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CONCLUSION

Since we began scanning for twins there has generally been an upward trend in scanning and lambing percentage. In 1995, the scanning percentage was 155%, in the drought year of 1996 it declined to 144%, and then increased to 160% and 173% in 1997 and 1998 respectively. For the same four years, the lambing percentage (excluding hoggets) was 115, 119, 133 and 141% respectively. To date the benefits of scanning have been mostly in improved flock management, but in future the selection of replacements from twin-bearing ewes that have lambed as hoggets and the assignment of ewes having a second single birth to the terminal sire flock, will also improve the genetic merit of the flock.

Field data analysis of lamb survival and mortality rates occurring between pregnancy scanning and weaning

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ABSTRACT

Ultrasonic scanning for pregnancy diagnosis in commercial sheep flocks has highlighted the magnitude of lamb loss from scanning to docking or weaning. From seven ram breeding flocks in Landcorp Farming Limited, lamb survival rates were derived from the number of lambs per ewe present at six stages: pregnancy scanning, birth, born alive, 48h after birth, end of lambing and weaning. Differences in lamb survival rates between adjacent stages provided the mortality rates for five intervals: pregnancy scanning-birth; birth-born alive; born alive-48h after birth; 48h after birth-end of lambing; end of lambing-weaning.

Flock-year affected lamb survival rate at all stages ($P<0.001$) but varied with ewe age and lamb birth/rearing rank ($P<0.001$). Mean lamb survival rates for 3- and 4-year-old dams were generally higher than those of other dam age groups. Triplet-reared lambs had consistently lower survival rates than single- or twin-reared lambs ($P<0.001$).

Lamb mortality rates for the five intervals were 0.03, 0.08, 0.03, 0.03 and 0.04 lambs per potential lamb at scanning, respectively. Lamb mortality was highest at birth, with lower survival rate of triplet-born lambs compared with single- and twin-born lambs (0.82 ± 0.006 *vs* 0.93 ± 0.004 and 0.93 ± 0.002 lambs per potential lamb respectively; $P<0.001$)

The results indicated when, and to what extent, lamb losses occurred in the field between pregnancy scanning and weaning, and the importance of applying appropriate ewe/lamb feeding and management policies to minimise lamb mortality rates.

Keywords: Sheep; ultrasonic scanning; pregnancy diagnosis; lamb survival.

INTRODUCTION

Pregnancy diagnosis of ewes by ultrasonic scanning is routinely applied in many New Zealand sheep flocks. Knowledge of ewe pregnancy status enables producers to review pre-tupping feeding/management policies, to more appropriately allocate feed resources prior to (and during) lambing, and to compare the flock's "potential" lambing performance with the realised lambing performance.

Pregnancy diagnosis has highlighted to producers the magnitude of the gross lamb loss occurring between scanning in mid-pregnancy through to lamb docking or weaning. The objective of this analysis was to break down this gross lamb loss into more discrete time periods. Knowledge of when lamb losses occur between pregnancy diagnosis and weaning, and the extent of these losses, could enable producers to target ewe/lamb management to improve lamb survival rates.

MATERIALS AND METHODS

Data were collected from performance-recorded ram breeding flocks in Landcorp Farming Limited (one flock in 1996/97, five flocks in both 1997/98 and 1998/99). The flocks comprised two Romney flocks, two Landcorp Lamb Supreme flocks and one Texel flock. From a total of 18885 ewes pregnancy scanned, 16863 ewes with pregnancy diagnosis and present at lambing were analysed. The ewes that were excluded had died or were culled before lambing, hence while lamb survival and mortality rates were unaffected, calculated ewe reproductive parameters were based on the number of ewes present at both pregnancy scanning and lambing. Information was available on the numbers of lambs per ewe (NL) at pregnancy diagnosis (NLPD), birth (NLB), alive at birth (NLA), alive 48h post partum (NL48), end of lambing (NLE), and weaning (NLW). The number of lambs present at each stage was classified by year, flock, dam age (2, 3, 4, 5 and 6 years), and rank (single, twin and triplet/quadruplet).

In all flocks in all years, ewes were managed from pregnancy diagnosis according to their recorded pregnancy status. Ewes diagnosed as carrying single lambs were managed separately from those recorded as carrying twins, which in turn and when numbers permitted in practice (particularly in one of the Romney flocks) were managed separately from those diagnosed as carrying triplets.

Using least squares methods, survival variables analysed were the number of lambs surviving in each stage divided by the number of lambs surviving from the previous stage (i.e., NLB/NLPD, NLA/NLB, NL48/NLA, NLE/NL48 and NLW/NLE), as well as total survival (NLW/NLPD). Summary data for survival accumulated across several stages were derived by multiplying the survival rates of adjacent stages. Mortality rates between stages, expressed relative to NLPD, were calculated from the difference between the corresponding cumulative survival rates.

All models included flock-year, age of dam and number of lambs per ewe present from the preceding stage (equivalent to a lamb *in utero*, birth or rearing rank). First-order interactions were also investigated and retained if significant at the P<0.01 level. However, results are presented as least squares means from the main effects models only. Subclass means from models including the interaction effects were found to be inestimable.

RESULTS

The overall least squares mean NLPD per ewe present at pregnancy diagnosis and lambing was 1.80 (se = ±0.004), with NLB = 1.73±0.005 and NLW = 1.41±0.006 per ewe present at lambing.

Flock-year was a highly significant source of variation in lamb survival up to 48h after birth (P<0.001). The Texel flock generally had lower within-stage lamb survival rates than the other flocks. Age-of-dam effects were highly significant for each survival variable (Table 1), but differences between consecutive dam age groups were not always significant. In general, lamb survival increased with dam age up to 3 or 4 years of age and then decreased. Overall survival of lambs out of 2- and 6-year-old dams was lower than that of lambs out of dams in the other age groups (NLW/NLPD; P<0.001). Significant flock-year x age of dam interactions were found for the survival variables NLB/NLPD, NLA/NLB, NL48/NLA and NLW/NLPD (P<0.001).

Lamb survival rate at each stage depended on the rank of the lambs at the start of the stage (P<0.0001; Table 1). A survival rate greater than unity was observed for single-born lambs for NLB/NLPD. This was due to 215 out of 4234 ewes diagnosed as carrying single lambs, which were ultimately recorded as producing >1 lamb at birth. Triplet lambs had lower survival rates than either single or twin lambs at all stages (P<0.001). Twin lambs had lower survival rates than singles for NLB/NLPD and NLW/NLE only (P<0.001). Overall lamb survival (NLW/NLPD) was 0.88±0.006 lambs per potential lamb for single lambs compared with 0.79±0.003 for twin lambs (P<0.001), which in turn was higher than the survival rate of triplet lambs (0.57±0.011; P<0.001). Interactions of flock-year x lamb rank (i.e., number of lambs present per ewe at the start of the stage), were highly significant for NLB/NLPD, NLA/NLB, NL48/NLA, NLW/NLE, and NLW/NLPD.

Lamb survival (cumulative) and mortality rates, across the six stages, are shown in Table 2 for the pooled

TABLE 1: Effects of age of dam and number of lambs reared per ewe on lamb survival rate (lambs per lamb from the previous stage).[1]

Effect	Stage[2] NLB/NLPD	NLA/NLB	NL48/NLA	NLE/NL48	NLW/NLE	Overall NLW/NLPD
Age of dam (yr):						
2	0.957^{a}	0.915^{a}	0.970^{b}	0.967^{b}	0.951^{a}	0.780^{a}
3	0.979^{b}	0.921^{ab}	0.978^{c}	0.972^{b}	0.964^{b}	0.826^{b}
4	0.980^{b}	0.931^{b}	0.973^{bc}	0.973^{b}	0.955^{ab}	0.823^{b}
5	0.977^{b}	0.927^{ab}	0.972^{bc}	0.966^{b}	0.955^{ab}	0.818^{b}
6	0.974^{b}	0.918^{ab}	0.956^{a}	0.954^{a}	0.946^{a}	0.771^{a}
Mean sed	0.007	0.007	0.004	0.004	0.005	0.010
Number of lambs reared:						
Single	1.011^{c}	0.934^{b}	0.977^{b}	0.970^{b}	0.970^{c}	0.883^{c}
Twin	0.961^{b}	0.927^{b}	0.973^{b}	0.969^{b}	0.951^{b}	0.794^{b}
Triplet	0.907^{a}	0.823^{a}	0.919^{a}	0.938^{a}	0.867^{a}	0.574^{a}
Mean sed	0.007	0.006	0.004	0.005	0.006	0.010

[1] Within main effect and stage, values with different superscripts differ significantly (P<0.05).
[2] See text for details.

TABLE 2: Lamb survival (cumulative) and mortality rates from pregnancy diagnosis to weaning (lambs per potential lamb).

Effect			Stage: Pregnancy diagnosis	Birth	Born alive	Alive at 48h	End of lambing	Weaning
Pooled	Survival		(1.00)	0.970	0.893	0.867	0.839	0.801
	Mortality			0.030	0.077	0.026	0.028	0.038
Age of dam (yr)	Mortality	2		0.043	0.082	0.026	0.028	0.041
		3		0.021	0.078	0.020	0.025	0.031
		4		0.020	0.068	0.025	0.024	0.039
		5		0.023	0.071	0.025	0.030	0.038
		6		0.026	0.080	0.039	0.039	0.044
Rearing rank	Mortality	Single		-0.011	0.067	0.021	0.028	0.027
		Twin		0.039	0.070	0.024	0.027	0.041
		Triplet		0.093	0.161	0.060	0.043	0.086

data. Lamb mortality rates, partitioned by stage, are also shown for age-of-dam and lamb-rank subclasses. Lamb mortality was highest in the Birth-Born alive interval (0.077 lambs per potential lamb at pregnancy diagnosis), compared with the other intervals. Triplet-born lambs had a Birth-Born alive mortality rate that was more than twice that of single or twin lambs. The negative mortality rate for single lambs in the Pregnancy diagnosis-Birth interval arose from ewes being diagnosed as carrying single lambs, when in fact they were recorded as producing >1 lamb at birth.

DISCUSSION

It could be misleading to compare lamb mortality rates in this study with those based on earlier work conducted prior to the routine application of ultrasonic pregnancy scanning, particularly work based on farm surveys. Since the pregnancy status of the ewe (i.e., number of foetuses) was largely unknown in those studies, pre-partum feeding/management may not have been appropriate, with consequent effects on lamb survival rates. Based on a large volume of field data, our study at least provides information for current sheep producers on lamb survival and mortality rates under conditions in which ewes of medium to high fecundity were managed pre- and post-partum according to their (known) pregnancy status. It is noted that the existence of significant interactions indicates that year and flock effects, ewe age group and pregnancy status management/feeding levels all have an important influence on lamb survival rates.

Smith and Knight (1998) reported that most lamb deaths occur at, or within three days of birth. In the present study, lamb mortality rate summed over the two intervals Birth-Born alive and Born alive-Alive at 48h supports this statement (Table 2). However, the number of lambs born dead was the single largest lamb loss, regardless of age of dam or birth rank. Triplet-born lamb mortality was more than double that of single- and twin-born lambs. Dalton *et al*. (1980) observed a curvilinear relationship between lamb mortality and birth weight; lamb mortality rates were higher at lighter birth weights (e.g., multiple-born lambs) and at heavier birth weights (e.g., single-born lambs). The high incidence of twin and triplet/quadruplet lambs in the present study (71.9 and 13.7% of lambs born respectively), suggests that despite identification of multiple-bearing dams at pregnancy diagnosis, low birth weight was a contributing factor to the high lamb mortality at birth, particularly in triplet-born lambs. Lamb mortality rates immediately after birth (i.e., in the Born alive-Alive at 48h interval) were considerably higher for triplets compared with singles and twins. Starvation/exposure may well have been the cause of these lamb losses through the high birth rank/low birth weight relationship (e.g.,McCutcheon *et al*., 1981). There remains a requirement to positively manipulate multiple-born lamb birth weights (especially those of triplets) through nutrition/management factors. The comparable mortality rates at birth of single- and twin-born lambs suggested that heavy birth weight effects in the singles (e.g., dystocia), may not have been an important factor and that post-scanning feeding of the single-bearing ewe was appropriate in this study.

It is difficult to explain the lamb loss between pregnancy diagnosis and birth (0.03 lambs per potential lamb; Table 2). Although there had been no history of either campylobacteriosis or toxoplasmosis in the flocks studied, abortion may have partially contributed to this lamb loss. There was evidence in Table 2 of a disproportionately higher lamb mortality in 2-year-old dams compared with older dams, which is suggestive of toxoplasmosis infection. However, this could be an age effect *per se*. Lamb loss between pregnancy diagnosis and birth could also have resulted from ewes deserting their lambs before their lambing was recorded, and (or) from ewes being incorrectly diagnosed at scanning (i.e., diagnosed foetal number > number of lambs born). It is noted that such a misdiagnosis would not be distinguishable in the data from "natural" lamb/foetal loss.

A more distinguishable ewe pregnancy diagnosis error occurred where diagnosed foetal number < number of lambs born. This served to increase the apparent lamb survival rate (and reduce the apparent lamb loss) between pregnancy diagnosis and birth (provided recording the number of lambs born was error-free). While this error occurred across all flock-years and all NLPD-NLB subclasses, it was particularly apparent in one flock-year where 24.1% of ewes diagnosed as carrying single lambs were recorded as having twins or triplets, compared with a corresponding incidence of 5.1% in the data pooled over all flock-years.

The combined lamb mortality rate over the two intervals Alive at 48h-End of lambing and End of lambing-Weaning was surprisingly high (0.07 lambs per potential lamb). Some of this loss may be attributed to starvation/exposure deaths in the first few days beyond 48h of birth, and to deaths by misadventure. That the lamb mortality rate was greater in the End of lambing-Weaning interval than in the Alive at 48h-End of lambing interval (when the converse may have been expected) suggests that the practice of flock recording *per se* may have introduced an artefact in the results. After editing the recorded data for known/recorded lamb deaths from birth to the time of birth data input (i.e., at end of lambing), the number of lambs expected to be present on the datafile for input at weaning would be greater than the number actually recorded as present due to unknown/unrecorded lamb deaths at *any* stage up to this point. The result would be an artificially inflated lamb mortality rate between end of lambing and weaning.

In summary, from a mean of 180.0 potential lambs per 100 ewes present at pregnancy diagnosis and at lambing, 5 were "lost" between pregnancy diagnosis and birth, 14 lambs were born dead, 5 died within 48h of birth, 5 died between 48h and the end of lambing, and 7 were lost from the end of lambing to weaning. Producers should concentrate on providing high quality feed from scanning through lambing for multiple-bearing ewes, whilst appropriately restricting the pre-partum intake of single-bearing ewes.