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The effect of non-genetic factors on preweaning survival rate in the Tygerhoek Merino lambs

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Abstract

The aim of the study was to investigate the effects of non-genetic factors on preweaning survival rate of Merino lambs maintained at the Tygerhoek Experimental Farm. A total of 8823 lambs born from 1970 to 1994 were used. Average survival rate from birth to 100 days of age was 0.79 and was influenced by lamb birth weight, year of birth, age of dam at lambing, type of birth (single, multiple) and sex of lambs. Lambs with a liveweight between 4.0 to 4.9 kg at birth showed the highest survival rate while lambs with a liveweight of ≤ 2.0 kg showed the lowest survival rate.

Keywords: Non-genetic factors; preweaning survival; Tygerhoek Merino lambs;

Introduction

Lamb mortality results in serious financial losses in sheep production (Petersson and Danell, 1985). It is a major factor affecting the number of lambs weaned per ewe (Fogarty *et al*., 1985; Haughey *et al*., 1985). Efficiency of lamb production can thus in many situations be improved more readily by increasing the preweaning survival rate than by improved growth and body composition (Dickerson, 1978). In terms of reproductive wastage, lamb losses represent a serious problem because all investments made for ewes to conceive and maintain pregnancy are wasted (Mukasa-Mugerwa and Lahlou-Kassi, 1995). Land *et al.* (1983) indicated that no discussion of increasing lambing rates would be complete without mention of lamb survival after birth.

Preweaning lamb survival is a complex trait influenced by the lamb's ability to survive and by its dam's rearing ability (Burfening, 1993). Various studies have reported that birth weight, age of dam, year of birth, sex of lamb and type of birth affect preweaning lamb survival (Meyer and Clarke, 1978; Dalton *et al*., 1980; Schoeman, 1990; Yapi *et al*., 1992a; Burfening, 1993; Mukasa-Mugerwa and Lahlou-Kassi, 1995). Birth weight plays an important role in lamb survival, and an intermediate optimum has been shown to exist

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for birth weight (Al-Shorepy, 2001), with very large lambs which are more likely subjected to dystocia losses while very small lambs are at risk of death from hypothermia, starvation, respiratory diseases and other causes (Meyer and Clarke, 1978; Petersson and Danell, 1985; Al-Shorepy, 2001).

Environmental conditions and management practices are also expected to make a considerable impact on lamb survival. Nevertheless, unless it is practiced along with some selection against high death losses, improved management alone may not resolve the problem of high lamb mortality rates (Yapi *et al*., 1992b). Except for the work of Heydenrych (1975), there is no information on the non-genetic factors affecting preweaning lamb survival rate in Merinos maintained at the Tygerhoek Experimental Farm. The purpose of the present study was to investigate the effects of various non-genetic factors influencing preweaning lamb survival rate of this flock.

Materials and Methods

The experimental animals originated from a selection experiment on the Tygerhoek Experimental Farm of the Department of Agricultural Development that was started in 1969. The farm is situated in the southern coastal area of the Western Cape province, about 150 km east of Stellenbosch at an altitude of approximately 168 m above sea level (34° 08′ S, 19° 54′ E). The area has an average annual rainfall of 429 mm, 60 % of which is recorded in winter (April – September). The average maximum (minimum) summer and winter temperatures are approximately 22°C (15°C) and 12°C (5°C), respectively.

Data of 8823 Merino lambs born from 1970 through 1994 at the Tygerhoek Experimental Farm were used in this study. These lambs were the progeny of 2422 dams and 629 sires. Details regarding the origin, history and management of the flock are described else where by Heydenrych *et al*. (1984) and by Cloete *et al.* (1992). Lamb survival is defined in this study as the number of lambs weaned (LW) per 100 lambs born (LB), i.e. (LW/LB) x
100. Data on dead lambs were obtained from lambs that were born alive and died subsequently. The dependent variable was lamb survival rate from birth to weaning and was coded as '1' if the lamb survived to weaning and as '0' if the lamb died prior to weaning. Information on cause of death was not available.

Significant fixed effects were identified using the CATMOD procedure of the Statistical Analysis Systems (SAS, 1996). Parameters measured to determine their effect on preweaning death losses included age of dam (2- to 6-year of age), type of birth (single, multiple), sex of lambs (male, female), year of birth (1970 to 1995) and birth weight. Birth weight was categorised into discrete classes as CATMOD is not modelled optimally for continuous

variables (SAS, 1996). Birth weight was categorised as follows: 1 = ≤ 2.0 kg; 2 = 2.1 – 2.9 kg; 3 = 3.0 – 3.9 kg; 4 = 4.0 – 4.9 kg; 5 = ≥ 5.0 kg. Simple t-test statistics indicated significant ($p < 0.05$) differences between the birth weight categories in mean preweaning survival rates. Crosstabulation in the Statistical Package for Social Sciences (SPSS, 1996) was used to estimate the percentage survival rate of lambs.

Results

Sources of variation considered and the associated probability levels are presented in Table 1. Maximum-likelihood analysis of variance for preweaning survival showed significant ($p<0.001$) effects of all fixed effects considered. The average survival rate from birth to 100 days was 0.79. Estimated number of lambs survived to weaning are indicated in Table 2.

Table 1. Maximum-likelihood analysis of variance of preweaning survival rate.

Source	df	Chi-square
Intercept	1	138.27***
Birth weight	4	315.72***
Year of birth	24	549.90***
Type of birth	1	223.55***
Age of dam	4	53.55***
Sex of lamb	1	34.76***
Likelihood ratio	2000	3031.93***

***= $p< 0.001$

Survival rate was significantly ($p<0.001$) affected by birth weight of lambs. The lightest lambs generally had the highest mortality rate. There was also a reduction in the survival rate of lambs as they became heavier than 4 kg at birth. Losses were particularly high in lambs of 2.0 kg or less at birth (0.63). Increased birth weight showed an increased survival rate of lambs' (Figure 1). Maximum survival rate of 0.87 was obtained for lambs weighed 4.0 to 4.9 kg of liveweight at birth.

Age of dam had a highly significant ($p<0.001$) influence on preweaning lamb survival. Survival of lambs from 2-year-old ewes was the lowest, whilst it was highest in lambs from 4-year old ewes. The general trend was for preweaning survival to increase as ewes increased in age from 2- to 4-years, whereafter it decreased (Figure 2).

Table 2. Estimated preweaning survival rate of lambs as affected by birth weight, sex of lambs and type of birth.

Source	N	lambs survived to weaning	
		in number	in percentage (%)
Birth weight category			
1 (≤ 2.0 kg)	284	104	37
2 (2.1-2.9 kg)	1653	1127	68
3 (3.0-3.9 kg)	3902	3133	80
4 (4.0-4.9 kg)	2486	2175	87
5 (≥ 5.0 kg)	498	403	81
Sex of lambs			
Male	4335	3343	77
Female	4488	3599	80
Type of birth			
Single	5022	4274	85
Multiple	3801	2668	70

Type of birth also had a significant ($p<0.001$) influence on preweaning survival rate of lambs. Single born lambs had a higher survival rate than multiples (0.85 and 0.70, respectively).

Year of birth of lambs had also a significant ($p<0.001$) influence on preweaning lamb survival, with no distinct trend. In general, survival rate was better in earlier years than in later years of the study period (not shown).

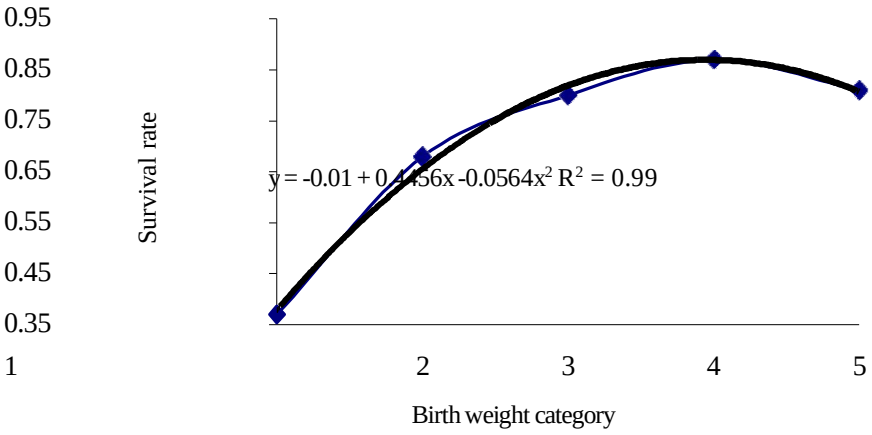

Figure 1. Thre regression of lamb survival on birth weight category.

Survival rate was also significantly ($p<0.001$) influenced by sex of lambs. Male lambs showed a higher pre-weaning mortality incidence than female lambs (0.23 and 0.20, respectively). The sex ratio (male/female) for surviving lambs was about 0.48:0.52.

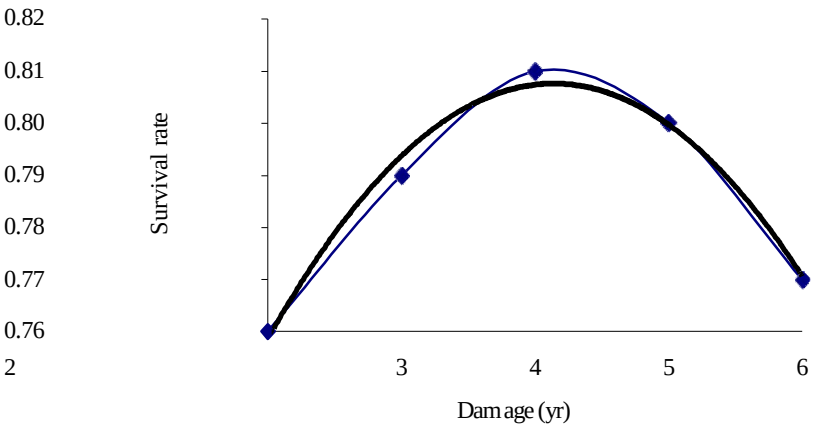

Figure 2. The regression of lamb survival rate on dam age.

Discussion

Average survival rate from birth to 100 days obtained in the present study was within the range of 0.74 to 0.85 reported in the literature for other sheep breeds (Dalton *et al*., 1980; Wiener *et al*., 1983; Schoeman, 1990; Mukasa-Mugerwa and Lahlou-Kassi, 1995; Cloete and Scholtz, 1998; Solomon and Gemeda, 2000). Low birth weight, poor mothering ability, environmental stress (chilly, windy, wet and harsh temperature conditions) on the newborn, starvation and respiratory diseases were reported as the major causes of death of lambs (Heydenrych, 1975; Dalton *et al*., 1980; McCutcheon *et al*., 1981; Mukasa-Mugerwa and Lahlou-Kassi, 1995; Solomon and Gemeda, 2000). According to McCutcheon *et al*. (1981), about one-third of preweaning lamb mortality is considered to be due to starvation and exposure losses.

Birth weight was one of the factors affecting preweaning lamb survival in this study. Heydenrych (1975), who used part of the same data set, indicated that low body weight at birth and a concomitant rapid exhaustion of energy reserves appeared to be the most significant cause of perinatal deaths in twin lambs while excessive body mass and consequent dystocia seemed to cause most deaths amongst single born lambs. In the present study, lambs that survived to weaning weighed 0.5 kg more at birth than lambs that died

prior to weaning (3.7 and 3.2 kg, respectively). Losses were particularly high in lambs that weigh 2.0 kg or less at birth. These results agree with those of Solomon and Gemeda (2000) and Mukasa-Mugerwa *et al*. (2000). These authors indicated that those lambs that were born with less than 2.0 kg birth weight, when the mean birth weights were 2.1 to 2.7 kg, had a greater risk of dying before weaning in two indigenous Ethiopian sheep breeds. In the present study, the maximum survival rate obtained from lambs with medium liveweight at birth of about 4.0 to 4.9 kg was within the weight range reported by Heydenrych (1975). In his study, lambs with a body weight at birth between 3.8 and 5.2 kg showed the highest survival rate. According to Peterson and Danell (1985), optimal birth weight seems to be higher than the mean birth weight. Likewise, in the present study, a maximum survival rate of 0.87 was obtained from lambs with 4.0 to 4.9 kg of liveweight at birth (Figure 1), which was above the 3.7 kg mean birth weight reported for this flock (Gemeda, 2001). Thus, since the relationship between birth weight and preweaning lamb survival is causative, it would be advisable to introduce farm management routines, which can help to increase birth weight. One option is to supplement ewes in the last trimester (Scales *et al*., 1986; Yohannes *et al*., 1998), especially to animals in poor body condition and to those carrying twins since both the foetus and the udder undergo rapid development during this period (Mukasa-Mugerwa *et al*., 2000). According to these latter authors, cross-foster of weak or orphan or abandoned lambs shortly after parturition are the other options. They also indicated that the rotation of twins during nursing can also help to ensure that each twin mate gets enough milk.

Cloete *et al*. (2000) indicated that shearing of ewes prior to lambing might be advantageous under certain conditions, particularly when lamb survival is likely to be low. Nevertheless, in their study, lambs born to ewes that were shorn prior to lambing tended to be lighter than those from ewes shorn prior to joining.

Unlike the observations in the present study on the effect of age dam, Schoeman (1990) and Cloete and Scholtz (1998) reported that there were no significant differences in survival rate between lambs born to ewes of different ages. The difference might be due to management practices. It was, however, in general agreement with most results reported in the literature (Wiener *et al*., 1983; Petersson and Danell, 1985; Atkins, 1986; Gama *et al*., 1991; Solomon and Gemeda, 2000; Morris *et al*., 2000; Mukasa-Mugerwa *et al*., 2000) where preweaning lamb survival increased with ewe age, reached its peak by about 4 to 5 years of age and then decreased. This was partly accounted for by birth weight that was significantly lower for lambs born to 2-year-old ewes. It might also be attributed to poorer rearing ability for older ewes, which may result from udder damage and poor body condition. Lambs

born to 6-years-old ewes were lighter at weaning than those born to 3- to 5-year-old ewes (Gemeda, 2001). In general, maiden ewes require better management than older age groups of ewes to enhance lamb survival rate.

The non-significant effect of sex on lamb survival rate reported by Yapi *et al*. (1992a) and Malik *et al*. (1998) was incontrast to the current results. The sex effect observed in the present study was, nevertheless, in general agreement with most other results reported in the literature (Petersson and Danell, 1985; Wiener *et al*., 1983; Schoeman, 1990; Gama *et al*., 1991). Schoeman (1990) reported that survival rate was significantly ($p<0.001$) affected by type of birth, with a higher survival rate in singles (0.88) than those of twins (0.78). Notter & Copenhaver, (1980), Wiener *et al*. (1983), Schoeman (1990), Solomon *et al*. (2000) and Mukasa-Mugerwa *et al*. (2000) suggested that the differences in mortality rates between singles and twins were primarily determined by differences in birth weight *per se*.

Differences between years may be a reflection of differences in feed availability between years, caused by differences in rainfall if feeding is pasture based. Severe weather conditions that were occasionally experienced at lambing can contribute to high environmental variance for lamb survival (Brash *et al*., 1994). The Southern Cape area is subjected to dry years with limited feed availability. The significance of year effects may also be attributed to changes in general management of the flock. According to Ducker and Fraser (1973), a "low level of husbandry" at the time of lambing may increase lamb mortality. Nevertheless, in a South African study, Cloete and Scholtz (1998), referring to the work of Brand *et al*. (1985), pointed out that very intensive management failed to reduce lamb mortality to levels below 15%. Other South African studies by Schoeman (1990) and Cloete and Scholtz (1998) reported that survival rate was significantly influenced by year and season of birth. In general, to improve lamb survival the constraints imposed by genetics, nutrition, husbandry, disease and weather should be addressed (Haughey, 1991).

Male lambs showed a higher incidence of preweaning death losses than female lambs. This finding was in contrast to results reported by Schoeman (1990), Cloete and Scholtz (1998), Malik *et al*. (1998) and Solomon *et al*. (2000). They reported that survival rate was not influenced by sex of lambs. Generally, the current results were in agreement with several results reported in the literature (Meyer and Clarke, 1978; Schwulst and Martin, 1993; Peterson and Danell, 1985). Meyer and Clarke (1978) and Gama *et al*. (1991) found a higher mortality rate amongst males than amongst females.

Conclusions

The results of this study indicated that several non-genetic fixed factors have a significant influence on preweaning lamb survival. Of these, birth weight was one of the factors affecting preweaning lamb survival. Thus, improving birth weight of lambs by using different management practices such as improving prepartum feeding of breeding ewes may partially solve the problem. Preferential treatments of maiden ewes as a separate management group and providing preferential treatment to ewes lambing multiples are also suggested.

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