BREEDING FOR IMPROVED REPRODUCTION IN SHEEP

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SUMMARY

Breeding for improved reproduction in sheep is discussed with special reference to the influence that production conditions can have on the objectives of improvement. The main characteristics of the existing production system for sheep in New Zealand are pasture grazing and once-a-year spring lambing practices; they differ from those used in other countries and may change in the future. Selective breeding for increased number of lambs born per ewe under grazing conditions and lambing once-a-year has been successful through raising the incidence of multiple-births. Breeding to increase the ewe's reproductive capability, so that she may complete double-gestations in 12 months, is considered as an important objective for future improvement. Some problems of achieving this objective are outlined and stress is laid on the need to make optimal use of crossbreeding and within-flock selection for genetic improvement.

INTRODUCTION

It is generally accepted that productivity of a sheep flock can be substantially altered by the breeding method used over a period of years. However, for improvement in productivity to occur, the extra potential generated by breeding must be fully utilized and frequently this means that additional resources have to be made available as inputs to the production system. Managerial co-ordination is just as essential for securing improved individual productivity by breeding as it is taken for granted in improving flock performance by feeding. The present discussion on breeding for *improved* reproduction in sheep therefore cannot be made relevant without reference to the production management system, or at least to the basic operating characteristics of such a system in which the animal is kept.

The major managerial characteristics of the sheep flocks in New Zealand, as far as reproduction is concerned, is the practice of restricting lambing to once-a-year in the spring. This has implications for improvement of reproduction by breeding and the first part of this paper is concerned with some aspects of this question. In the remaining portion of the paper, consideration will be given to breeding for reproductive

versatility of the ewe so that she may be better fitted to the requirements of intensive sheep production systems of the future.

LAMBING ONCE-A-YEAR IN THE SPRING

The biological requirements essential for achieving satisfactory reproduction in a ewe capable of lambing once-a-year are well known. Improvement by breeding in this area has been concerned mainly with some end expressions of reproduction vital to the economics of sheep enterprise. Among these, the number of lambs born per ewe, or the reproductive rate, has received emphasis in experimental and commercial breeding programmes. The effectiveness of within-flock selective breeding for reproductive rate in sheep has been reviewed by Turner (1969) and reported recently by Clarke (1972) for the New Zealand Romney. The evidence presented indicated that the selection method used was effective in increasing the annual reproductive rate of the ewe largely through the increased proportions of twin-births.

Incidence and Rank Composition of Multiple-births

A question of considerable interest is the incidence and rank composition of multiple-births at lambing, as the selection response of the ewes in the flock reaches an average value of two lambs per ewe joined. The answer to this question would provide not only material for suggesting and reviewing theories about the mechanism giving rise to such a phenomenon, but also raise practical issues in management of the flock. Although the data depicted in Fig. 1 are limited to one year's observations, and must be interpreted with qualifications, they are presented here as a realistic example of selection response for discussion purposes. The data were obtained from a CSIRO Merino breeding experiment in which, over a period of years, selection was practised for (in "B" and "T" flocks) and against (in "O" flock) multiple-births; detailed accounts of this work have been given elsewhere (Turner, 1962; 1968). The "C" flock is a random control introduced in 1970.

The reproductive performance of the "B" flock, with the actual average of just over two lambs born per ewe joined must be considered to have reached an advanced level of selection response. Whether or not the rank composition of multiple-births recorded for this flock (in Fig. 1) is typical of other sheep flocks at a comparable stage of selection is unknown, but it seems safe to make two observations at this point. First, "B" flock was developed and maintained under

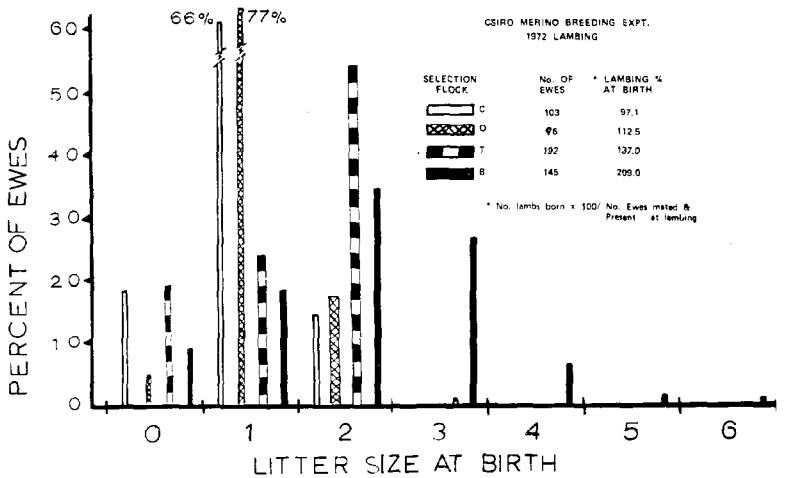

FIG. 1: *Distribution of litter size in four Merino flocks.*

grazing conditions. The significance of this fact is of course difficult to assess, but if adaptation to a year-round grazing management situation is important to sustain ewes of above-average reproductive rate, comparisons between stock such as the "B" flock, and samples of exotic breeds developed under very different conditions, could provide useful information to plan for efficient utilization of scarce breed resources in improving reproduction of the grazing sheep. Secondly, of the 145 ewes of the "B" flock joined for mating in 1972 36% or 52 ewes at lambing produced triplets and lambs of higher-order births. Quite obviously some modifications in husbandry procedures, originally designed for Merino ewes with single lambs, are necessary if sheep wastage is to be reduced to an acceptable level. The problem is to decide on the kind and the scale of operations, particularly in relation to lamb rearing, under a least-cost approach. While industry significance of the problem of raising triplets and lambs of higher-order births is likely to be limited to isolated instances at present, its impact on profitable utilization of prolific sheep breeds and on the scope for continuing breeding improvement in reproduction is unmistakable.

CURRENT OBJECTIVE OF IMPROVEMENT BY BREEDING

Under the flock management system where the practice is to restrict seasonal lambing to once-a-year, increasing the proportion of multiple-births per ewe has been accepted in prac-

tice as a realistic objective of improvement by breeding. Other characters of the ewe, such as age at puberty and length of the annual breeding season, could be considered in breeding programmes but only limited scope seems to exist in the industry at present for utilizing the extra reproductive capacity if it was thus generated. As intensification of sheep production advances, it is inevitable that the practice of breeding from ewe lambs and out-of-season lamb production will increase, but to date no clear-cut evidence is available to establish the necessity for using breeding as a major avenue for improving the reproductive characters related to these husbandry practices.

Under New Zealand conditions, breeding for improved reproductive performance of the ram has received little emphasis. Factors responsible for this situation are presumably the short period of ram use each year, and demands made on the available selection differential in other traits of economic importance.

It appears, therefore, that the incidence of multiple-births is the only character which should be, and to date has been emphasized, in breeding for improved reproduction of sheep kept under current conditions. This has enabled selection, applied under either within-a-flock or mass-screening conditions, to be directed towards a relatively simple but realistic objective of improvement. This is essential if the available selection differential in the industry is to be used to breed for tangible improvement within a reasonable time period.

BREEDING FOR IMPROVED REPRODUCTION IN THE FUTURE

It is impossible to be precise about the reproductive capabilities required of the sheep which must survive under management conditions yet to be evolved. However, it can be suggested that the capability of the ewe to lamb more frequently per unit of time, and, in the extreme, for her to complete two, or double-gestations in one 12-month period, is likely to be required regardless of the actual conditions of future sheep production.

The potential advantages to be gained by having ewes capable of annual double-gestations are many and, among them, one in particular could be developed at the flock level to increase the opportunities for product diversification in response to marketing demands. Thus, it may well be feasible for one ewe flock to produce slaughter lambs in one lambing and replacement sheep in the second lambing within the 12 months period by using appropriate types of rams. Or else the increased rate of generation turnover, as a result of two lamb-

ings per year, could be utilized to accelerate the rate of selection response in productive characters including the reproductive traits themselves.

Some Problems of Breeding for Annual Double-gestations per Ewe

An initial but major obstacle is to devise a simple but effective method of identifying the ewes which are potentially capable of double-gestations per annum. A satisfactory solution to this problem is important as it would allow development of a mass-screening technique for use with minimum disruption of management practices in existing flocks so that industry-wide resources can be tapped for discovering valuable breeding animals. The physiological requirements essential for successful completion of annual double-gestations per ewe are not well understood (Hunter, 1968; Casida, 1971) and screening criteria based on some simplified physiological index can be tried at present probably only under experimental conditions.

Another problem is concerned with the effectiveness of breeding as a method of achieving annual double-gestations per ewe. More specifically information is required to decide if and to what extent, this complex character is heritable and hence amenable to improvement by selection as are other traits of the sheep. The scarcity of published data that can be used for this purpose introduces difficulties for developing efficient breeding plans.

Interval of Post-partum Anoestrus (IPPA)

The length of IPPA of the ewe governs the feasibility of achieving more frequent lambing than once-a-year, and information on the nature of variation in this character may assist the understanding of the more complex problems of breeding for improved capability of annual double-gestations. As part of an investigation on genetic improvement of sheep reproduction by the CSIRO Division of Animal Genetics, the length of IPPA has been studied in several sheep breeds currently available in Australia. Some results of this study, which is still in progress, are presented here, primarily to serve as illustrations. In particular, observations on the Dorset Horn breed should be of interest since it has, in various ways, contributed to breeding for improved reproduction in overseas countries, *e.g.*, the Finn-Dorset cross in the United Kingdom (Land and McClelland, 1971).

The observations reported here were made on ewes in experimental breeding flocks maintained on CSIRO Field Sta-

tion "Arding", near Armidale (30° 31′ S., 150° 35′ E.; Altitude 1067 m), N.S.W. Descriptions of the data essential for present purposes are:

(1) The length of IPPA for a ewe was calculated as the number of days between the dates of lambing and of occurrence of first oestrus, which, with few exceptions, is the commencement date for resumption of the ewe's regular oestrous cycles.

(2) Vasectomized rams were grazed with the ewes and a daily record of ewes marked by the rams was kept; occurrence of oestrus was inferred from these observations.

(3) The ewes were joined annually in the autumn during a 5-week mating period; the median of the lambing season was about the third week in September. Lambs were weaned on average when between 10 and 12 weeks of age.

Several sets of data, one for each breed or strain of ewe, were analysed using the least-squares method (Harvey, 1960). The results quoted in Table 1 are the least-squares means obtained from these analyses.

TABLE 1: VARIATION IN INTERVAL OF POST-PARTUM ANOESTRUS (DAYS)

Flock	*Dorset Horn*	*Merino Strains*				
		MNP	*MPB*	*SNP*	*SWA*	*Corriedale*
Overall mean	100.4	107.0	105.7	107.6	102.9	151.6
Error d.f.	231	179	132	117	259	326
Error SD ±	18.3	11.5	12.3	11.9	15.2	22.2
Lambing years	1969-71	1968-9	1968-9	1968-9	1969-71	1969-71

There is a noticeable similarity in mean IPPA values, not only for the various strains of Merino ewes studied, but also between the Merinos and the Dorset Horn. In practice, this implies that the interval of post-partum anoestrus, as a naturally occurring phenomenon in these ewes, is unlikely to be a limiting factor for increasing the lambing frequency per unit of time from once-a-year to, say, three times in every two years. The same scope does not seem to exist for the Corriedale ewes included in the observational series.

Following a spring lambing, the mean value for length of IPPA observed in 17 Dorset Horn ewes under United Kingdom conditions was about 42 days (Land, 1971). This value is less than half of that (100.4 days) found in the Dorset Horn ewes reported here. Factors responsible for the observed dis-

crepancy are unknown, but some management practices are different in these two sets of observations. For example, in Land's study detection of oestrus was made using entire rams under hand-service conditions, whereas vasectomized rams were used under pasture grazing conditions to identify ewes in oestrus in the present work. The importance of the effects of a grazing environment on occurrence of first oestrus following a spring (or autumn) lambing is unknown; information is required to decide if they are restrictive to the occurrence of first oestrus *post partum.*

TABLE 2: VARIATION IN INTERVAL OF POST-PARTUM ANOESTRUS (IPPA) BETWEEN STUD-OF-ORIGIN

	Dorset Horn		*Merino SWA*	
IPPA (days)	*No. studs*	*No. ewe yr*	*No. studs*	*No. ewe yr*
79	0	0	0	0
82	2	9	0	0
85	0	0	0	0
88	0	0	0	0
91	3	37	0	0
94	2	19	2	32
97	3	80	1	18
100	3	37	5	110
103	0	0	2	38
106	2	21	3	63
109	4	51	1	24
112	1	9	0	0
115	0	0	0	0
Total	20	264	14	285

Some variation exists in mean IPPA values between ewe groups sampled originally from various Dorset Horn and Merino stud flocks (Table 2). However, the results obtained do not appear to support the idea that between-stud difference is an important source of variation in the interval of post-partum anoestrus following a spring lambing.

CROSSBREEDING

Crossbreeding between breeds or strains may contribute towards achieving the objective of annual double-gestations per ewe. Land and McClelland (1971) reported that some, but not all Finn-Dorset cross ewes, actually achieved annual double-gestations in each of two years. The performance of these crossbreds highlights the possibilities of this approach, but the more exact role of crossbreeding for the continuing improvement of this character requires further investigation.

Newton and Betts (1967) recorded four purebred Dorset Horn ewes out of a total of 30 that achieved four lambings each over a two-year period. Undoubtedly, crossbreeding and within-flock selection of the purebreds can both contribute towards the objective of breeding for annual double-gestations, but the optimum utilization of each method can be decided only in relation to a given set of resources.

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REFERENCES

Casida, L. E., 1971: *J. Anim. Sci., 32:* 66 (Suppl. 1).
Clarke, J. N., 1972: *Proc. N.Z. Soc. Anim. Prod., 32:* 99.
Harvey, W. R., 1960: Least-squares analysis of data with unequal subclass numbers. *U.S.D.A., A.R.S., ARS-20-8.*
Hunter, G. L., 1968: *Anim. Breed. Abstr., 36:* 347.
Land, R. B., 1971: *J. Reprod. Fert., 24:* 345.
Land, R. B.; McClelland, T. H., 1971: *Anim. Prod., 13:* 637.
Newton, J. E.; Betts, J. E., 1967: *Expl. Agric., 3:* 307.
Turner, H. N., 1962: *Wool Technol. Sheep Breed., 9:* 19.
Turner, H. N., 1968: *Proc. Symp Physiology of Reproduction in Sheep.* Oklahoma State Univ. Stillwater, Okla. (July).
Turner, H. N., 1969: *Anim. Breed. Abstr., 37:* 545.