Augmentation of Fertility in Sheep

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I think few will question the importance of the lambing percentage level in relation to the well-being of the New Zealand sheep industry, and in most districts the enormous scope that exists for improvement in this respect is generally recognised.

As some of you are no doubt aware, one of my main research interests at Ruakura lies in investigating methods whereby lambing percentages may be increased. As one method of approach to the problem, I have been attempting to breed for improved fertility, and as another have been studying the nature and extent of neo-natal mortality among lambs, to see whether there is not some hope of raising the proportion of lambs reared by judicious flock management prior to and during lambing. Further, it is clear that a major factor limiting fertility in the ewe is the number of eggs shed at the successful mating heat, and I have been investigating two methods by which this may be influenced. In a paper delivered at this conference last year, I discussed the extent to which the ovulation rate may be stimulated by an enlightened flushing programme. My purpose this morning is to describe the results of experiments designed to achieve a similar result by the use of injected gonadotrophic hormone.

I do not intend to attempt to review the voluminous literature that now exists on this subject, for this has lately been done by Robinson, who worked with Hammond at Cambridge in this field during recent years. It will, however, be convenient to mention the principal findings which guided us in planning the work at Ruakura. A number of workers have produced evidence that by administration of gonadotrophic hormones during the later stages of the oestrus cycle of the sheep, development and subsequent ovulation of an abnormally large number of follicles can be induced. But in general, overall results have been somewhat disappointing. Often lambing percentages have not been significantly increased and in many instances an unduly high proportion of the treated animals failed to conceive to the heat following injection. Robinson's recent work has, however, been encouraging, and although he also has achieved no spectacular increases in final lambing percentages, his work has thrown considerable light on the reasons underlying previous failures and has emphasised that further work on the question is amply justified.

In essence, the technique recommended by Robinson consists of injecting ewes approximately 12 days after oestrus—i.e. 4-5 days before their next anticipated heat—with sufficient gonadotrophic hormone to induce multiple ovulations. He advocates a dose level that will induce 3-10 ovulations. This ovulation rate he maintains does not render conception more difficult yet provides enough eggs to prevent the number shed forming a factor limiting fertility. Early embryonic mortality he considers may be relied upon to reduce the size of the litters actually born to 2, 3 or occasionally 4, which, while considerably above normal size, are nevertheless of manageable size.

The work undertaken at Ruakura has been planned with a view to the possible application of such treatment in New Zealand fat lamb production. Mature ewes have been used as experimental animals, partly because these were thought likely to prove most responsive, and partly because of their predominant importance in the fat lamb industry. For gonadotrophic material, commercial dried pregnant mare serum has been used, both because it has given promising results in the hands of other workers, and because it is readily available and

reasonably cheap, a consideration of major importance should the injection technique ever be used in farming practice. Available evidence indicates that dried P.M.S. is as effective as the fresh serum, provided it is correctly standardised.

In the experimental work at Ruakura, the first step was to standardise the P.M.S. (Antostab) used. This was most kindly undertaken by Mrs. Basset, who reported that the particular batch of P.M.S. selected for use was in fact of the labelled strength. With this reassuring information to hand, a small experiment was designed to determine the dosage level necessary in order to obtain the recommended range of 3-10 ovulations. For this purpose 80 ewes were run with raddled teaser rams.

The date of the first heat of the season was noted for each animal. One group of 20, forming the controls, was left untreated, while all the other ewes received an injection of P.M.S. either 12 or 13 days after their first heat. The dosage levels chosen for the three experimental groups, each again of 20 ewes, were respectively 250, 500 and 1000 I.U. of P.M.S. Following injection, all the ewes were run with raddled fertile rams and half the number in each group were slaughtered a few days after their second oestrus—i.e. the heat immediately following injection. The remainder were slaughtered about a month after their first service by the fertile rams. The reproductive organs of all the animals were recovered at slaughter and the ovulation rates among the control and experimental animals determined.

It was found that the control ewes had a mean ovulation rate of 1.17, whereas those groups which had received injections of 250, 500 and 1000 I.U. had mean ovulation rates of 1.50, 2.07 and 4.33 respectively. In the control group only 17% of the ewes had multiple ovulations, whereas in the group which received 250 I.U., 50% of the ewes showed double ovulations. After 500 I.U. the ovulation rate ranged from 1-3, with 87% of ewes showing multiple ovulations, while in the 1000 I.U. group the number of eggs shed ranged from 1-13, with 83% of multiple ovulations.

Among the 10 ewes which received 1000 I.U. and which were killed at the end of the first month of pregnancy, there were five animals which had ovulated more than 3 eggs, but in no case had more than three embryos survived.

This preliminary experiment, then, showed that in order to obtain the ovulation rate recommended by Robinson, a dose of 1000 I.U. of P.M.S. was necessary. (This dosage level is approximately double that which Robinson found necessary to achieve a similar result with Suffolk and B.L. X Cheviot ewes, a finding with quite interesting implications). The pilot experiment also indicated that, if 1000 I.U. of P.M.S. were to be administered, there was little risk of many ewes lambing more than triplets and that about 2 lambs per head would be born to the ewes which lambed to the heat immediately following injection. These findings formed the basis of the other trials now to be described.

The major trial involved 197 ewes made available by Mr. Clarke from the hill country flock at Whatawhata. Half these ewes were 6 tooth, the remainder being 4-year-old ewes. They were shifted to Ruakura for the tupping season, and at first run with raddled vasectomised rams. As the ewes came on heat they were removed to a separate paddock, where, either 12 or 13 days after the date of first oestrus, half of them received an injection of 1000 I.U. of P.M.S. The other half comprised the controls and were not injected. All ewes were put with fertile Romney rams for their second heat period. Tupping dates were again recorded, and about a week after being tupped by the fertile rams, the ewes were returned to the hill country station where

both treated and control animals were run together as a single flock. Strict lambing records were kept, the lambs being identified on the day of birth. I am indebted to Mr. Clarke for these data.

There were, in addition, two small groups of ewes available for experimental purposes at Ruakura. One consisted of 20 6-year-old ewes and the other of 37 5-year-olds. All these animals were injected with 1000 I.U. of P.M.S. either 12 or 13 days after heat.

Let us consider first the results from the ewes at Whatawhata. The data are summarised below:—

Number of:—	Control	Injected
Ewes put to ram	103	94
Ewe deaths	1	1
Ewes failing to lamb	9	7
Ewes with quadruplets	—	3
Ewes with triplets	—	7
Ewes with twins	6	32
Ewes with singles	87	44
Ewes which lambed	93	86
Ewe deaths as % of ewes put to ram	0.97	1.06
Dry ewes as % of ewes put to ram	8.7	7.4
Lambs born as % of ewes lambing	106.4	164.0
% deaths among lambs born	10.7	26.2
Lambs weaned as % of ewes put to ram	86.4	110.6

The injection treatment appears to have had a profound effect upon the lambing results. The incidence of dry ewes is approximately equal in the two groups, but among those ewes which lambed there was a much higher percentage of multiple births in the injected than in the control group (48.8% as compared with 6.4%). Thus in the injected group there were three sets of quadruplets, seven sets of triplets, 32 sets of twins and 44 singles, whereas in the control group there were no quadruplets or triplets and only six sets of twins, but 87 singles. Note that in the control group the total number of lambs born, expressed as a percentage of the ewes lambing, was 106.4 as compared with a figure of 164.0% for the injected animals. Mortality was, however, very much higher among the lambs from the injected ewes, 26.2% of them failing to reach weaning age as compared with a percentage figure of 10.7 for the control lambs. Despite its higher death rate, the injected group has achieved a much better final lambing percentage (110.6% as compared with 86.4 %for the control group).

The heavy mortality among lambs born to injected ewes is, of course, associated with the high incidence of multiple births. The death rate rises sharply as the number of young produced at a birth increases. Indeed, in this trial, where the offspring were born and reared under hill country conditions, the number of lambs reared per ewe was not much greater for animals lambing triplets and quadruplets than it was for ewes with twins.

One quite pleasing feature of the results is the fact that the injected ewes conceived almost as readily as did the control animals. In the injected group 76.7% of the ewes which conceived held to the heat which followed injection, while in the control group 81.7% held to the first mating. The difference here is not large and is probably not significant.

Mention was made earlier that two small groups of injected ewes were run at Ruakura. In the group of 20, two failed to lamb and seven failed to hold to the injected heat—these all had singles. Of the 11 ewes which lambed to the injected heat, two had quadruplets, six had triplets, two had twins and one had a single. Based on the number of

ewes put to the ram, 190% of lambs were born, but if one considers only the performance of those ewes which lambed to the injected heat, this figure becomes 282%.

Of the other small group of 37 ewes, 1 failed to lamb, one became very emaciated and on slaughter was found to be carrying normally developing sextuplets, two had quintuplets, two had quadruplets, ten had triplets, eight had twins and 13 had singles. Based on the number of ewes put to the ram, 224% of lambs were born and 157% were reared.

I should like at this stage to review briefly the salient findings that have emerged from this work, to mention the features which I consider require further investigation, and to try and assess the circumstances under which a possibly improved injection technique might find application in New Zealand farming practice.

Definite evidence has been presented supporting the findings of other workers that P.M.S. can be used to increase the ovulation rate of ewes. We have seen that the magnitude of this increase is graded according to the dose administered. At the higher dose rates the response is greatest but it is also the most variable. In ewes stimulated to shed large numbers of eggs, early embryonic mortality certainly results in many of the developing foetuses coming to grief before term, but evidently these pre-natal deaths cannot be relied upon to reduce all litters to triplets or twins. Control measures in this connection must lie in the judicious choice of dosage levels so that not more than triple ovulations are induced. Fortunately, there seems to be every chance of finding a dose that will be effective in stimulating a high proportion of multi-ovulations among the treated animals while only causing very few ewes to shed more than three eggs at one oestrus.

The incidence of dry ewes does not appear to be altered by P.M.S. treatment—nor is there any appreciable change in the ease with which treated ewes can be got in lamb.

We come to the conclusion, then, that it is quite possible to increase substantially lambing percentage by P.M.S. without any undesirable side-effects, and to control the increase so that manageable numbers of lambs are born.

What are the difficulties that stand in the way of the immediate application of the technique to farming practice? First, the cost of the material. On to-day's prices, a single dose of 500 I.U. of P.M.S. costs about 3/-, and of course every dose administered will not be effective in producing an extra lamb—an average of 4 doses will be required to do this. Nevertheless, cost of the P.M.S. material, though high, is not prohibitive.

Next the labour requirement. This, at present, probably constitutes the greatest stumbling block to the extended use of the technique. Ewes have to run with teaser rams to determine the day of their first oestrus and drafted off and injected 12-13 days after heat. The teaser rams could be provided fairly easily, although not without some expense. Every second day the teaser rams would need to be caught and raddled, ewes tupped by them would have to be drafted off, and ewes tupped 12-13 days previously would need to be injected. The regular raddling of the teaser rams is probably the most laborious part of the procedure, but the development of a really satisfactory harness would in some measure overcome this. The interval between injecting occasions might possibly be extended should further research prove that good results can be achieved by injection on, for example, the 11th and 14th days after oestrus, as well as the 12th and 13th. Certainly in our experiments the 12th and 13th days appeared almost equally satisfactory in stimulating multiple ovulations.

A further consideration of some importance in applying the injection technique to farming practice is its effect upon the date of lambing. On New Zealand fat lamb properties, may ewes are mated by the rams at their first heat period of the season. The injection technique does not allow of ewes being mated before their second oestrus, so that the date of lambing might have to be somewhat later, and this might be a very real disadvantage. There is scope here for further work in methods whereby ewes may be induced to come into oestrus early in the season and preferably all at more or less the same time.

Perhaps the most obvious place for the injection technique in farming practice at present would be one those properties where ewes have to be heavily concentrated on a small area at tupping time in order to avoid the risk of facial eczema. Under these circumstances the ewe flock is usually held somewhere near the yards, and with drafting facilities handy, the injection technique could be most easily applied. And this brings me to my final point. I believe that the P.M.S. technique will pay the greatest dividends if used in flocks where the lambing percentage is normally relatively low because of a small proportion of twins being born; and low lambing percentages due to this cause are to be expected from ewes poorly fed at tupping time.

I believe that the P.M.S. approach could form the basis of a considerable increase in fat lamb production. That extra effort would be called for to achieve this is not denied—but then I do not believe that increased meat production is likely to be obtained unless a definite and sustained effort is made to achieve it, and in a world hungry for meat, should not the effort be made?

I have perhaps in this paper laid undue stress upon the practical aspects of the work. It does, however, raise some quite fundamental issues that merit further investigation. For instance, some ewes made to shed many eggs are quite capable of carrying quite a number of foetuses through to lambing—others fail to produce at term more than a single survivor. May it not be that in some strains of animals fertility is restricted by the ovulation rate, but that in others the limiting factor is embryonic mortality?

REFERENCES:

(1) Robinson, T. J., 1951: Reproduction in the Ewe. Biol. Rev. **26**, 121.
(2) Robinson, T. J., 1951: The control of fertility in sheep. Part II. The augmentation of fertility by gonadotrophin treatment of the ewe in the normal breeding season. J. Agric. Sci. **41**, 6.

Discussion

Col. DURRANT: What were the killing weights?

Dr. WALLACE: There was the normal difference between singles and twins. The survivors of the quadruplets and triplets had approximately the same commercial value as lambs reared as twins.

Mr. BURRIDGE: Is there any limit to the number of eggs produced by a ewe in her lifetime? Also is there any possibility of bringing the bulk of the ewes on heat at the same time?

Dr. WALLACE: If there is a limit, it is not likely to be reached in practice. At present there is no reliable method available whereby all ewes may be brought into oestrus at the same time.

Prof. CAMPBELL: Have you any figures comparing the number of corpora lutea present in the ovaries with the number of foetuses? With implantation work there has been difficulty in obtaining fertilized ova from super-ovulated animals.

Dr. WALLACE: In those cases where such a comparison was made, not all the corpora lutea present in the ovaries were represented by foetuses. However, many eggs appear to be fertilized but the resulting embryos degenerate at an early stage. For instance, one ewe slaughtered when about 30 days pregnant had 13 corpora lutea and only two surviving foetuses. Seven degenerating embryos were found, however, indicating that most of the eggs shed by this ewe had been fertilized.

Mr. HART: Is there any evidence that super-ovulation in the ewes is associated with an increased rate of movement of the eggs down the oviduct?

Dr. WALLACE: The rate of transport of the eggs down the tubes was not studied. Robinson found that, although in general multiple ovulated eggs are highly fertilisable, when 15 or more are shed the rate of tubal transport is considerably accelerated and the proportion fertilized is reduced.

Mr. McCANN: Were the ewes in the experiments flushed? Was there a greater ante-partum risk?

Dr. WALLACE: All the ewes were run on a fairly low plane of nutrition. Had the ewes been flushed, it is possible that somewhat lower dose rates might have been equally effective. The ante-partum risk is probably increased. Pregnancy toxaemia is likely to become a risk though we had no losses due to this complaint.

Mr. CARTER: Are low lambing percentages due to a low ovulation rate or to a high foetal mortality?

Dr. WALLACE: Where few multiple births occur, this is mainly due, I think, to a low ovulation rate.

Mr. GERRING: Twins are sometimes undesirable as, for instance, on hill country. Ewes carrying twins require special treatment.

Mr. McGUINNESS: The usual opinion of hill sheep men is that they prefer 100% of their ewes to have single lambs rather than have only 80% of their ewes lamb, 10% of them with twins. Bearing trouble is often associated with multiple births.