EFFECT OF TIME OF JOINING ON REPRODUCTIVE WASTAGE IN MERINO SHEEP

R.J. LIGHTFOOT*

SUMMARY

An experiment of factorial design was conducted to quantify variation in the components of reproductive wastage in Merino ewes following artificial insemination (AI) in either January, March or May. Semen from 6 individual rams was used in either fresh or deep frozen form, the latter providing a ram "control" to identify variation in wastage as of either paternal or maternal origin. Results showed comparatively little difference in either ovulation or fertilisation rates between the 3 times of AI. There was, however, highly significant variation in lambing rate with best results following AI in March and poorest results in January. Depressed fertility in January was associated with a much higher incidence of embryo wastage. Despite generally reduced fertility, AI with frozen semen produced an identical pattern of lambing between January, March and May to that achieved with fresh semen. The results indicate that most variation in reproductive wastage was due to changes in the level of embryo mortality associated with failure of maternal, rather than paternal mechanisms.  (Keywords: Sheep, fertility, embryo mortality, deep frozen ram semen)

INTRODUCTION

Extensive field research through the early 1970's (Lindsay et al. 1975; Knight et al. 1975; Marshall et al. 1976; Wroth and Lightfoot 1976) has identified the major components of reproductive wastage among Merino flocks in South-Western Australia. The results highlighted low rates of ovulation with high (though variable) additional wastage due to embryo/foetal failure.

Relatively little is known, however, of either the magnitude or causes of variation in the components of reproductive wastage between different times of joining. Failure to mate can be a problem in flocks joined before January (Marshall et al. 1976; Wroth and Lightfoot 1976) and there is evidence to suggest that ovulation rates can increase through the autumn months (Fels et al. 1969). With respect to embryo mortality, Lindsay et al. (1975) reported a significant correlation between high summer temperatures and egg wastage between ovulation and lambing.

The present experiment was designed to define more precisely variation in the mechanism of reproductive wastage between three different times of joining, January, March and May. By comparing fertility after artificial insemination (AI) with fresh semen to that from a bank of deep frozen semen from the same rams it was hoped to effect a ram "control" between the various times of joining and thereby differentiate between ram and ewe effects on infertility.

MATERIALS AND METHODS

The work was conducted with a flock of approximately 1,000 mixed age medium wool Merinos grazed on annual (subterranean clover based) pastures at the Wongan Hills Agricultural Research Station located approximately 200 km N.E. of Perth. The area experiences a Mediterranean climate with 70 per cent of 350 mm mean annual rainfall recorded over the period May to September.

* Department of Agriculture, South Perth, W.A., 6151

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The base experiment was of factorial design (6 x 3 x 2) and examined the effects of variation between individual sires (6 Merino rams) on the fertility of ewes following AI in the last week of either January, March or May over two successive years (1971, 1972). For each AI programme, oestrus was synchronised over 14 days using progesterone impregnated intra-vaginal-pessaries. For a period of 5 days commencing 17 days after pessary withdrawal (second synchronised oestrus) ewes marked by harnessed vasectomised rams were drafted twice daily (0700 and 1700 h) and allocated in the ratio of 2:1 for AI with either fresh or frozen semen respectively.

Frozen semen was drawn from individual ram sperm banks prepared by the pellet method (Lightfoot and Salamon 1970) just prior to commencing each year’s AI programme. After thawing and reconcentrating the semen by centrifugation (Lightfoot and Salamon 1970) ewes were inseminated (0.05 ml) twice, first within 3 h of drafting and again approximately 12 h later. Fresh semen was collected by artificial vagina and used undiluted (0.1 ml) as a single insemination within 3 h of drafting. One half of the ewes inseminated with fresh semen were subject to tubal flushing for egg recovery via mid-ventral laparotomy approximately 60 h post-insemination to determine fertilisation rate. The remaining ewes, together with all those inseminated with frozen semen were grazed as one flock for individual lambing observations.

Two Chi-Square analyses (Clarimbold 1961) were performed: one for ewes inseminated with fresh semen only, contrasting the effects of treatments on both fertilisation and lambing rates, and the other for ewes carried through to lambing, contrasting differences between fresh and frozen semen.

RESULTS

Ovulation rate

Ovulation rates in 1971 were 1.06, 1.19 and 1.17, and in 1972, 1.15, 1.18 and 1.26 following AI in January, March and May respectively. Pooling results over both years, the ovulation rate in summer (January, 1.11) was lower than that in the autumn months (March, 1.19 and May, 1.22).

Fresh semen : fertilisation versus lambing

There were no significant differences between either individual rams or years in the proportion of ewes fertilised or lambing to AI with fresh semen (Table 1). The proportion of ewes yielding fertilised eggs was, however, significantly higher (89% v 57%, p < 0.001) than the proportion of ewes lambing, thereby providing an estimate of overall embryo/foetal losses at approximately 36 per cent on a ewe basis. As this figure does not include partial losses (e.g. one embryo from a ewe with two fertilised eggs) it must be regarded as a minimum estimate.

There was also a highly significant \( \chi^2 = 24.06, p < 0.001 \) main effect due to month of AI with fertility generally higher following AI in March compared with either January or May. The magnitude of this effect was modified, however, by interactions with both stage of pregnancy (month x stage, \( \chi^2 = 6.13, p < 0.05 \)) and year (month x year, \( \chi^2 = 7.37, p < 0.05 \)). In the former interaction (month x stage, Table 1) the relationship between fertilisation and lambing (reflecting the extent of embryo mortality) varied according to month of insemination. Embryo mortality was lowest (25%) following AI in March, intermediate (38%) in May and highest (50%) in January. The latter interaction month x year was of less practical significance, reflecting relatively more variation in "fertility" (ewes
fertilized + ewes lambing) between the 3 months of AI in 1971 (60, 69 and 74% for January, March and May respectively) compared with 1972 (66, 74 and 70% respectively).

Table 1 Effects of year and month of insemination on fertilisation (fresh semen) and lambing (fresh and frozen semen) (No. of ewes inseminated in parenthesis)

<table>
<thead>
<tr>
<th>AI Month</th>
<th>% Ewes fertilized*</th>
<th>% Ewes lambing**</th>
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</thead>
<tbody>
<tr>
<td>January</td>
<td>80 (60)</td>
<td>88 (67)</td>
</tr>
<tr>
<td>March</td>
<td>95 (74)</td>
<td>91 (78)</td>
</tr>
<tr>
<td>May</td>
<td>91 (69)</td>
<td>85 (67)</td>
</tr>
<tr>
<td>Overall</td>
<td>89</td>
<td>88</td>
</tr>
</tbody>
</table>

* Ewes yielding fertilised eggs/Ewes yielding eggs
** Ewes lambing/Ewes inseminated

Despite the absence of any significant differences between individual rams in the proportion of ewes lambing to AI, the results (Table 1) show highly significant ($p < 0.001$) main effects due to month of insemination ($\chi^2 = 39.73$), semen type ($\chi^2 = 49.12$) and year ($\chi^2 = 14.57$). Lambing was generally higher in 1971 than 1972 (52% v 34%) and highest following AI in March (57%) compared with intermediate levels in May (45%) and low results in January (31%). There were no significant first order interactions.

**DISCUSSION**

The first objective of the experiment was to quantify variation through time in the components of reproductive wastage. The results showed that ovulation rates tended to increase by approximately 10 per cent from summer (January, 1.11) through autumn (March, 1.19 and May, 1.22) and were generally higher in 1972 than 1971 (1.20 v 1.14). Such effects were relatively small and often inconsistent, however, compared with the level and pattern of variation in overall lambing percentages. It must be concluded, therefore, that ovulation was not a biologically significant cause of variation in the overall pattern of wastage. Fertilisation rates showed no significant differences between the three times of AI, nor between years and were therefore also dismissed as a significant component of variation in wastage in this experiment.

It is apparent that the major component of wastage in the present study resulted from the loss of embryos and/or foetuses between fertilisation and lambing. On overall results (fresh semen), the proportion of ewes with fertilised eggs that subsequently failed to lamb was estimated at 50 per cent following AI in January, 25 per cent in March and 38 per cent in May. Such levels fall within the range reported by Marshall et al. (1976) and Wroth and Lightfoot (1976) with natural mating flocks under paddock conditions. Although
the above authors noted no variation due to time of joining, research in Victoria has suggested a higher level of embryo mortality in summer than autumn (Cumming et al. 1975; Davies et al. 1976).

With respect to the experiment’s second objective (to identify ram versus ewe effects), the results reported herein clearly implicate the ewe as the major contributor to variation in the level of wastage between January, March and May. The relative lack of ram effects was indicated initially by the lack of variation in fertilisation rates between the individual rams, the three times of AI, and the two years of experimentation. Further evidence supporting the relative significance of maternal effects was obtained through the use of deep frozen sperm banks for each ram. Although generally depressed when compared with fresh semen, results following AI in January, March and May with frozen semen of constant quality (providing in effect a ram “control”) produced an identical pattern of lambing to that obtained with fresh semen. The extremely low interaction term for semen type x month of AI on lambing ($\chi^2 = 0.55$) confirmed that variation in percent ewes lambing (reflecting the sum of all wastage components) was independent of ram semen quality and therefore of maternal origin.

The present experiment provides no direct evidence on the cause(s) of higher levels of embryo mortality due to maternal failure in January and May compared with March. High ambient temperatures, a factor known to cause early embryo mortality in the ewe under laboratory conditions, were a feature of the January treatments and have been implicated previously by Lindsay et al. (1975) in reproductive wastage under field conditions in Western Australia. Despite the probable role of high temperatures in January, this could not have been significant in May when temperatures were characteristically mild. Further research is needed to identify those environmental factors primarily responsible and establish appropriate changes in husbandry to improve overall lambing results.

ACKNOWLEDGEMENTS

The author is grateful for skilled technical assistance provided by T.J. Johnson, R.B. Guthrie and A.E. Ralph throughout the experiments and for financial support from the Wool Research Trust Fund.

REFERENCES