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SOME TECHNIQUES FOR INCREASING REPRODUCTIVE RATES IN SHEEP AND THEIR APPLICATION IN THE INDUSTRY*

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Progress in techniques for increasing the reproductive potential in farm animals, and in particular sheep, has been the subject of several recent reviews (Ch'ang, 1973; Gordon, 1973; Hunter, 1968 a, b.; McDonald and Cumming, 1973; Polge and Rowson, 1973; Turner, 1969). This review will not attempt to critically examine all the new or possible techniques available for improving reproductive rates in sheep but will assess several techniques and where they may fit into the sheep industry.

The percentage of lambs marked in New Zealand flocks is variable but averages between 95 and 100. Consequently there is considerable scope for increases in reproductive rates and therefore efficiency and economy of lamb meat production.

In a recent paper Coop (1972) stated "From the 60 million sheep in the country, with a lambing percentage of 100, the industry should aim to reach 100 to 120 million in the year 2000—80 million on hill country with a lambing percentage of 125 to 135, 30 to 40 million on the flats with a lambing percentage of 200."

Given this aim, various means of increasing reproductive rates may be considered. Increases may come from more lambs per ewe lambing, more lambings per lifetime or more lambings per year. The effects of selection and crossbreeding and increases in twinning obtained from improved nutrition through flushing and higher liveweights are well known and will not be discussed.

SYNCHRONIZATION AND SUPEROVULATION

Synchronized mating offers few managerial advantages. Although there may be greater efficiency in allocation of feed resources before lambing, the seasonal spread of lambing is not reduced compared with a normal mating programme. Rather lamp drop will tend to occur in discrete peaks representing ewes conceiving, and returning to service from the synchronized peak of mating.

The introduction of rams just before the start of the breeding season usually results in some concentration of mating activity 20 to 25 days after rams are introduced. This tech-

* Paper presented at the Society's session, N.Z.I.A.S. Agricultural Science Convention, August 1973.

nique gives unpredictable results due to differences between years in the onset of ovarian activity of ewes and will not be considered further.

Synchronization with the use of synthetic progestagens is generally used in conjunction with a programme of artificial insemination or superovulation. With the advent of the intravaginal sponge a simple method was available for the continuous administration of progestagen. In the earliest report (Robinson 1965), fertility was satisfactory at the synchronized heat 36 to 60 hours after withdrawal of sponges. However, further research has shown that the conception rate at the synchronized heat is usually reduced in comparison with similar ewes mated at a normal heat. Fertility appears quite normal at the following heat 17 days later.

The ovulation rate in ewes may be quite simply increased by the use of serum gonadotrophin obtained from pregnant mares (PMS) or gonadotrophins of pituitary origin. A single injection of PMS is given on day 12 to 14 of the cycle, but with pituitary gonadotrophins it is usually necessary to give repeated injections. Ovulation responses between animals are variable, and may vary with season. Greater responses have also been achieved in ewes of higher fecundity (Bindon *et al.*, 1971).

Large increases in the number of lambs born following treatment with PMS were demonstrated by Wallace *et al.* (1954). In spite of increases in perinatal mortality lamb marking percentages were increased by up to 30%. However, there is no advantage in using high doses of PMS compared with a smaller dose rate to increase lamb drop. Although large numbers of eggs are shed, become fertilized and begin implantation, mortality between 17 and 19 days after mating reduces the mean number of embryos per animal conceiving to 2 to 2.5. The use of high doses of gonadotrophin should therefore be used only when the large number of eggs shed are to be recovered and transferred into other animals. Egg transfers are discussed later in this paper.

The use of gonadotrophins to increase lamb drop is of greatest advantage when ovulation rates are low because of low body weights or for any other reason.

Recent research at Invermay has shown the use of PMS to be applicable in ewes of very low liveweight. Differential nutrition resulted in mean liveweights of 55 kg and 43 kg, respectively, in two groups of 120 ewes. Ovulation rates and fertility can be seen in Table 1. Treatment with PMS increased the ovulation rate in all groups but the response was greater in the heavier ewes. Fertilization rates were not different between the two liveweight groups and uterine capacity did not appear to be affected either. Low liveweight ewes treated with 1000

TABLE 1: REPRODUCTIVE PERFORMANCE OF EWES OF DIFFERING MEAN LIVEWIGHT TREATED WITH PMS (*n* = 34 — 39)

Mean Liveweight (kg)	Dose PMS (iu)	Mean Ovulation Rate	% Conceiving at Treatment Heat	% Normal Embryos 22-24 days Post-mating
43	0	1.3	81	123
	600	2.0	76	164
	1000	3.9	74	208
55	0	1.5	81	137
	600	3.0	69	207
	1000	5.3	71	237

international units of PMS gave a similar performance to heavier ewes treated with 600 international units. In Romney ewes weighing approximately 43 kg the ovulation rate would normally be less than 1.3 and in several other trials at Invermay has been 1.1 or less. The use of superovulation may be a profitable method of increasing ovulation rate and lamb drop as the feed cost of increasing ewe body weight by 12 kg would be considerable. Also the increase in twinning would only be of the order of 15% (Coop, 1966). For synchronization and superovulation costs will be in the vicinity of \$1.50 per ewe (including the cost of intravaginal sponges). Consequently an increase in lamb marking percentage of 20% would more than cover costs. In the present work considerable increases have been shown in the number of normal embryos 22 to 24 days post-mating although this is only in about 70% of all ewes. After this time embryonic mortality is not high.

Provided lamb mortality is minimized in intensive lambing systems superovulation can be profitable. However, it should be stressed that PMS treatment to increase lamb drop should be regarded only as a stop-gap method until there are more fecund ewes available which will produce the same results in normal circumstances.

EGG TRANSFER

Large numbers of eggs resulting from multiple ovulation can be transferred to recipient ewes to increase the number of offspring in selected animals. In sheep the collection of eggs for transfer and the transfer itself are quite simple procedures. It is preferable to recover eggs 3 to 3½ days after mating when they have developed to eight cells or more and to transfer two at a time to the recipient ewes. Two and four cell eggs recovered at an earlier time should be transferred to the Fallopian tubes but success rates of transfers may be less.

While discussing egg transfers it is appropriate to consider the increased number of offspring which may be achieved. Figure 1 outlines a series of success rates for each part of a programme involving 100 donor ewes. The assumptions made are realistic and some are slightly conservative. Provided treatment of donor ewes begins after the start of the breeding season most ewes should come into heat and be mated. If 1500 international units of PMS are used, the mean ovulation rate will probably be eight or more although there will be considerable individual variation. Following various losses the net result could be an extra 259 lambs. This figure, added to a number of lambs from the donor ewes re-mated, gives a considerable increase in total lamb production. This example has considered only one PMS stimulation of the ewes.

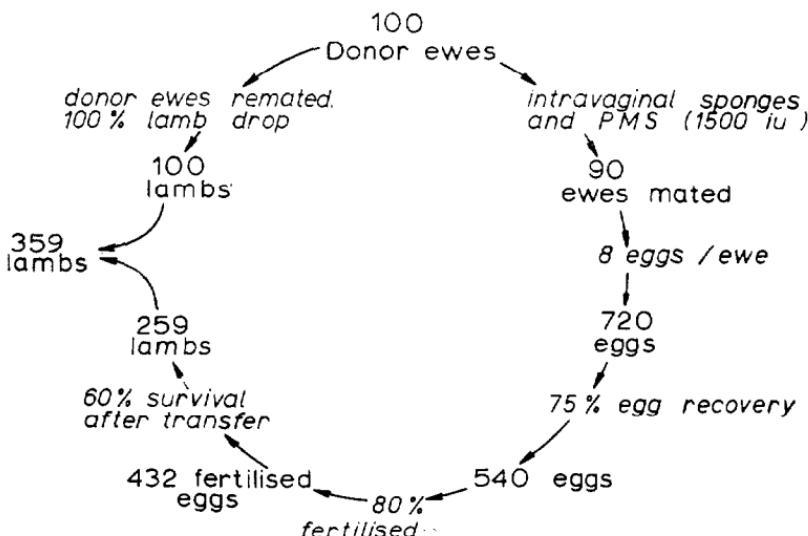


FIG. 1: Possible results of an egg transfer programme.

The practicability of carrying out numerous operations on one animal has not been established. Repeated surgical intervention and handling of the reproductive tract tends to cause the development of adhesions, even following extreme care, and there is also the problem of a decreased ovarian response to PMS treatment (Hulet and Foote, 1969). Egg transfer could play a significant role in genetic improvement by increasing the number of progeny from selected females.

Ultimately it may become possible to deep freeze sheep eggs for long periods before transfer. Workers in the United King-

dom have recently achieved remarkable success following freezing of mouse embryos to -196°C . Over 80% were shown to survive after thawing (Whittingham *et al.*, 1972). Successful application of such a technique would be extremely useful in sheep breeding.

ARTIFICIAL INSEMINATION

The intensive use of superior sires is an important advantage of artificial insemination (AI). However, regardless of possible genetic gains the monetary advantage must at least balance the added cost. Artificial insemination will probably have a use in the rapid multiplication of various imported breeds of sheep at present on Somes Island. Although Salomon (1971) achieved quite acceptable lambing rates from ewes inseminated with frozen semen, reports from other laboratories have given variable and sometimes disastrous results. The use of frozen semen for AI in sheep cannot yet be considered a commercial proposition. When considering selection for clean wool weight in Merino ewes Dunlop and Young (1961) calculated the advantages of using AI. With 0.2% of rams being used for AI and 2% with natural mating they concluded that AI was no advantage in flocks of 1000 ewes or fewer owing to problems with inbreeding. Rates of progress should be from 18 to 26% higher in flocks of 3 to 7000 ewes.

The use of AI to increase selection pressure in large flocks may be attractive when 2% of rams are used as is the general practice in New Zealand flocks. However, recent research at Invermay has shown that such a practice grossly underestimates the mating potential of rams. Two trials using 4- and 6-tooth Romney rams mated with Romney ewes older than two years have shown ram:ewe ratios from 1:50 to 1:210 gave similar results for the percentage of ewes mated and the reproductive performance of those ewes which were mated.

Mating data are summarized in Table 2. There were no differences between any of the groups for either the number

TABLE 2: INDIVIDUAL MATING PERFORMANCE OF RAMS MATED WITH DIFFERENT FLOCK SIZES OF EWES

Ram/Ewe Ratio	Total Ewes Mated	No. Mated by each Ram in first 17 days			% Lambs born per Ewe present at Lambing
3/150	136	122	112	96	122.0
3/450	413	297	268	205	116.6
3/210	171	144	117	111	115.6
3/630	520	365	338	332	115.2

of spermatozoa per ejaculate throughout the mating period, or losses in ram liveweight during mating. When most rams are capable of mating 200 or more ewes in a 17-day period, conventional mating ratios must be questioned. Also the wider use of superior sires by AI may no longer be so desirable. Certainly the use of more productive sires over many more ewes than is normal has a greater immediate application than has the use of AI. However, this practice presupposes that performance-recorded sheep are freely available. Of approximately 4000 registered sheep studs 16% are in the national flock recording scheme representing 32% of all registered ewes. Although some of the remainder may have records, many sources of flock rams may have no objective information on which producers can select superior sires. Equally important is that many studs which have production records are not asked for this information by prospective purchasers.

BREEDING MORE THAN ONCE PER YEAR

Little research has been done in New Zealand on increasing the frequency of lambing. The main deterrent to breeding more than once a year is the restricted breeding season of our predominantly British breed ewe flock. Attempts to re-breed within two to three months of lambing with the aid of exogenous hormones have been variable and generally unsatisfactory (Hunter, 1968 a, b). Induction of post-partum oestrus is feasible but very low fertility to consequent matings has often resulted.

In any system involving lambing at intervals of eight months or less it would certainly be more preferable to use animals with extended breeding seasons which return to heat within a comparatively short time after parturition. The Romney is in anoestrus following lambing and will not return to heat for six months. Breeds with known extended breeding seasons may well contribute to a ewe population capable of more frequent lambings. Of these the Merino, Dorset Horn and Polled Dorset are in the country, while some Finnish Landrace sheep are currently in quarantine. Very little investigation work has been done on the cyclical activity of these breeds and their crosses in New Zealand and this must be considered a high priority for research. Intervals between lambing and subsequent oestrus in ewes lambing at different times of the year, and factors which may affect this, such as nutrition, time of weaning, season, age of ewes and presence of the ram must be determined before any application to the industry can be assessed.

Other important factors are libido and semen quality of rams used for mating during the spring and summer. Post-

parturient heats may be short, and of low intensity, making activity of rams a critical factor. Seasonal depressions in semen quality, if evident, could also contribute to low fertility in matings within 2 to 3 months of lambing.

A comprehensive programme involving different breeds and crosses should be undertaken at one or two locations in preference to a series of small and possibly ineffectual trials throughout the country.

BREEDING OF EWE HOGGETS

Hogget mating seems an obvious method of increasing the number of lambs born in a ewe's lifetime. The proportion of ewe lambs which exhibits oestrus will vary with liveweight and age. In general the heavier a group of ewe hoggets the greater proportion will come into heat between seven and nine months of age. Data on the breeding of ewe hoggets are scarce. However, it can be concluded that once the difference in liveweight due to the yearling lactation is made up, probably at the 4-tooth stage, subsequent reproductive performance is not impaired.

The practice seems to have the stigma of resulting in poorly grown two-tooths. Perhaps this is due to the considerable emphasis placed on the importance of liveweight in determining levels of twinning. While liveweight is of major importance in determining twinning it must be remembered that the reproductive performance of 2-tooths which have reared lambs is not drastically reduced in relation to those not mated. In fact, at Invermay, Lewis (unpubl.) recorded a depression of 0.2 lambs per ewe mated for 2-tooth ewes which were mated as hoggets. However, over the ewes' lifetime those mated as hoggets produced 0.8 more lambs. This would surely indicate hogget mating to be profitable at least in some circumstances. Depressions in 2-tooth lambing performance may well be alleviated by early weaning and then additional feeding of hoggets which have lambed. The latter point needs to be clarified by future research.

INCREASES IN LAMB SURVIVAL

Lamb losses at birth or shortly after birth account for about 15% of all lambs born in New Zealand. Although this considerable mortality in newborn lambs is of major economic significance, research findings have given few leads in reducing this mortality. Intensive lambing systems, including shed lambing, have been shown to reduce lamb losses but the economics of such systems are doubtful particularly when multiple births are not too frequent. Research in Australia has shown

that the provision of shelter can reduce lamb losses by up to two-thirds but ewes must be confined to the known sheltered areas.

Recent information from a large-scale breeding scheme in the North Island (G. K. Hight—pers. comm.) has shown very large differences in mortality between groups of progeny from different rams mated with similar groups of ewes. Whether these differences are related to skeletal differences between the progeny with resultant changes in difficulty of birth or to other factors is not clear. However, selection and/or culling of rams based on a progeny test of this type is possibly the most promising method of reducing perinatal mortality. With the advent of more fertile ewe flocks intensive lambing systems may become an economic proposition.

There is no doubt that the more widespread use of existing information would enable large increases in lambing percentages in existing flocks. The techniques discussed, in conjunction with adequate nutrition, selection and crossbreeding, make it possible to achieve the aims outlined at the beginning of this paper.

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