and grazing sheep are forced to consume large amounts of the clover, which in time produce the toxic effects listed above.

After several years however, the clover builds up the nitrogen levels in the soil and, provided adequate superphosphate has been used, grasses and other non-leguminous plants usually become the dominant pasture species. Under these conditions the more spectacular signs disappear or become of minor importance. In some cases a small, but definite infertility seems to persist, but whether this is due solely to subterranean clover is not yet known.

In recent years large areas of virgin country have been developed and sown to pasture. Such pastures have rapidly become clover dominant and sheep have had little or no alternative grazing. In addition there has been a widespread use of the two strains, Yarloop and Dwalganup, which are now known to be the most dangerous. The inevitable result has been that clover disease has again become a major problem.

Although we still do not know the exact ways in which subterranean clover causes breeding troubles in sheep, it is possible to make recommendations which should give a good measure of control. This article is a summary of field observations and of the more practical aspects of research carried out in Western Australia and in other States up to the end of 1964.

BASIC ASPECTS OF CLOVER DISEASE

The female reproductive system of all mammalian species is controlled largely by a group of chemical compounds called “female sex hormones,” or more commonly, “oestrogens.” These compounds are formed in the ovaries and are secreted into the blood stream. The oestrogens of all mammals have a special
chemical structure, but other compounds producing similar effects occur in certain plants and still other types have been made artificially.

Under normal conditions, the supply of oestrogens to the organs of the body is carefully regulated. If for any reason this control breaks down or if the animal is subject to an outside source of oestrogens, certain tissues and glands develop and function abnormally. The male also contains tissues which are sensitive to excess oestrogen but under normal conditions the male sex hormone (produced mainly by the testicles) can counteract the effect of such oestrogen. In the castrate male this protection is absent and excess oestrogen can cause striking pathological changes.

Very early in the history of clover disease it was shown that the clinical signs in sheep were those which would be produced by the ingestion of an excessive amount of oestrogen over a prolonged period. Laboratory tests showed that the Dwalganup strain did in fact contain such substances although their nature was not known at the time.

In 1951 it was shown that the Dwalganup strain contained two closely related compounds called genistein* and formononetin.* Some years later another very similar compound, biochanin A,* was isolated from the clover. Tests with mice and guinea pigs showed that genistein had small but definite oestrogenic activity, biochanin A was about half as active as genistein while formononetin showed no activity. Confirmatory feeding tests with sheep were not possible because of the enormous cost of these compounds but on the basis of the small animal tests it was concluded at the time that genistein was the main cause of clover disease.

At present the actual potential of any strain of clover for producing clover disease can be assessed with any confidence only by measuring the effect on the breeding performance of ewes over a number of seasons. This is being done both by the Department of Agriculture and by C.S.I.R.O., but there are great difficulties in carrying out controlled experiments of this type. Research workers have therefore devised short-term tests with the idea of obtaining some quick assessment of the potency of any particular strain. Three such tests are currently being used:

CHEMICAL ANALYSES: New and simple chemical tests have been devised to estimate the amounts of genistein, formononetin, and biochanin A in the leaf of various clover strains.

WETHER TEAT LENGTH TEST: If potent strains of clover are fed to wethers for five to 10 days there is a marked increase of teat length due to the oestrogen in the clover. By feeding a known amount of clover and by measuring the increase of teat length it is possible to estimate the oestrogenic activity of the clovers.

EWE UTERINE WEIGHT TEST: In this test, clover is fed for six days to spayed ewes (ewes with ovaries removed) after which the animals are killed. If the clover has oestrogenic activity it is found that the uterus or womb has increased in weight, and the weight increase is related to the amount of oestrogen consumed by the sheep.

The results of the two animal tests are rather similar, and parallel in a very broad way the field observations that there are great differences in the oestrogenic potency of the clover strains used in Western Australia. However, the correlations between the two animal tests, the chemical analyses and the field observations are far from perfect, and we cannot be certain that the result of any test actually measures the potential of a strain for producing clover disease in the field. It would seem likely that high levels of both genistein and formononetin are necessary to produce the disease but we cannot exclude the possibility that there are still undiscovered factors in subterranean clover which are involved.

* These compounds had been isolated previously from other plants but their oestrogenic nature was not suspected. Their curious names are derived from the plants in which they were originally found—Genista tinctora, a broom bush, Ononis spinosa, a small leguminous shrub from Europe, and germinated "chana" or chick pea, a legume used for human food in India.
CLINICAL CONDITIONS CAUSED BY SUBTERRANEAN CLOVER

A number of variations of clover disease are recognised, affecting both ewes and wethers. The descriptions given in the following paragraphs are restricted to those conditions involving the reproductive tract. A subsequent article will deal with kidney stones and urinary calculi which sometimes form in sheep grazing subterranean clover and which account for a significant fraction of actual deaths associated with consumption of the plant.

It is obvious that the manifestations of clover disease will be more noticeable and of greater severity during the early stages of the development of a subterranean clover pasture than in later years when a "balanced" sward has been achieved. During the early stages of pasture development more than one sign of clover disease is usually noticed. In following years a lowered fertility is usually the most pronounced sign with only a low incidence of the other signs. There seems to be a tendency for one particular sign of the disease to predominate in any affected flock but no explanation can be offered why one sign rather than another should thus occur.

EWES

1. Stillbirth and Early Neonatal Death

Under usual farming practice in Australia about 10 to 20 per cent. of lambs are born dead or die within the first week of life and this is accepted as a normal loss.

Investigations have indicated that the more important causes of these losses are starvation and mismothering, climatic stress and, occasionally, disease of infectious origin. These main causes appear to be as important in non-clover areas as in districts in which pastures are based on subterranean clover.

However, ewes which have grazed dominant subterranean clover pastures for a prolonged period may show losses which are appreciably higher than the usual figure. These losses are probably due to a lengthening of the normal duration of the process of birth. Although this is not sufficient to cause the severe difficulties of lambing as described below, it does interfere with the essential oxygen supply to the lamb during the critical birth process and may cause its death, either during its passage through the birth canal, or within the ensuing 24 to 48 hours.

Maternal behaviour of the Merino ewe has been shown to be greatly affected by the degree of difficulty of the birth process. If this is slow and long from any cause, or painful, desertion of the lamb by the ewe may follow. Thus the appreciable increase in the lambing time caused by subterranean clover may be a real factor in mismothering.

It has been known for many years that heavy loss of lambs in these ways is one of the main features of clover disease.

2. Dystocia or Difficult Birth

Difficult birth of lambs, mainly due to uterine inertia, has been known for many years to be one of the major complications in ewes which have been grazing on potent subterranean clover pastures. In this form of the disease, the influence of clover oestrogens on the reproductive tract of the ewe is great enough to depress profoundly the normal physiological functions of the birth process.

By uterine inertia we mean that the normal contractions of the uterus are so weak, and the associated periods of labour so feeble, that little or no progress toward expulsion of the lamb takes place. Sometimes the lamb is delivered but is dead. This form of dystocia of course merges with the kind of clover disease described in (1) above. More characteristic, however, is the complete failure to deliver a lamb either living or dead. Usually the so-called "water bag" ruptures and part of the lamb is extruded and becomes visible. A portion of the head or forequarters may be seen emerging from the birth canal and the ewe may be making little or no effort to assist in the birth. The loss of the normal lubricant of birth consequent to the breaking of the "water bag" results in the drying out of the lamb.

Thus normal birth becomes almost impossible and the partially-born lamb quickly dies and undergoes decomposition followed by a septic degeneration of the uterus and its contents. Death of the ewe sometimes follows or the retained lamb becomes mummified.
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In none of the forms of clover disease is there any shortening of the normal term of pregnancy; although lambing is abnormal, it begins on the expected date. If premature births are observed, some form of infectious disease should be suspected.

Accumulated experience suggests that dystocia is principally associated with previous grazing of potent strains of green subterranean clover but many months may elapse between the last period of consumption of the green clover and an outbreak of dystocia in which many lambs and ewes may be lost.

3. Infertility

Ewes from clover-free areas show a progressive decline in lambing and marking percentages when depastured annually on potent strains of subterranean clover. Little or no effect is noted in introduced ewes during the first year or two but the lambing percentage may drop to as low as 10 to 20 per cent. in four or five years. Affected ewes take the rams normally and return for service more or less regularly at the normal heat periods (17 day cycle).

The severity of the infertility increases with the duration of grazing on potent clover and the effect may begin in the first six months of life when ewe lambs graze substantial amounts of green clover.

Experiments carried out on infertile ewes, both in South Australia and Western Australia, have shown that in some cases the infertility persisted for at least several years after transfer of the ewes to non-clover grazing. In some cases, presumably among animals which were less affected, a recovery of fertility did occur.

In Western Australia infertility due to subterranean clover is associated with marked changes in the reproductive tract. The linings of the uterus and cervix (the neck of the uterus) become covered with fluid-filled cysts which vary from microscopic size up to one half inch in diameter, a condition which has been well described as "cystic endometrium." The cystic condition becomes progressively worse with continued grazing of potent clover. In severe cases these cysts appear to be permanent and fertility is not restored by a transfer to clover-free pastures. For a long time it was thought that the cysts acted mechanically and prevented sperm transport and implantation of the fertilised egg. It is now considered doubtful whether these are the only effects, as normally developed lambs have occasionally been observed in ewes with pronounced cystic changes in the uterus.

We can only say at present that cystic degeneration is the end result of the consumption of potent subterranean clover over a period of years, paralleling in a general way the decline in fertility in which fertilisation and implantation appear to be prevented or hampered.

Gradual Decline in Fertility

It has already been mentioned that "well-balanced" pastures containing a relatively small proportion of subterranean clover may be responsible for a slight general decline in ewe fertility without any of the more obvious signs of clover disease.

Tests are being carried out at the Avondale Research Station, Beverley, to compare the lambing performance of sheep grazing for five seasons on cereal crops only as compared with those grazing on the normal grass-Dwalganup subterranean clover pasture of the Research Station. After four years a considerably greater number of lambs and particularly of twins, has been obtained from the group grazing cereals only. Furthermore, there has been a noticeable lengthening of the lambing period of the flocks on the oestrogenic clover pasture, resulting from the failure of some of the ewes readily to get in lamb. This lengthening of the lambing period may be the first practical indication of the adverse effect of clover grazing during the previous one or two seasons. Further investigations of these aspects are necessary but the results do indicate the importance of restricting the intake of potent clover by breeding ewes.

Mating on Green Potent Clover

In eastern Australia a marked infertility, similar to that found in clover disease, has been observed in ewes grazing on red clover for a number of seasons. Red clover contains appreciable amounts of formononetin and biochanin A but lacks genistein which is present in large
amounts in the toxic strains of subterranean clover. Research workers investigating the effects of red clover have also discovered another type of infertility which is apparently different from the types mentioned above. This occurs when sheep are grazing potent clover at the time of mating. It appears that the infertility is of a temporary nature, lasting up to about five weeks, and the sheep will subsequently conceive if transferred to non-clover pasture. As Western Australian sheep are usually mated on dry subterranean clover, which appears to be non-potent, this type of infertility would not occur under normal conditions. However, in years of early rainfall, green clover could be present in some southern areas and cause lowered fertility when mating is carried out for spring lambing.

4. Prolapse of the Uterus

A partial or complete eversion of the uterus is a not-uncommon occurrence in ewes which have recently grazed, or are grazing, potent subterranean clover pastures. This form of disease is mainly seen in the period August to October, when the oestrogenic content of the pastures is at its height. Prolapse of the cervix or uterus may also be seen occasionally during the summer months on dry feed, often long after experience with green subterranean clover.

Very much less severe prolapse is sometimes seen in unbred ewes. Probably in these cases the uterus does not turn completely inside out because the uterus and opening of the cervix are not enlarged as they are in pregnancy, and the prolapse appears to be restricted to the cervix. All degrees of eversion may be seen, from a small inflamed tube to a thick greatly swollen mass of tissue protruding from the vulva. Occasionally, straining and other lambing signs are seen in these unbred ewes. The tissues of a prolapsed uterus may become infected or die and this leads to early death of the affected ewe.

It is difficult, if not impossible, to treat uterine prolapse successfully under the extensive grazing conditions of most districts of Western Australia, and it is better to destroy affected animals and remove the balance of the flock to a safe pasture.

“High-tail”

Prolapse of the uterus is basically related to another clover disease manifestation, popularly known as “high-tail,” in which the base of the tail appears to be elevated due to a rotation of the pelvis. Both conditions are the result of relaxation of the pelvic ligaments and of a loss of normal tenseness or firmness of the tissues in the pelvic region. “High-tail” may be considered as evidence of previous experience of subterranean clover oestrogens and may be further manifested by abnormal movements, and a grating sound, when the pelvic bones are manipulated. “High-tail” is not, however, necessarily associated with lowered fertility due to clover disease and should be regarded as an indication only of a possible loss of fertility.

5. Lactation

Occasionally virgin ewes may exhibit some degree of udder development and lactation. This has been considered to be a manifestation of a highly oestrogenic pasture.

WETHERS

At least three clinical conditions resulting from potent green subterranean clover intake are recognised in the castrated male sheep.

1. Lactation in Wethers

Lactation of wethers is probably the commonest sign of clover oestrogen intake. It has no economic importance but is a useful sign of the potency of a green subterranean clover pasture and of the possible occurrence of more serious consequences to wethers if allowed to continue to graze on the pasture.

There is still some doubt whether oestrogens are the only cause of this, as lactation has been seen occasionally in wethers grazing on non-potent subterranean clover pastures and even on pastures containing little or no subterranean clover of any kind.

2. “False Bladder”

“False bladder” is first noted in the form of fluctuating swellings in the region under the tail and on either side of the anus. Internally it is a large sac or
"False Bladder."—Urinary organs of a wether affected with clover disease, showing the greatly-enlarged bulbo-urethral glands.

bladder communicating with the urethra (the tube leading from the bladder to the penis) and is filled with fluid.

This structure is derived from two small glands (bulbo-urethral glands) which are normally present on the upper surface of the urethra in all male sheep. These glands are affected by clover oestrogen in much the same way as the female uterus and cervix; they enlarge, become cystic and, with prolonged oestrogen stimulation, break down to form the large sac which becomes filled with fluid.

The condition usually becomes clinically obvious during the spring. Affected wethers show the external swelling in the region of the crutch. In advanced cases, the animals lose condition and may die but the exact cause of death is not known.

In some cases the enlarged glands become infected and the wether is likely to die. It has also been thought for a long time that the urethra may become blocked with dead tissues from the gland, but the absence of rupture of the urinary bladder in the vast majority of cases casts considerable doubt on this belief. The swollen bulbo-urethral glands may sometimes rupture externally with discharge of the contents, sometimes mixed with urine, over the crutch.

If mildly affected animals are changed to non-clover grazing, the enlarged glands will diminish in size and may become clinically inapparent, although it
is doubtful if they ever return to normal. A similar regression occurs at the end of spring when the clover wilts and the oestrogenic potency decreases rapidly.

**RAMS**

The entire male is protected from the effects of the clover oestrogen by the male sex hormone which is secreted by the testicles. Workers in eastern Australia have shown that synthetic oestrogens can reduce ram fertility but there is no evidence to suggest that potent clover produces similar effects. Limited testing up to the present time has shown no measurable effect on the quality of semen from rams grazing potent clover.

Lactation has been observed in rams grazing subterranean clover but this is rare.

**PRACTICES RECOMMENDED FOR MINIMISING CLOVER DISEASE**

IN spite of the toxic nature of at least some of the strains, subterranean clover has been responsible for enormous increases of general productivity in large areas of Western Australia. It seems that farmers must learn to live with subterranean clover, to utilise its advantages and to minimise as far as possible its undesirable properties.

Although there is no likelihood that any other clover will be available for large-scale replacement of existing strains of subterranean clover in the immediate future, it is possible that non-potent strains will eventually become available. The Institute of Agriculture at the University of Western Australia has successfully bred strains which, judged by chemical tests, are virtually free from the known oestrogens, but it will be some years before such strains are thoroughly tested. It is also possible that low-activity field selections will become available in the interim.

**Other Legumes**

There are a few legumes which may prove useful substitutes for subterranean clover in certain areas.

Rose clover (*Trifolium hirtum*) and cupped clover (*Trifolium cherleri*) are probably non-oestrogenic but there is little evidence on their performance under heavy grazing pressure or on the most suitable methods of grazing management for these species.

Cyprus barrel medic and harbinger medic grow well on neutral, alkaline or calcareous soils of the drier areas but these two legumes can contain appreciable amounts of another oestrogen, coumestrol. Although there is no field evidence to suggest that the coumestrol is affecting the breeding performance of ewes, some caution may be desirable until controlled tests have been made.

Commercial strains of lucerne and serradella are non-oestrogenic. At present, lucerne is used only on a small scale. It could, however, be used extensively on the western sandplain and along the south coast, particularly on the deeper sands. The use of serradella has been limited so far to deep sands in the medium to higher rainfall areas where it has proved to be a useful pioneer legume.

**Avoiding Toxic Strains**

It is now clearly established that among the commercial strains of subterranean clover there are marked differences in oestrogenic potency. By use of less toxic strains, the danger of clover disease can be greatly reduced.

Field evidence and short-term sheep tests clearly indicate that Yarloop (also known as white seeded) and Dwalganup are the most potent of the commercial strains. In some old-established areas, Dwalganup pastures are regarded as “safe.” This appears to be due to the fact that such pastures now contain a large proportion of grass or other non-leguminous species so that the amount of clover eaten is relatively small.

There is little field evidence against the Dinninup strain but chemical analysis and sheep tests indicate that this strain must be regarded as potentially dangerous.

At the other end of the scale, the Mt. Barker (Mid-season) strain has not been known to cause any breeding troubles with sheep and sheep tests indicate that it has a very low oestrogenic activity. Bacchus Marsh is very similar in chemical composition to Mt. Barker and it has been
used for many years at the Esperance Downs Research Station with no untoward effects. Occasional reports of lowered fertility have been attributed to Bacchus Marsh but it would seem generally to be a safe strain.

The Geraldton, Woogenellup and Clare strains appear to occupy an intermediate position. There are no field reports that these strains cause clover disease but the short-term sheep tests indicate that they have some degree of potency which, however, is usually much less than that found in Yarloop or Dwalganup.

At present no assurance can be given that sheep will not develop any signs of clover disease if grazed for a prolonged period on dominant stands even of the "safe" strains. It is certain, however, that the effects will be much less severe than with Dwalganup or Yarloop.

Dry Clover is Safe

The potent strains of subterranean clover maintain their activity throughout the growing period. During wilting, the clover oestrogens largely disappear and dry clover is safe for both ewes and wethers. Clover hay as usually prepared in Western Australia is likewise inactive although it is possible to prepare highly potent hay by very rapid drying. No sheep tests have been made with clover silage which, from chemical analysis, contains an appreciable amount of oestrogens.

A Measure of Control . . .

The following procedures should give a considerable measure of control of clover disease:

1) The Yarloop and Dwalganup strains are highly oestrogenic and should not be planted if it is possible to grow other strains. The Dinninup strain is probably potent as well. If rainfall, soil conditions and general pasture requirement permit, Mt. Barker should be planted; otherwise, Woogenellup or Geraldton are recommended. Bacchus Marsh and Clare may also be used but generally they have no agronomic advantages over the other strains mentioned.

2) Every effort should be made to encourage the growth of grasses and to shorten the period during which clover is the dominant plant species, particularly where toxic strains are grown. This may be very difficult in the early years of pasture establishment before the soil nitrogen level has been built up. The local agricultural adviser can advise on the best method for any particular area but the following general procedures have been successfully used to reduce clover dominance.

Adequate superphosphate should help to shorten the time necessary to establish grasses.

Oversowing with oats will lessen the percentage of clover in the sward and will provide alternative non-oestrogenic grazing.

Harrowing will encourage the growth of Wimmera rye grass in some areas. If this is not present in established pastures, it should be sown.

Nitrogenous fertilisers applied in the early stages of pasture development may help prevent clover dominance.

3) Ideally, breeding ewes and wethers should not be grazed on pastures dominated by toxic strains of subterranean clover during the growing season. Farmers are sometimes forced to use such pastures and some clover disease must be expected if any prolonged grazing is given. Clover-dominant paddocks are best grazed by non-breeding ewes.

Lactation has been observed in virgin heifers grazing on Yarloop clover but no other effects have been noted in cattle grazing the toxic strains under West Australian conditions. Clover dominant pastures are safe for any stock when dry and hay is probably safe. Until more information is available, caution should be used when grazing breeding ewes on
dominant stands of the less toxic varities.

Mating should not be carried out on green clover pastures.

(4) When buying new ewes, it pays to make sure that they have not come from clover-dominant areas. The buyer is likely to inherit somebody else's infertility problem.

CURRENT RESEARCH

Research into clover disease in Western Australia is coordinated by a Technical Committee on which are represented the Department of Agriculture, the C.S.I.R.O. Division of Plant Industry and the Institute of Agriculture of the University of Western Australia.

Current research includes the study of—

- Long term effects of various strains of subterranean clover on the breeding performance of ewes under field conditions.
- Effects of mating ewes on green subterranean clover.
- Effect of subterranean clover on lamb survival.
- Effects of trace elements on clover disease.
- Breeding and selection of clover strains low in or free from oestrogens.
- The effect of fertilisers and other environmental factors on the amounts of oestrogen in subterranean clover.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the members of the Western Australian Technical Committee for Sheep Infertility, to many Officers of the Department of Agriculture and to Dr. H. W. Bennetts for discussions on the material set out in this paper.

APPENDIX

Selenium, Cobalt and Clover Disease

Since the discovery of white muscle disease and the associated selenium deficiency of sheep in Western Australia in 1960, there has been considerable speculation concerning the possible beneficial effects of selenium on clover disease. Annual surveys conducted by the Animal Health Laboratory and the Government Chemical Laboratories have shown that many subterranean clover pastures in the higher rainfall districts are likely to be deficient in selenium during the late winter and early spring.

However, limited trials carried out by the W.A. Department of Agriculture have so far given no support for the contention that selenium supplements have a protective effect in clover disease.

Work is continuing on this aspect of the problem and it is hoped that more definite information will be available in the near future.

Suggestions have also been made that a lack of cobalt may be responsible for clover disease. Tests carried out in this State and elsewhere have failed to give any support for this theory.