IMPROVING LAMB SURVIVAL IN MERINOS

INTRODUCTION

B.J. McGUIRK*

It is widely recognized that the reproductive performance of the Australian Merino is poor by comparison both with many breeds around the world and with crossbred ewe flocks in this country. While poor overall performance may be due to any one of the steps in the reproductive process, the level of lamb wastage to marking or weaning is high. For example, it is estimated that losses to marking account for about 11 million lambs in Australia annually, based on an average mortality of 20 per cent. A recent survey of 142 properties in southern and central-western New South Wales revealed that 22.1 per cent of pregnant ewes (10,111 out of a total of 45,768) failed to rear a lamb to marking (Anon. 1980). The range was from 3.9 to 61.4 per cent. These are minimum estimates of loss as some ewes lost more than one lamb, while other ewes lost one lamb from a set of twins. Even higher levels of lamb loss are suggested from surveys in semi-arid tropical (Moule 1954) and central-western Queensland (Smith 1962).

This contract will attempt to review the management options open to producers seeking to improve lamb survival, and the potential for improving survival by selection. The emphasis will be on reducing perinatal losses, defined as those occurring just prior to, during or in the first seven days after birth, as most losses occur in this period. The management options considered in the first paper include nutritional and environmental manipulation, and the value of close supervision at lambing. Later papers will examine the likely benefit of selection, especially selection for improved maternal performance.

PERINATAL LAMB MORTALITY

B.D. FERGUSON**

This paper briefly discusses the causes of perinatal lamb mortality, and the husbandry options for reducing it.

CAUSES OF LOSSES

Most lamb deaths occur in the parturient or post-parturient periods. Ante-parturient deaths usually constitute less than two per cent of all losses (Haughey 1981). The most common categories of perinatal loss are birth injury and mismothering/starvation, with losses attributable to infections, primary predation, nutritional deficiencies and congenital malformations generally being of less importance.

(i) Birth injury Birth injury to the central nervous system (CNS) can be caused by feto-pelvic disproportion, and prolonged or unduly vigorous labour. Severe injury causes death during or shortly after birth from the effects of severe asphyxia. Less severe injury impairs feeding and walking activity making lambs vulnerable to secondary hypothermia even in comparatively mild weather, and to dehydration and heat exhaustion in hot conditions.

(ii) Mismothering/starvation This is generally the most common category of loss, and losses due to a variety of causes are generally grouped under this heading. For example, the losses can be due to starvation brought about by aberrant ewe or

*CSIRO Division of Animal Production, Prospect, N.S.W., 2149.
**Department of Agriculture, Agricultural Research and Veterinary Centre, Orange, N.S.W., 2800.

lamb behaviour, by a deficient milk supply and by teat and udder abnormalities (Hayman *et al.* 1955). Again hypothermia and hyperthermia can cause deaths and these will often by included in the mismothering/starvation category. Primary hypothermia can occur during inclement weather when heat loss exceeds heat production, even when there are adequate foetal energy reserves. At the other extreme, hyperthermia and dehydration is a common cause of mortality in hot, dry areas (Smith 1961).

It is not certain to what extent mismothering/starvation losses are due in fact to birth injury. Haughey (1981) has claimed that damage to the CNS during birth is responsible for many post-parturient deaths commonly attributed to starvation, mismothering and exposure. There is evidence that birth injury increases the susceptibility of lambs to hypothermia, either immediately after birth or after 12-24 hours of inclement weather (Alexander *et al.* 1980).

(iii) Infections Studies such as those by Alexander and Peterson (1961), Hughes *et al.* (1964) and Dennis (1965) indicate that infections cause less than 10 per cent of lambs deaths in Australia. They can, however, be important in individual flocks, and the chance of losses due to bacterial infections acquired at or soon after birth is increased with high stocking rates and intensive lambing systems (Haughey 1981).

Congenital infections can cause lamb deaths. They can be due to a variety of bacterial and viral agents, the most common being listeriosis, vibriosis and toxoplasmosis. These infections occur widely and, while they generally cause only few losses, can give rise to occasional abortion "storms".

(iv) Primary predation Losses can only be attributed to primary predation when the carcase shows extensive and severe antemortem trauma and no other gross lesions (Haughey 1981). The most common predators are foxes, domestic dogs, dingoes, feral pigs, ravens and crows (*Corvus ssp.*) and wedge-tailed eagles. Predators are often blamed for more deaths than they cause. Many of these deaths are of non-viable lambs, and these should more correctly be described as secondary predation. In addition lamb carcases are also mutilated by scavenging animals. Primary predation losses generally comprise 2 to 5 per cent of deaths (McFarlane 1964; Dennis 1969) but can be responsible for much heavier losses. For example, Smith (1964) reported ravens to be responsible for 13.7 and 51.4 per cent of deaths in single and twin lambs, respectively. Plant *et al.* (1978) estimated that feral pigs killed over 600 lambs from 1,422 pregnant ewes.

(v) Nutritional deficiencies and congenital malformations Congenital deficiencies of copper, iodine and selenium are endemic to certain districts where heavy mortality may occur in sporadic outbreaks (Haughey 1981). Vitamin A deficiency can also lead to deaths. Provided that these deficiencies are not due to inborn errors of metabolism, as can be the case for iodine, then losses can be reduced by appropriate prophylactic treatment.

About one per cent of perinatal mortality is due to lethal congenital malformations (Haughey 1981) with deaths occurring before, during and after birth.

HUSBANDRY OPTIONS FOR REDUCING LAMB LOSS

There are several approaches to reducing perinatal loss within a flock. These include nutritional manipulations, and alterations to the physical environment and the degree of supervision of lambing ewes.

(i) Nutritional manipulation The aim of nutritional manipulation is to feed ewes in late pregnancy to reduce the likelihood of lamb deaths. Specifically the nutritional regime should attempt to produce as many lambs as possible within the range of 3.5 to 4.5 kg at birth and an abundant milk supply from the ewe.

Unless ewes are fed at close to the optimum level during the pre-natal period serious lamb losses are inevitable and efforts to rectify the situation by husbandry at lambing time are unlikely to succeed. Poor nutrition in late pregnancy can cause pregnancy toxaemia and poor maternal behaviour. It results in the birth of small and weak lambs which are slow to suck and follow the ewe, and are more susceptible to climatic stress (Alexander 1980). On the other hand, over-abundant nutrition can result in large single lambs and difficult births which in turn can lead to poor maternal behaviour.

A commonly accepted practical recommendation is to feed ewes to gain 6-8 kg in live weight during late pregnancy. This could be modified according to the expected incidence of twins. For example, older ewes need to gain more weight than maiden ewes. Provided that a near-optimum feeding regime is achieved, it is unlikely that small nutritional manipulations will greatly influence lamb survival. More precise recommendations on feeding levels will depend on the development of a practical means of identifying single and twin-bearing ewes.

(ii) Environmental manipulation The main aim of environmental manipulation is to protect lambs from cold, windy weather in southern Australia and from excessive heat in more tropical areas. It should also attempt to reduce the chance of mis-mothering, especially of twin-born lambs.

Some measure of environmental control can be provided by the choice of lambing and shearing times, the selection of a suitable lambing paddock and the provision of shelter. While lambing can be timed to avoid temperature extremes its timing will be affected by many other factors, so that there is generally only limited flexibility in this choice.

Shearing ewes prior to lambing has been claimed to reduce lamb loss. Evidence from Armidale suggests that newly-shorn ewes lose fewer lambs (Barrett and Rocks 1953; Alexander et *al.* 1980), especially twin-born lambs. The benefits of shearing were perhaps slightly greater when Phalaris shelter belts were also provided, newly-shorn ewes showing a greater tendency to use this protection (Stevens et *al.* 1981). It is not clear how general these findings are and the advantages may well be less under more favourable weather conditions (McGuirk *et al.* 1966). In addition to the practical problems associated with shearing ewes close to lambing, ewes in poor condition could be put at risk if exposed to cold, wet conditions off-shears.

Where ewes are lambing under hot conditions they should be provided with adequate shade as this will enhance the survival prospects of their lambs (Morgan *et al.* 1972).

The influence of other characteristics of lambing paddocks generally remain unstudied. These include the size, aspect and topography of paddocks, the number and disposition of watering points, and the degree of timber or scrub cover. These latter features could influence the chance of separation of ewes especially from twin-born lambs, and protection afforded to predators.

(iii) Supervision at lambing The degree of supervision of lambing ewes varies widely, from zero supervision through drift lambing to lambing in individual pens. Most producers will inspect lambing ewes once or twice a day and provide assistance at the occasional difficult birth. However it is not known how this procedure would compare with less attention (zero interference) or more intensive management programmes, provided by either drift or pen lambing. More research is needed in this area.

Tyrrell and Giles (1974) found that, over a three year period, 13 per cent of lambs died in a drift lambing system at Trangie compared with 21 per cent for a completely unsupervised group of ewes. However, in a subsequent five year period, there was virtually no difference in lamb loss from supervised and unsupervised groups (14.6 v 15.9 per cent) when the latter group was split into three on expected lambing date. The authors suggested that the improvement in performance of the unsupervised group was due to a reduction in lamb stealing. The average litter size in the flocks examined was high, at 1.50.

Alexander (1980) has argued that as a general rule frequent inspections are probably advantageous for flocks with few multiple births, both to provide assistance at difficult births and to facilitate bonding of ewe and lamb. However these advantages may be outweighed in flocks with a higher incidence of twins, as twin lambs can easily become permanently separated from their dams.

DISCUSSION

While producers may be aware of their lamb marking percentages, they are generally unaware of the reasons for reproductive wastage in their individual flocks and particularly of the contribution made by lamb loss. While this remains true it will be difficult to convince producers to modify their management.

Even when lamb loss is known to be a significant problem in a flock it is still difficult to offer recommendations with any confidence. This is because the causes of lamb loss are likely to vary between years and also because of the relatively limited information available on the merits of various strategies.

For these reasons we are left with the general recommendations to maintain flock health and provide adequate nutrition in late pregnancy. This latter recommendation will need to be re-assessed when a method of identifying twin-bearing ewes becomes available.

An alternative approach, and one that will be considered in later papers, involves the potential for reducing lamb losses by breeding. Provided that the ability to rear lambs is heritable, permanent genetic gains can be made by selection. Given the structure of a breed such as the Merino, these selection efforts can be focussed upon the ram breeding sector and especially the studs.

LIFETIME REARING PERFORMANCE OF MERINO EWES AND ITS RELATIONSHIP WITH PELVIC SIZE AND EARLY REARING STATUS

K.G. HAUGHEY* and J.M. GEORGE**

Statistics on the lifetime rearing performance of individual ewes, including the frequency with which they fail repeatedly to rear progeny, are not available. This paper summarises the rearing performance of ewes surviving four lambings in three Merino flocks. Additional data are presented for two of these flocks on the associations between repeated rearing failure and mature maternal pelvic size and between rearing performance at two years of age and at subsequent lambings.

MATERIALS AND METHODS

The lifetime rearing performance was assessed in three Merino flocks of ewes

*Department of Veterinary Clinical Studies, University of Sydney, Camden, N.S.W. 2570.
**CSIRO Division of Animal Production, Armidale, N.S.W. 2350.

which had completed four lambings from not more than five joinings. Rearing performance was defined as the number of occasions from four opportunities that a ewe reared at least one lamb. Ewes which reared lambs on three or all occasions from the four opportunities were classified as Good History ewes and those which failed to rear lambs on two, three or all occasions were classified as Repeat Failures.

In Flock 1 rearing performance to weaning was recorded on 377 fine-wool Merino ewes born between 1958 and 1971 (George 1975). Flock 2 comprised 202 Peppin Merino ewes born in 1968 and surviving the experiment reported by Donnelly (1978). Detailed records were not available and rearing performance to lamb-marking was determined by the "wet-dry" technique (Dun 1963). Flock 3 comprised an unselected sample of 84 Peppin Merino ewes from Trangie Agricultural Research Station. The ewes were born in 1967 and 1968 and came mainly from a flock selected for increased net reproductive rate, weaning weight and hogget fleece weight (Atkins 1980).

Detailed lambing records were available on all ewes in Flocks 1 and 3, and in these flocks rearing performance at the next three lambings was examined relative to rearing performance at two years of age. The area of the pelvic inlet was calculated for mature ewes in Flocks 2 and 3 as the product of the transverse and conjugate diameters. These were determined either from dissected pelves measured after slaughter (Quinlivan 1971; Flock 2), or by radiographic pelvimetry of the live sheep (Haughey and Gray 1982; Flock 3).

RESULTS

Details were available on the fertility and fecundity of Flocks 1 and 3, and on the survival of their single- and twin-born lambs. In Flock 1, in which only 8.8 per cent of ewes gave birth to twins, survival was significantly higher for single-born lambs (77.4 per cent v 61.0 per cent, $P < 0.001$). In Flock 3, where 26.4 per cent of ewes gave birth to twins, survival rate was slightly, but not significantly, higher for twin-born compared to single-born lambs (86.1 per cent v 81.4 per cent).

The average proportions failing to rear lambs in Flocks 1, 2 and 3 were respectively 22.7, 26.6 and 14.9 per cent (Table 1). Repeat failures, ewes

TABLE 1 Rearing efficiency of Merino ewes over four lambings

Flock	1 (Fine-wool)		2 (Peppin)		3 (Peppin)	
Rearing performance	Number of ewes	(%)	Number of ewes	(%)	Number of ewes	(%)
Always reared	143	(37.9)	69	(34.2)	55	(65.5)
Reared 3 times	147	(39.0)	73	(36.1)	13	(15.4)
Reared twice	69	(18.3)	39	(19.3)	12	(14.3)
Reared once	14	(3.7)	20	(9.9)	3	(3.6)
Always failed	4	(1.1)	1	(0.5)	1	(1.2)
Total	377	(100.0)	202	(100.0)	84	(100.0)
Annual failure %		22.7		26.6		14.9

which always failed to rear a lamb or reared only once or twice in their lifetime, accounted for the majority of failures in each flock. In Flock 1, for example, these ewes constituted only 23.1 per cent (1.1 + 3.7 + 18.3) of the total, yet they accounted for 57.1 per cent of failures (196 out of a total of 343 failures). In Flock 2, 29.7 per cent of ewes accounted for 60.0 per cent of failures (142 out of 215) and in Flock 3, 19.1 per cent of ewes accounted for 74.0 per cent of failures (37 out of 50). The probability of repeated rearing failure among ewes which failed once was 0.37, 0.45 and 0.55 in Flocks 1, 2 and 3 respectively.

In Flock 3 Repeat Failures had a significantly smaller mean pelvic area than Good History ewes (84.1 cm^2 v 91.8 cm^2, $P < 0.001$) whereas in Flock 2 they did not (93.5 cm^2 v 94.3 cm^2, ns).

In Flocks 1 and 3 it was possible to relate lamb rearing performance at the ewe's first lambing with her performance over the three subsequent lambings. In both flocks the two were positively related. In Flock 1, ewes which reared at least one lamb at their first lambing had an average rearing efficiency of 79.7 per cent, compared with 74.9 per cent for ewes failing to rear at their first lambing (ns). Comparable figures in Flock 3 were 88.7 v 68.8 per cent ($P < 0.001$).

DISCUSSION

The observations reported here were on ewes that had lambed on four occasions from a maximum of five opportunities to lamb. Despite their above average fertility, these ewes in Flocks 1 and 2 were characterized by very poor life-time rearing efficiency, with a substantial proportion of ewes failing repeatedly to rear their lambs. Over both flocks a mean of only 36.6 per cent of ewes always reared, whereas a mean of 25.4 per cent failed to do so at least twice from four opportunities. Although significantly more ewes in Flock 3 always reared lambs (65.6 per cent), the proportion of Repeat Failures was still substantial (19.1 per cent). At least part of Flock 3's superiority is likely to be genetically determined, as this flock has responded to selection for improved rearing ability and lamb survival (Atkins 1980).

In all flocks repeated rearing failure accounted for the majority of lamb losses; on average 59.7 per cent of losses were attributable to 24.6 per cent of ewes. Similarly ewes that failed to rear a lamb at two years of age gave the lowest rearing efficiency at subsequent lambings. This latter finding suggests that rearing performance at two years be a useful selection criterion. At the same time, the nature of repeated rearing failure is a clear priority for research. Repeat rearing failure indicates that maternal and possibly fetal factors operate to threaten lamb survival throughout a ewe's breeding life. For example, feto-pelvic disproportion has been implicated in birth injury and is a likely cause of repeated rearing failure. Small pelvic size has been associated with repeated rearing failure in Romney Marsh and Dorset Horn ewes (e.g. McSporran and Fielden 1979; Fogarty and Thompson 1974) and this would also appear to be true in Flock 3. High birthweight has been correlated with the prevalence of birth injury (Haughey 1973), dystocia and stillbirth (Gunn 1968) and unpublished results show that repeated failure in Flock 2 is associated with an unexpectedly high proportion of heavy lambs sired by particular rams. Thus feto-pelvic disproportion of maternal or fetal origin could account largely for repeated rearing failure in Flocks 2 and 3.

The failure of research to provide clear guidelines to the Merino industry for reducing perinatal mortality is probably due to two overriding factors. Firstly we have been preoccupied with the fecundity of ewes without reference to the survival of their progeny. Secondly we have been preoccupied with the lamb's role in survival, to the neglect of that of its mother. It is submitted that survival of lambs to weaning has to be seen in the context of a successful partnership between mother and offspring throughout pregnancy, parturition and lactation, with successful rearing the critical test of the "fitness" of the mother-offspring unit. Maternal influences impairing lamb survival include small pelvic size, poor maternal behaviour, inadequate milk supply and udder abnormalities.

GENETIC VARIATION IN INDIVIDUAL AND MATERNAL COMPONENTS OF LAMB SURVIVAL IN MERINOS

L.R. PIPER*, J.P. HANRAHAN**, R. EVANS*** and B.M. BINDON*

Lamb survival is a complex phenomenon influenced by the lamb's own capacity to survive (viability) and by its dam's rearing ability. In this paper we review published and unpublished estimates of the heritability of each of these components of survival and discuss the implications for breeding programmes aimed at increasing lamb survival in the Australian Merino.

GENETIC VARIATION IN LAMB VIABILITY

Survival is an all-or-none variable when treated as a trait of the lamb. Because dead lambs leave no offspring, the heritability of viability cannot be determined from offspring-parent analyses, but can be estimated from the variation in mean survival between half-sib groups of lambs. Several such studies have been reported.

Piper and Bindon (1977) analysed survival to seven days of age in a random-bred flock of Merinos and obtained heritability estimates of 0.02 ± 0.02. Piper et *al.* (unpublished) have recently extended these analyses to include a second random mating flock and to cover the period of survival from birth to weaning. In the flock studied by Piper and Bindon (1977) the heritability of survival to weaning was 0.05 ± 0.03 while for the second flock (4160 lambs and 232 d.f. for sires) the estimate was slightly negative. Similar low estimates of heritability of survival to weaning have been observed by Smith (1977) for a range of purebred and crossbred lambs in the United States, and by Cue (1981) for Scottish Black-face and Welsh Mountain breeds in the United Kingdom.

These low heritability estimates and the increased generation interval inherent in a progeny testing programme for choosing replacement sires means that there is very little scope for improving lamb survival by direct selection over and above gains automatically being achieved by natural selection.

An alternative approach would be an indirect selection programme, changing birth weight or perhaps birth coat genetically in order to enhance lamb survival. Heritability estimates for birth weight were also obtained by Piper and Bindon (1977) and Smith (1977) and they were of the order of 0.2-0.3. However estimates of the genetic correlations with lamb survival were small and variable in sign. As the phenotypic relationship between birth weight and survival is generally curvilinear, it may be difficult to decide if selection should be for increased or reduced birth weight. In any event, the magnitude of the genetic correlation is such that the correlated response in lamb survival is likely to be trivial.

GENETIC AND PHENOTYPIC VARIATION IN REARING ABILITY

Rearing ability may be defined for an individual lambing ewe as the ratio of the number of lambs weaned to the number of lambs born (LW/LB). Rearing

*CSIRO, Division of Animal Production, Armidale, N.S.W. 2350.
**The Agricultural Institute, Western Research Centre, Tuam, Co. Galway, Ireland.
***CSIRO Division of Animal Production, Prospect, N.S.W. 2149.

ability therefore takes values of 0 or 1 for single bearing and 0, 0.5, or 1 for twin bearing ewes etc. Other definitions used by various authors treat rearing ability as an all-or-none character; for example wean at least one lamb *versus* wean no lambs and wean all lambs born *versus* wean none.

(i) Repeatability In the previous paper, Haughey and George (1982) adopted the wean at least one *versus* wean none definition of rearing ability and found that the major proportion of lamb loss in three flocks of Merinos was attributable to ewes that repeatedly (2, 3 or 4 times out of 4) failed to rear their lambs. Recent analyses of data from two random mating flocks of Merinos at Armidale (Hanrahan *et al.*, unpublished) also demonstrate that rearing ability is repeatable. They estimated the repeatability of LW/LB as the average within-year of birth regression of subsequent on prior record. The estimates of adult (> 2 years old) ewes were 0.16 ± 0.02 and 0.15 ± 0.02 in the two flocks. If the two year old lambing only was used as the prior record, the corresponding estimates of repeatability were 0.05 ± 0.03 and 0.12 ± 0.02. While the two year old record may be a poorer predictor than later records these estimates indicate that significant gains in current flock performance could be achieved by culling ewes on the basis of rearing ability. Essentially similar conclusions may be drawn from the study of Shelton and Menzies (1970) who obtained estimates of 0.06 and 0.10 for the repeatability of rearing ability (defined as wean at least one lamb *versus* wean none) in two flocks of Rambouillet ewes.

(ii) Heritability Analyses of genetic variation in rearing ability have recently been completed for two random mating flocks of Merinos at Armidale (Hanrahan *et al.*, unpublished). Heritability estimates for lambing ewes ranging in age from two to seven years were obtained by paternal half-sib and daughter-dam regression methods for all three measures of rearing ability as defined above. While there was some evidence of variation according to flock, method of estimation and age of ewe, the average heritability estimates for all three measures of rearing ability were about 0.10 and of the same order as the estimates for lambs born and lambs weaned. In the Rambouillet data of Shelton and Menzies (1970) the half-sib heritability estimates of rearing ability in two flocks were 0.131 ± 0.051 and 0.190 ± 0.090. The corresponding estimates for twinning frequency were 0.139 ± 0.062 and 0.102 ± 0.113. Taken together these estimates of the heritability of rearing ability indicate that it should be possible to improve lamb survival in the Merino by selection for increased rearing ability in the ewe. With heritabilities of the order of 10 per cent, progress would be greater if selection was based on several records, as for example in a breeding programme where replacement males and females were chosen on the basis of their dam's lifetime rearing ability. In more general terms, these results indicate that some attention should be given to rearing ability as well as to litter size at birth (Turner 1969) in breeding programmes aimed at increasing reproductive efficiency in the Merino.

A PRACTICAL ATTEMPT TO BREED FOR BETTER LAMB SURVIVAL

F.B. DONNELLY*

Previous papers in this contract have considered the possibility that the maternal contribution to lamb survival is a repeatable and a heritable characteristic. In this paper I will discuss the implementation of a practical breeding programme which has been operated over a ten year period with the aim of improving lamb survival.

*Department of Agriculture, Parkes, N.S.W. 2870.

MATERIALS AND METHODS

This breeding programme was set up at "Plevna", a 3,237 ha wheat growing/ sheep raising property located 10 km north east of Trundle in central western New South Wales. The long-term annual average rainfall for the property is 495 mm.

The medium-wool Merino sheep on the property were run in two flocks, a ram-breeding portion and a commercial flock, The ram-breeding portion was not registered when the breeding programme was started in 1970, but was inspected and accepted as registered Merino Stud Flock No. 3748 in 1979. The selection programme in the ram-breeding flock has emphasised high greasy fleece weight and freedom from fleece rot and body strike, while maintaining a high visual standard of excellence.

In 1972 a group of 181 ewes (1968 drop) was selected on their lamb rearing performance in 1970 and 1971. This group, and their progeny, will be referred to as the Nucleus flock. They were selected from a total of 431 ewes from the Plain-bodied portion of the commercial flock on the property, which were also involved in a five-year comparison (1970-1974) of plain and wrinkled Merinos (Donnelly 1978).

The 181 ewes selected had all reared at least one lamb to marking at each of their first lambings in 1970 and 1971 and were free of udder or teat damage. The selected ewes also conformed to other requirements of the breeding plan; namely high fleece weight, freedom from fleece rot and body strike, wool that was acceptable visually for colour, character and handle, and above-average body size through body length. In order to remain in the Nucleus these base ewes and succeeding replacement ewes have been required to rear a lamb each year.

The rams joined to the Nucleus ewes in 1972 and 1973 were selected without regard to their dam's rearing performance. The rams chosen were 14% above the drop average for hogget liveweight, 26% above-average in greasy wool weight and 3% below average for fibre diameter. In addition their combined score for neck fold and body wrinkle (Turner *et al.* 1953) was no greater than the upper limit of five (5) decided upon at the outset of the breeding programme. Some attention was also given to wool quality and animals with fleece rot or flystrike were automatically excluded.

Since 1974 the Nucleus ewes have been joined to rams bred in the Nucleus flock. The principal criterion used in selecting replacement ewes and rams was that their dams had successfully reared a lamb in each of her first two years in the breeding flock. Attention was also given to the other production, body and wool characters listed above.

Mating of the Nucleus ewes each year has taken place over a period of six to eight weeks in the Autumn, following shearing a few weeks earlier. Prior to 1977 the ewes were allowed to lamb as a mob in one paddock for the full duration of lambing. Since 1977 the Nucleus ewes have been lambed down through a set of six 2 ha drift lambing paddocks. At least once a day during the peak of lambing, and less frequently as it tapers off, ewes which have not lambed in the preceeding 24 hours are "drifted" away from the ewes with newborn lambs into an adjoining empty paddock. The newborn lambs, left with their mothers (carrying an identifying numbered neck plate), are weighed and ear tagged on the day of birth, and the information on sex, birth type and birth weight of the lamb, together with neck plate numbers of their mothers are recorded daily in the lambing book. Other information recorded includes assisted births, skeletal faults, deformities and undesirable pigments. The date on which lambs are found dead in the drift paddocks is also recorded against tag numbers.

At lamb marking each ewe is examined (Dun 1963) to record those which have failed to rear their lambs and possible reasons for failing, e.g. deformed or damaged teats or udders, mastitis, etc. The tag number of lambs present for marking and mulesing is recorded.

In this paper the lambing and rearing performance of the Nucleus flock has been compared with Stud ewes on the property. The two flocks are run together at all times of the year other than at joining and are managed identically. Selection in the Stud has emphasised overall visual merit, high greasy wool weight, overall wool quality and freedom from fleece rot and body strike. There has been no culling of ewes that fail to rear a lamb, and ram and ewe replacements have been selected without regard to their dam's rearing performance.

RESULTS AND DISCUSSION

Only ewes born in 1975 and subsequent years have been included in the comparison of Nucleus and Stud flocks, made over five lambings, 1977 to 1981. All lambing and rearing observations have been treated as if they were independent, even for repeat observations on the same ewe in different years. Summed over the five lambings there were 216 and 190 ewe records in the Nucleus and stud flocks, where a ewe was joined and alive at the start of lambing. Reproductive performance in the two flocks was similar, with 92.1 and 94.2 per cent respectively of the Nucleus and Stud ewes lambing.

Detailed individual lambing records were obtained on all but 7 of these lambings. If these 7 records are excluded 17.0 and 16.4 per cent of ewes in the Nucleus and Stud flocks respectively produced twins.

Details of ewe rearing performance are summarised in Table 2. Overall, the Nucleus ewes reared nine per cent more lambs to marking than did the Stud ewes (88.9 v 79.6 per cent) and the superior rearing performance of the Nucleus ewes was apparent for both single and twin-born lambs. It is interesting to note that the better survival of Nucleus-bred lambs was achieved despite being on average 0.23 kg heavier than Stud lambs at birth, and the weight of both groups was well above the oft-quoted 'ideal' birth weights cited for the Merino, of 3.5 to 4.0 kg.

The differences in lamb rearing percentages between the Nucleus and Stud flocks are a mixture of both permanent genetic and current generation gains, as there is a continuing programme to cull Nucleus ewes that fail to rear a lamb. Although still relatively small, the difference in lamb rearing ability is encouraging, especially as there has been simultaneous selection hopefully to improve or at least maintain several other production characters.

TABLE 2 Lamb survival in Nucleus and Stud flocks

	No. of lambs born	Per cent born alive	Per cent marked †	Average birth weight (kg)
All lambs				
Nucleus	227	96.9	88.6	4.94
Stud	206	94.2	79.6	4.71
Single lambs				
Nucleus	161	95.7	91.3	4.99
Stud	148	93.9	81.1	4.63
Twin lambs				
Nucleus	66	100.0	81.8	4.81
Stud	58	94.8	75.9	4.91

†Number of lambs born alive or marked as a percentage of those born.

SUMMARY AND CONCLUSIONS

B.J. McGUIRK

In this contract we have argued that the chance of improving the survival prospect of Merino lambs is small if we limit our options to the development and adoption of improved management practices. At present there is little that research can offer the industry with confidence in this area. This situation is likely to hold while Merino flocks are run under extensive conditions, where there is limited control over feed supply and environmental conditions. Some improvements may be made with the development of real time ultra-sound equipment, suitable fo identifying twin-bearing ewes in early pregnancy under field conditions (see for example Wilkins and Fowler, these Proceedings). However this development will only have its full impact if it is presented as part of an overall management package, which would place greater emphasis on the nutritional management of the ewe flock, In the meantime, the provision of shelter can obviously help in reducing lamb losses due to extremes of weather. And producers should be encouraged to routinely check their ewes before joining and to cull any with faulty or damaged udders and teats.

The evidence presented in the preceding papers strongly suggests that ewe rearing performance in the Merino can be improved by selection. The trait appears to be both repeatable and heritable, and the breeding programme described by Donnelly has already produced encouraging results. Atkins (1980) has also described the reduced levels of lamb loss now found in the Trangie Fertility flock, further evidence of the effectiveness of selecting for improved ewe rearing performance. In both studies, the survival of both single and twin-born lambs appears to have been improved.

The selection programmes described by Donnelly and by Atkins (1980) were initiated before any information was available on the heritability and repeatability of ewe rearing performance, or on its correlation with ewe lambing performance. As such information becomes available it will be possible to assess the merits of alternative selection strategies for improving ewe reproductive performance, given that our overall aim is to increase the number of lambs marked or weaned. Further research is also needed to identify alternative selection criteria, particularly those which might be used as a basis for selection before ewes enter the breeding flock.

Genetic gains in ewe rearing performance in the Merino industry will depend on the adoption of appropriate identification and selection procedures in ram breeding flocks, and especially in the studs. Ewes requiring assistance at lambing , and their progeny, need to be identified, as do ewes that lose their lambs prior to marking or weaning. Selection can then favour the progeny of ewes with a good rearing history, while ewes with a poor history can be culled. It remains for research to assess the relative benefit to be gained from these two approaches, and to place improved ewe rearing performance in context in the overall objectives for the Australian Merino industry.

ACKNOWLEDGEMENTS

The authors wish to thank Mr John Aveyard of "Plevna", Trundle and Messrs R. Wilson and W. Callaghan for their help and support in undertaking observations at Plevna and in providing information on ewe lambing and rearing performance. The Director and staff at Trangie Agricultural Research Station kindly provided the information on ewe rearing performance for the Trangie ewes. The research programme at the University of Sydney was supported by funds from the Australian Wool Corporation, on the recommendation of the Wool Research Trust Fund.

REFERENCES

ALEXANDER, G. (1980). In "Reviews in Rural Science", No. 4, p.99, editors Manika Wodzicka-Tomaszewska, T.N. Edey and J.J. Lynch. (UNE Press: Armidale.)

ALEXANDER, G., LYNCH, J.J., MOTTERSHEAD, B.E., and DONNELLY, J.B. (1980). Proc. Aust. Soc. Anim. Prod. 13: 329.

ALEXANDER, G., and PETERSON, J.E. (1961). Aust. Vet. J. 37: 371.

ANON. (1980). Final Report, Sheep Fertility Service, Wagga Wagga. New South Wales Department of Agriculture.

ATKINS, K.D. (1980). Proc. Aust. Soc. Anim. Prod. 13: 172.

BARRETT, J.F., and ROCKS, R.L. (1953). In Annual Report 1952-53, C.S.I.R.O. Regional Pastoral Laboratory, Armidale, p.49.

CUE, R. (1981). Ph.D. Thesis, University of Edinburgh.

DENNIS, S.M. (1965). Journal of Agriculture, Western Australia. 6:216.

DENNIS, S.M. (1969). Aust. Vet. J. 45: 6.

DONNELLY, F.B. (1978). Wool Technol. Sheep Breed. 24(1): 9.

DUN, R.B. (1963). Aust. J. Exp. Agric. Anim. Husb. 3: 228.

FOGARTY, N.M., and THOMPSON, J.M. (1974). Aust. Vet. J. 50: 502.

GEORGE, J.M. (1975). Aust. Vet. J. 51: 262.

GUNN, R.G. (1968). Anim. Prod. 10: 213.

HAUGHEY, K.G. (1973). Aust. Vet. J. 49: 9.

HAUGHEY, K.G. (1981). In "Refresher Course on Sheep", The University of Sydney Post-Graduate Committee in Veterinary Science, Proceedings No. 58, p.657.

HAUGHEY, K.G., and GRAY, C.H. (1982). Aust. Vet. J. 58: in press.

HAYMAN, R.H., TURNER, H.N., and TURTON, E. (1955). Aust. J. Agric. Res. 6: 446.

HUGHES, K.L., HARTLEY, W.J., HAUGHEY, K.G., and McFARLANE, D. (1964). Proc. Aust. Soc. Anim. Prod. 5: 92.

McFARLANE, D. (1964). Wool Technol. Sheep Breed. 11(1): 11.

McGUIRK, B.J., PAYNTER, J., and DUN, R.B. (1966). Aust. J. Exp. Agric. Anim. Husb. 6: 305.

McSPORRAN, K.D., and FIELDEN, E.D. (1979). N.Z. Vet. J. 27: 75.

MORGAN, P.D., ARNOLD, G.W., and BOUNDY, C.A.P. (1972). Proc. Aust. Soc. Anim. Prod. 9: 371,

MOULE, G.R. (1954). Aust. Vet. J. 30: 153.

PIPER, L.R., and BINDON, B.M. (1977). Proc. 3rd SABRAO Congr., 10.17.

PLANT, J.W., MARCHANT, R., MITCHELL, T.D., and GILES, J.R. (1978). Aust. Vet. J. 54: 426.

QUINLIVAN, T.D. (1971). N.Z. Vet. J. 19: 73.

SLELTON, M., and MENZIES, J.W. (1970). J. Anim. Sci. 30: 1.

SMITH, G.M. (1977). J. Anim. Sci. 44: 745.

SMITH, I.D. (1961). Aust. Vet. J. 37: 205.

SMITH, I.D. (1962). Aust. Vet. J. 38: 500.

SMITH, I.D. (1964). Proc. Aust. Soc. Anim. Prod. 5: 100.

STEVENS, D., ALEXANDER, G., and LYNCH, J.J. (1981). Appl. Anim. Ethol. 7: 149.

TURNER, Helen Newton (1969). Anim. Breed. Abstr. 37: 545.

TU'RNER, Helen Newton, HAYMAN, R.H., ROBERTS, N.F. , and WILSON, L.T. (1953). C.S.I.R.O. Divisional Report No. 4 (Series SW-2).

TYRRELL, R.N., and GILES, J.R. (1974). Aust. J. Exp. Agric. and Anim. Husb. 14: 600.