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Effects of Prenatal Shearing of Ewes on Birth Weight and Neonatal Survivability of Lambs

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Summary

A three-year study was conducted with a flock of mixed-aged Rambouillet ewes to determine the effect of late-gestation shearing on lamb birth weights (N = 480) and survival rates during the neonatal period in typical West Texas conditions. Ewes were randomly assigned, within sire family and year of birth, to one of two shearing treatments, prenatal shorn or unshorn. The ewes remained on the same treatment for all 3 years. The prenatal shorn ewes were shorn in early January, 2 to 54 d prior to lambing (mean = 20 d). The unshorn ewes were shorn after lambs were an average of 96 d old. Lamb survival rates were analyzed using a model that included fixed effects of shearing, year, sex of lamb, type of birth, age of dam, significant interactions, and linear and quadratic effects of birth weight and ambient minimum temperature on the day of birth. Lamb survival rates were not affected by age of dam, but were lower ($P < .02$) on day 3 for triplet compared to twin and single lambs (74.3, 88.0 and 89.2 ± 5%, respectively). A significant interaction between sex of lamb and shear treatment ($P < .05$) was found for lamb survival. Male lambs from shorn ewes had 12% lower ($P < .01$) survival rates at one day of age than male lambs born to unshorn ewes, whereas, survival rates of female lambs was not affected by prenatal shear treatment. Lamb birth weight ranged from 1.6 to 7 kg and was not affected by shear treatment ($P > .5$). Lamb survival rates increased quadratically as both birth weight ($P < .05$) increased and as minimum temperature on day of birth ($P < .01$) increased. Predicted lamb survival rates at 3 days of age for 3, 4, 5, and 6 kg birth weight lambs were 81.7, 91.0, 95.0 and 94.0 ± 4%, respectively. Predicted lamb survival rates at 3 days of age for minimum temperatures at lambing of -7, -1 and 4° C were 72.1, 88.8 and 93.5 ± 5%, respectively. The results of the present study demonstrate that prenatal shearing of Rambouillet ewes 20 d prior to lambing in typical West Texas conditions did not increase birth weights or improve survival rates of neonatal lambs.

Key words: birth weight, lambs, shearing, survivability

Introduction

Lamb deaths represent a considerable economic loss to the sheep industry each year. A 1996 USDA report estimated that 9.4% of lambs born alive died prior to weaning. In Michigan flocks, Rook (1989) reported mortality rates of 15 to 20%, and found that the majority of these deaths occurred within the first three days of life.

Simpson (1995) found that weather related causes were responsible for 40.5% of the lamb deaths, with only predator losses accounting for a greater proportion of lamb deaths. Weather losses include deaths from lightning, drowning, and chilling. Other post-mortem studies suggest that 30% of all neonatal deaths may be the result of hypothermia, starvation, or the combination of the two (McCutcheon et al., 1981). Hypothermia and starvation share physiological mechanisms and each condition may contribute to the other. Lambs in a cold environment must increase heat production to avoid hypothermia. This increased heat production depletes body reserves and can lead to starvation unless the lamb receives adequate energy from nursing. As lambs become hypothermic their ability to suckle is impaired. Failure to suckle, whether from mismothering, central nervous system injury due to dystocia, or discomfort will result in starvation, thereby contributing to hypothermia as lambs have less energy to utilize for heat production. This phenomenon has been called the starvation-exposure syndrome (McCutcheon et al., 1981).

In a study conducted in Nebraska, Azzam et al. (1993) examined the effects of environmental conditions on neonatal calf mortality rates. They reported that mortality rates of non-dystocia calves born in a dry environment increased from less than 4% at 30° C to over 18% when the ambient temperature was -20° C. Precipitation amount on the day of calving also negatively affected calf mortality rates, particularly at lower temperatures. Azzam et al. (1993) also found that calves with low birth weights (< 1.5 SD below the mean) had much higher mortality rates than heavier calves. Low birth weight lambs are also much more susceptible to death during the neonatal period than heavier lambs. Alexander and McCance (1958) reported that the rectal temperatures of lambs that died within 72 h of birth were significantly

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lower at 6 h of age than the temperatures of lambs that survived.

Management practices that are able to reduce the incidence of low birth weights of lambs will likely increase lamb survival rates. Rutter et al. (1971) demonstrated that shearing pregnant ewes 7 weeks prior to parturition increased lamb birth weights by 16% compared with unshorn ewes. Mortality rates also decreased from 35.8% in lambs born to unshorn ewes to 18.5% in lambs born to shorn ewes. Thompson et al. (1982) found that lambs born to shorn ewes and exposed to cold temperatures (1 to 6° C) for 5 weeks prior to lambing were 27% heavier than lambs born to unshorn ewes and exposed to warmer ambient temperatures (15° C).

A number of studies conducted outside of the United States have examined the effects of prenatal shearing on lamb survival rates. The objective of this experiment was to determine if shearing pregnant ewes during late gestation would increase birth weight and improve lamb survival in a West Texas Rambouillet flock.

Materials and Methods

A three-year study was conducted with a flock of mixed-aged Rambouillet ewes. Prior to mating in the first year of the study, ewes were randomly assigned, within sire family, and year of birth to one of two shearing treatments. The treatments consisted of shearing prior to lambing (prenatal shorn ewes) and shearing after lambing (unshorn ewes). The ewes in the unshorn group were tagged (sheared around udder and between rear legs) on the same day as the prenatal shearing group was shorn. The ewes in the prenatal shorn treatment were shorn in January each year an average of 20.1 ± 12.6 d prior to lambing, whereas, the unshorn ewes were not shorn until April, 96.2 ± 15.1 d after lambing. As young ewes were added to the flock each year they were assigned to a shearing treatment prior to mating. Once assigned to a shearing treatment, ewes were kept on the same treatment in subsequent years so that a 12-month fleece was produced. There were a total of 276 parturitions over the three-year period resulting in 480 lambs. The average body weight of the ewes at time of mating was 60.2 ± .6 kg.

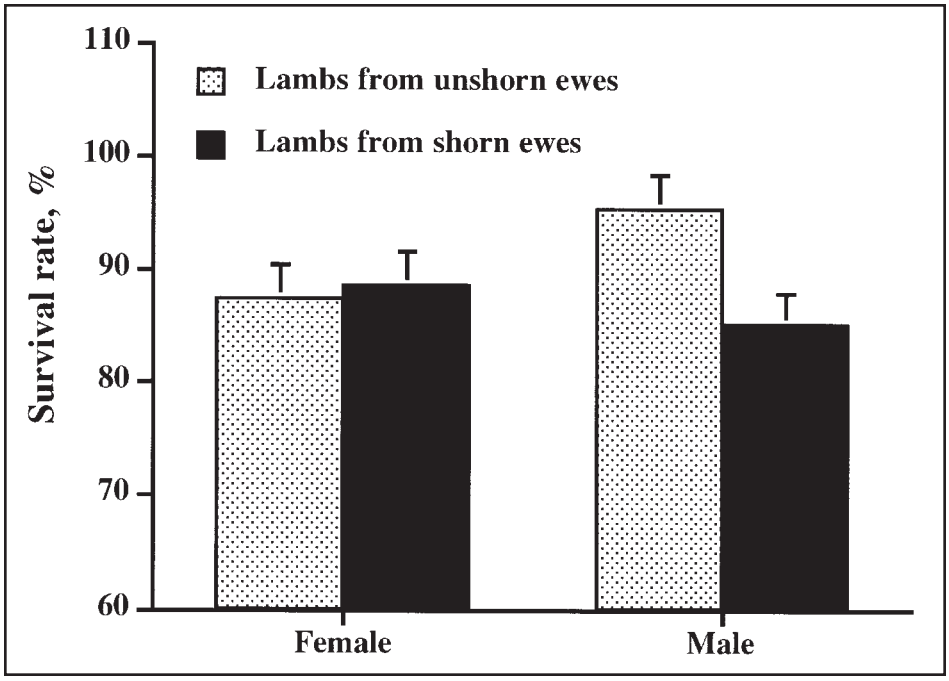

Figure 1. The effect of prenatal shearing on day-1 survival rates of female and male lambs. The prenatal shearing x sex of lamb interaction was significant (P < .05).

Upon shearing of the prenatal shorn ewes in January, both groups were housed in a common pen (45 x 90 m) with access to a three-sided shed. While housed in this pen, ewes were fed a diet consisting of 30% sorghum grain, 40% peanut hulls, 16.5% cottonseed meal, 8% molasses, 3% salt, 1% calcium carbonate, 1% urea, and 0.5% ammonium chloride. Ewes and lambs remained in this pen until lambs were 7 to 14 days of age, at which point they were returned to pasture.

Data collected at lambing included lamb birth weight, sex, type of birth (single, twin, or triplet), and age of ewe. Minimum and maximum temperatures on the day of birth were also recorded. Lamb survival was observed for up to 7 days of age. Data were analyzed using general linear model procedures in SAS (1996) to examine factors affecting birth weights. Variables in the model were shearing treatment, year, sex of lamb, type of birth, and age of dam. The age of dam was categorized as 2-yr-olds, 3- to 5-yr-olds or 6- to 7-yr olds. All interactions were examined in initial models and remained in the final model if P < 0.2, but there were no significant interactions in this model.

Survival rate on day 1 was coded as 0 if a lamb died at birth or during the first day of life or 1 if the lamb survived through the first day of life. Lamb survival rates through days 3 and 7 were likewise coded. This model included shearing treatment, year, sex of lamb, type of birth, and age of dam. The interaction of shearing treatment x sex of lamb had a P < .20 so it was also utilized in the model. In addition, linear and quadratic effects of day-of-birth minimum temperature and birth weight were included in the model.

Results and Discussion

The average litter size was not affected by shearing treatment (1.69 and 1.74, for unshorn and shorn, respectively). Age of dam affected litter size. The 2-yr-old ewes had smaller litters (P < .01) than did the 3 to 5-yr-old or 6 to 7-yr-old ewes (1.53, 1.81, and 1.79, respectively).

Type of birth significantly affected the birth weight of lambs (Table 1). Single lambs were 22.5% heavier than twin lambs (P < .001), and twin lambs were 17.8% heavier than triplet lambs (P < .001). Survival rates for triplet lambs were lower (P < .05) on days 1, 3, and 7 compared to single and twin lambs. Yapi et al. (1992) found a positive correlation between litter size and lamb mortality, which is probably due to heavier birth weights (McCutcheon et al.,

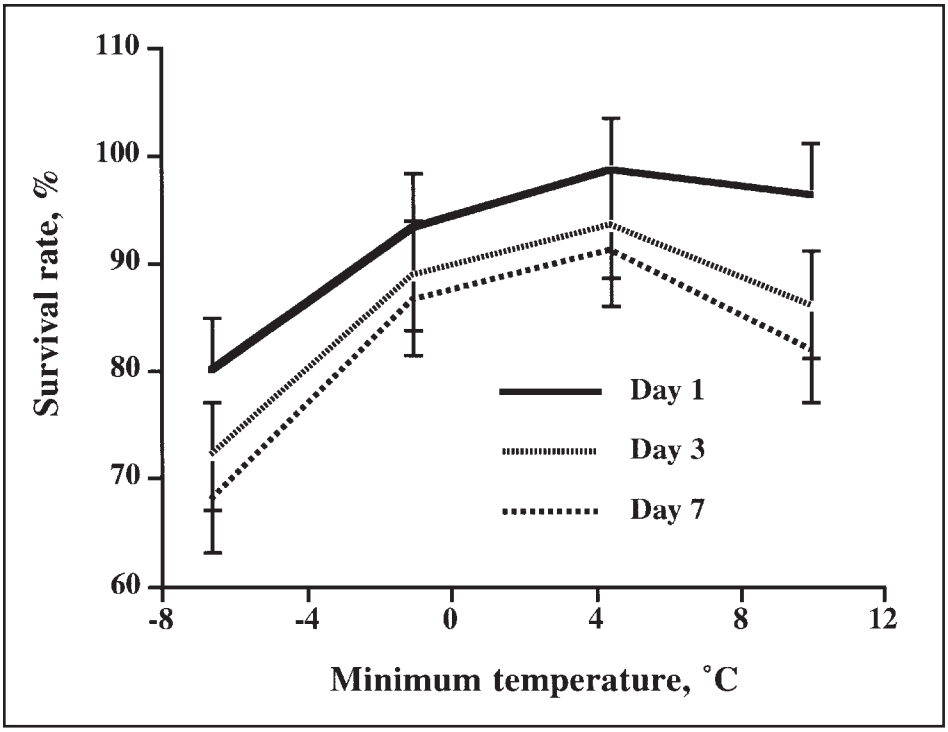

Figure 2. The effect of minimum temperature on the day of lambing on survival rates of lambs at 1, 3 and 7 days of age.

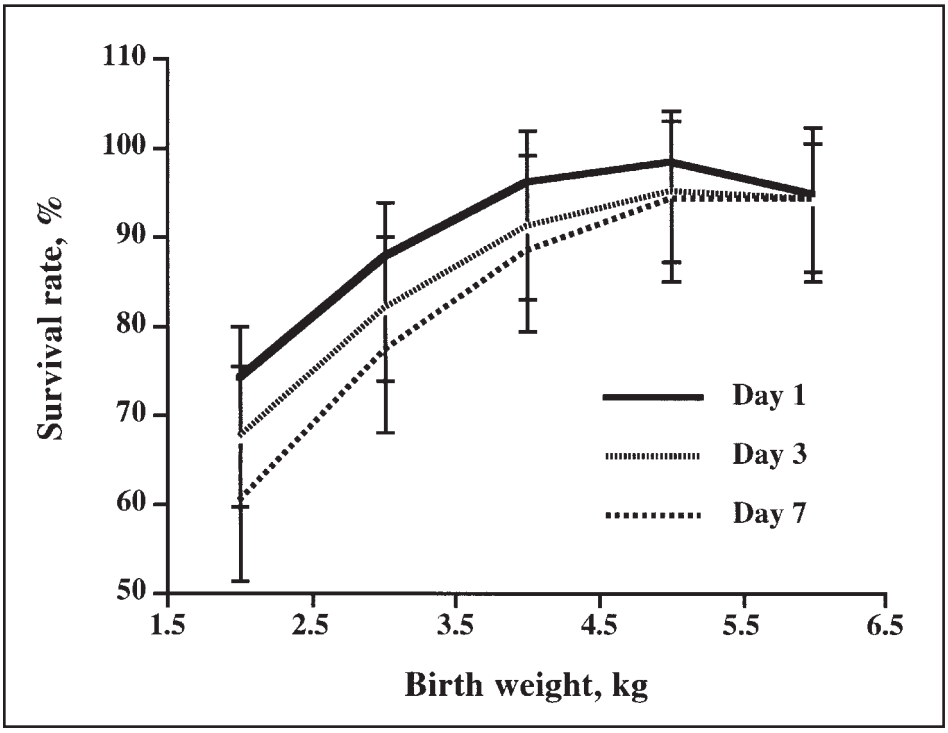

Figure 3. The effect of birth weight on lamb survival rates.

1983) and increased cold resistance (Stott and Slee, 1987) of single lambs compared to twin and triplet lambs. Despite finding that twin lambs were lighter than single lambs, no differences in lamb survivability between single and twin lambs were found in this study.

Minimum temperature on the day of lambing had a significant ($P < .01$) quadratic effect on survival rates for day 1, day 3, and day 7 (Figure 2). The optimum minimum temperature range was from 4 to 6° C. As temperatures fell below 4° C there was a decline in lamb survival rates. Compared to survivability at 4° C, survival rates declined 5% when temperatures decreased to -1° C and 23% when temperatures decreased to -6° C.

Lamb birth weight had a significant quadratic effect on lamb survival rates on day 1 ($P < 0.01$) and also tended to affect survival rates on day 3 ($P = .06$) and day 7 ($P < .10$). The effect of lamb birth weight on survival rate is illustrated in Figure 3. There was a 9% reduction in day-1 survival rates when birth weights decreased from 4 to 3 kg, and a 30% reduction when birth weights decreased from 4 to 2 kg. Similar effects were noted for survival rates on days 3 and 7. At heavier birth weights, survival rates declined slightly, reflecting possible complications from dystocia. Gama et al. (1991) found that birth weight was the best predictor of lamb mortality rates.

Age of dam had a significant effect on lamb birth weights (Table 2). Lambs from the 6 to 7-yr-old ewes were 4.7% heavier than lambs from 3 to 5-yr-old ewes and 14.1% heavier than lambs from 2-yr-old ewes. Age of dam was not a significant factor affecting survival on days 1, 3, or 7. This corresponds with Hanrahan (1986) who found no effect of ewe age on lamb survivability when adjusted for litter size.

Regardless of prenatal shear treatment, the majority of lamb deaths for 7 d mortality rates occurred within the first day of life. Deaths within the first day of life accounted for 61.8 and 53.4% of the 7 d mortality rates of prenatal shorn and unshorn treatments, respectively.

Lamb birth weight was not affected by prenatal shear treatment (Table 2). There was a significant interaction between prenatal shear treatment and sex of lamb for survival rates on days 1 ($P < .05$), 3 ($P < .01$), and 7 ($P < .01$). Prenatal shearing did not affect day 1 survival rates of female lambs, however, male lambs born to shorn ewes had lower ($P < .01$) survival rates than male lambs born to unshorn ewes (Figure 1). This was also the case for day 3 and 7 survival rates. The possibility was considered that prenatal shearing increased birth weights of male but not female lambs,

thereby increasing the incidence of dystocia in male lambs. This was not likely the case, however, since the interaction between prenatal shear treatment and sex of lamb for birth weight was not significant (P > .25). Moreover, previous studies have not reported significant interactions between sex of lamb and prenatal shear treatment for lamb birth weights or survival rates. The finding that male lambs born to shorn ewes had lower survival rates than male lambs born to unshorn ewes is contrary to results from previous studies (Table 3). Further inspection of the records provides insight into the significance of the sex of lamb and prenatal shear treatment. The mean survival rate for the 480 lambs was 88.5 %. The survival rates for female lambs were 87.6% and 86.8% for shorn and unshorn ewes, respectively. The survival rates for male lambs were 82.4% and 96.1% for shorn and unshorn ewes, respectively. There were 5 male lambs in the unshorn group that died. Therefore, it appears that the significance of the interaction was due to an unusually high survival rate for male lambs born to unshorn ewes. In those studies that have reported beneficial effects of prenatal shearing on lamb survivability it was also found that prenatal shearing increased birth weights. Therefore, the lack of a positive prenatal shearing effect on lamb survival in the present study is not surprising given that birth weight was also not affected.

Table 1. Effects of sex of lamb and type of birth on lamb birth weights and survival rates.

Factor	Birth Weight[a]	Survival Rate[b] Day 1	Day 3	Day 7
Sex of Lamb				
Female (n=250)	3.46	88.1	83.1	82.1
Male (n=230)	3.74	90.2	84.5	80.6
SE	.05	2.2	2.7	2.9
P-Value	.001	.39[c]	.65[c]	.66[c]
Type of Birth				
Singles (n=93)	4.30	94.6	89.2	87.5
Twins (n=324)	3.51	93.5	88.0	83.6
Triplets (n=63)	2.98	79.3	74.3	72.9
SE	.08	3.8	4.7	5.1
P-Value	.001	.01	.02	.09

[a]Birth weight of lambs, kg.
[b]Lamb survival rates: percentage of lambs alive after the 1st, 3rd or 7th day of age.
[c]Sex of lamb x shear treatment was significant for lamb survival rates (see Figure 1 and text).

Table 2. Effects of prenatal shearing treatment and age of dam on lamb birth weight and survival rates.

Factor	Birth Weight[a]	Survival Rate[b] Day 1	Day 3	Day 7
Shear Treatment				
Prenatal Shorn (n=231)	3.58	86.9	81.3	78.8
Unshorn (n=249)	3.61	91.4	86.4	83.9
SE	.05	2.1	2.6	2.9
P-Value	.50	.06	.09	.11
Age of Dam				
2-yr-olds (n=102)	3.34	86.3	83.5	79.2
3 to 5-yr-olds (n=299)	3.64	88.8	84.1	83.1
6 to 7-yr-olds (n=79)	3.81	92.4	83.9	81.8
SE	.07	3.1	3.9	4.2
P-Value	.001	.32	.99	.67

[a]Birth weight of lambs, kg.
[b]Lamb survival rates: percentage of lambs alive after the 1st, 3rd or 7th day of age.

One possible explanation as to why prenatal shear treatment did not increase birth weight or improve survivability of lambs in this study, is that the time interval from shearing to lambing may not have been long enough. Only 5 of the 17 studies reviewed in Table 3 reported no effect of prenatal shearing on lamb birth weight. In these five studies, the time interval from prenatal shearing to lambing was only 21 to 36 d, whereas, in the studies that reported an increase in birth weight due to prenatal shearing , the length of time from shearing to lambing was typically greater than 40 d. Two studies specifically examined the effects of length of time from shearing to lambing on birth weights (Black & Chestnutt, 1990; Morris & McCutcheon, 1997). In these two studies, the smallest increases in birth weight due to prenatal shearing occurred when the time interval from shearing to lambing was less than 40 d (Table 3). In support of this observation, Shelton et al. (1981) found that the percent lamb crop marked at weaning was significantly higher in lambs born to ewes that were shorn three to four months prior to lambing (111%) compared to lambs born to ewes shorn approximately one month prior to lambing (91%) or lambs born to ewes shorn one to two months after lambing (96%). The time interval from shearing to lambing was investigated in the present data set. A linear covariate for the time interval between shearing and lambing, nested within shearing treatment, was included in the model for lamb survival in order to investigate the significance of the time interval from shearing to lambing. Results showed that there was no significant difference between the estimated regression coefficients for the two treatments. Because of the management practices employed and the time of year of the shearing date, the time interval between shearing and lambing was related to other

Table 3. Influence of prenatal shearing of ewes on lamb birth weights and survival rates.

Reference	Experimental Conditions	Prenatal Temperature	Prenatal Treatment Days	Birth Weight	Survival Rate	Other
Rutter et al. (1971)	shorn vs unshorn	Not reported	105	↑ 16%	↑ (81.5 vs 64.2%)	
Rutter et al. (1972)	shorn vs unshorn	Not reported	105	↑ 21%	↑ (91 vs 78%); nonsignificant	
Austin & Young (1977)	shorn vs unshorn	0.5 to 14° C	70	↑ 14%	↑ (98 vs 93%); nonsignificant	↑ ewe intake
Maund (1980)	shorn vs unshorn	Not reported	70	↑ 7.5% twins ↑ 22.5% triplets	↑ for twins & triplets	↑ ewe intake
Symonds et al. (1986)	shorn vs unshorn	11.9° C	56	↑ 16%	Not reported	↑ ewe glucose levels
Vipond et al. (1987)	shorn vs unshorn	Not reported	40 to 66 3-year study	↑ 15% (average)	↑ (94 vs 88%); nonsignificant	↑ ewe intake ↑ gestation length
Black & Chestnutt (1990)	shorn vs unshorn	Not reported	28, 42, 63 or 84	↑ 5%--28 d ↑ 22%--42 d ↑ 15%--63 & 84 d	Not reported	↑ gestation length ↑ ewe intake ↑ ewe plasma glucose
Fernandez et al. (1991)	shorn vs unshorn	Not reported	25 to 30	No effect	No effect	
Boer (1994)	shorn vs unshorn	Not reported	56	↑ 14%	↑ (91.4 vs 82.4%)	
Cloete et al. (1994)	shorn vs unshorn	7 to 19° C	14--YR 1 28--YR 2	↑ 3.9%--YR 1 No effect--YR 2	↑ (73 vs 67%)--YR 1 no effect--YR 2	↑ lamb growth to 8 weeks; ewes on pasture
Dabiri et al. (1994)	shorn vs unshorn	Not reported	21 to 28	No effect	Not reported	ewes on pasture
Cueto et al. (1995)	shorn vs unshorn	Not reported	30	↑ 5%	Not reported	
Dabiri et al. (1995)	shorn vs unshorn	Not reported	36	No effect	No effect	
Cueto et al. (1996)	shorn vs unshorn	Not reported	35	↑ 8%	Not reported	
Dabiri et al. (1996)	shorn vs unshorn	Not reported	32	No effect	Not reported	
Husain et al. (1997)	shorn vs unshorn	8° C	35	↑ 14%	Not reported	↓ ewe rectal temperature
Morris & McCutcheon (1997)	shorn vs unshorn	4 to 12° C	20, 50 or 80	↑ 7% --20 d ↑ 9%--50 d ↑ 16% --80 d	Not reported	Shearing affected birth weight of twin, but not single lambs

Table 4. Effects of prenatal shearing and (or) temperature exposure of ewes on lamb birth weights and survival rates.

Reference	Experimental Conditions	Prenatal Temperature	Prenatal Treatment Days	Birth Weight	Survival Rate	Other
Slee & Samson (1982)	cold + shorn vs warm + unshorn	2 to 8° C (shorn) Thermoneutral (unshorn)	42	↑ .7 kg--Study 1 ↑ .4 kg--Study 2	Not reported	↑ gestation length
Thompson et al. (1982)	cold + shorn vs warm + unshorn	1 to 6° C (shorn) 15° C (unshorn)	35	↑ 27% singles ↑ 9% twins	Not reported	↑ plasma glucose in lambs and ewes
Stott & Slee (1985)	cold + shorn vs warm + unshorn	6° C (shorn) 26° C (unshorn)	14	no effect	Not reported	↑ norepinephrine-induced metabolic response
Shelton & Huston (1968)	24-h warm; 12-h warm vs control	32° C (warm) 24° C (control)	50 to 75	↓ 40%--24-h warm ↓ 20%--12-h warm	55%--24-h warm 80%--12-h warm 100%--control	
Brown et al. (1977)	warm--housed vs pastured	28° to 38° C (warm) Pasture--Not reported	50	↓ 30%	↓ (66 vs 96%)	↑ weak lambs
Bell et al. (1989)	warm vs control	40° C (warm) 20° C (control)	70	↓ 17%	Not reported	

factors. The simple correlation between the time interval between shearing and lambing and minimum temperature on the day of birth was .29. This positive correlation shows that ewes with longer intervals also lambed on warmer days, as it was getting closer to spring. Because ewes were kept in the pen and fed between shearing and lambing, the time interval is also a measure of days on feed. Indeed, the correlation between the time interval and birthweight was .21. The inclusion of the time interval between shearing and lambing did not result in substantial differences in the results of the analyses without the time interval.

A second reason for a lack of a prenatal shearing effect may be that the ambient temperatures during late gestation were too mild. The 3-year average minimum temperature on the day of lambing in this study was 2.4 ± 4.5° C (range of -8.3 to 15.0° C), and the average maximum temperature on day of lambing was 18.1 ± 6.5° C (range of

-5.0 to 29.4° C). Surprisingly, few authors have reported the ambient temperature conditions that existed during their studies (Table 3). The studies that did report ambient temperatures were not extremely cold compared to the temperatures reported in the current study. Collectively, the results of studies presented in Table 4 clearly demonstrate that prenatal cold exposure enhances and prenatal heat exposure suppresses lamb birth weights, thereby potentially impacting lamb survival rates.

Despite the fact that prenatal shearing treatment did not increase lamb survivability in this study, the majority of prenatal shearing experiments have shown beneficial responses (Tables 3 and 4). There are a number of possible mechanisms whereby prenatal shearing may improve lamb survival rates. Prenatal shearing has been shown to affect ewe behavior at lambing. In ewes not housed during lambing, Lynch and Alexander (1976) observed that prenatal shearing increased the likelihood that ewes lambed in sheltered areas, thereby improving the chances of lamb survival especially during inclement weather. Another possible benefit from prenatal shearing could be increased colostrum consumption by lambs due to less wool around the udders.

Several studies have reported an increase in dry matter intake of ewes that were shorn prior to lambing (Austin and Young, 1977; Vipond et al., 1987; Symonds et al., 1992; Black and Chestnutt, 1990; Dabiri et al., 1996). This increase in intake was thought to be a factor in increasing lamb birth weights by increasing the total supply of nutrients available to the developing fetus. However, because cold exposure increases rate of passage and decreases digestibility, differences in metabolizable energy intake between shorn and unshorn ewes have been shown to be minimal (Symonds et al., 1986). In one trial, prenatal shorn and unshorn ewes were fed equal amounts of dry matter and the shorn ewes still had heavier lambs (Thompson et al., 1982).

Cold exposure may alter the way nutrients are partitioned in the ewe. Exposure to cold environmental temperatures has been shown to increase plasma glucose concentrations in ewes (Symonds et al., 1992; Clarke et al., 1997) as well as in fetuses (Thompson et al., 1982). Infusion of glucose into fetuses during the last 4 wk of pregnancy has been shown to increase fetal weights as well as the proportional mass of brown adipose tissue compared with saline-infused fetuses (Stevens et al., 1990).

Shearing pregnant ewes during late gestation may also be beneficial to lamb survival by reducing the thermal heat load of the ewe. Shelton and Huston (1968) examined the effects of heat stress during late gestation. Control ewes were housed at 24° C, whereas, warm-treated ewes were exposed to 32° C for 12 (partial) or 24 (full) h per day. The partial heat treatment lowered birth weights by 16% and increased lamb mortality rates to 20%. The full heat treatment resulted in a 40% reduction in birth weights and increased lamb mortality rates to 45% (Table 4).

In addition to increasing birth weight, prenatal shearing has also been shown to enhance brown fat metabolism in newborn lambs. Brown fat is present in newborn lambs and functions to produce heat through nonshivering thermogenic mechanisms to help prevent hypothermia (Carstens, 1994). Stott and Slee (1985) conducted a study where ewes were exposed to either warm (26° C, full fleece) or cold (6° C, shorn) treatments 14 d prior to lambing. Brown fat metabolism, measured as an increase in oxygen consumption in response to a norephinephrine challenge, was found to be 2.8 times thermoneutral metabolism in lambs from cold-exposed ewes, but only 1.7 times thermoneutral metabolism in lambs from warm-exposed ewes. Likewise, Symonds et al. (1992) found that lambs from cold-exposed ewes had 40% greater brown fat thermogenic activity than control lambs.

The factors that influence lamb birth weight and survival rate responses to prenatal shearing cannot be clearly delineated from the present study and those studies reviewed in Tables 3 and 4. Moreover, it is likely that numerous factors (i.e., prenatal nutrition of the ewe, weather patterns) interact with prenatal shearing of ewes to influence overall lamb survival rates. The review of these studies does suggest, however, that shearing of pregnant ewes at least 40 to 60 d prior to lambing may improve lamb survival rates during the neonatal period.

Conclusions

Results from this study indicate that prenatal shearing of ewes an average of 20 d prior to lambing did not increase birth weights or improve neonatal survival rates of lambs managed in typical West Texas conditions. It is apparent from reviewing other studies, that the effects of prenatal shearing on lamb survivability are influenced by the degree of cold exposure of the ewe during late gestation and the length of time between shearing and lambing. Therefore, the lack of a prenatal shearing effect on lamb survival rates found in this study may have been due to the time interval from shearing to lambing being too short. Collectively, these studies suggest that implementation of the management practice of shearing ewes 60 to 90 d prior to lambing may improve lamb survivability during the neonatal period.

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