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Usefulness of subjective ovine milk scores: I. Associations with range ewe characteristics and lamb production

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ABSTRACT: Range ewes are commonly evaluated for milking ability by producers to determine the ewe's ability to rear lamb(s). The U.S. Sheep Experiment Station has subjectively scored (low, average, high) a ewe's milking ability within 24 h of lambing for many years. The relationship of subjective milk scores with lamb production was investigated using lambing records of Columbia (n = 1,731), Polypay (n = 1,129), Rambouillet (n = 1,704), and Targhee (n = 1,638) ewes. The incidence of high milk scores increased from less than 10% at first parity to 29 to 40% at second and greater parities. At maturity, Columbia ewes (38%) had the highest percentage of high milk scores. A positive association existed between ewe BW and her milk score at third and later parities. Ewes with high milk scores gave birth to heavier lambs ($P < 0.05$), whereas ewes with low milk scores were associated with lighter ($P < 0.05$) lambs at birth. Ewes with low milk scores weaned less ($P < 0.05$) total weight than ewes with better milk scores across all age groups for all breeds. Lighter weaned litter weights

from ewes with low milk scores were linked to lighter birth weights and fewer weaned lambs. Differences for litter weight weaned between ewes with average and high milk scores were generally observed at 2 and 3 yr of age, when litter weights were heavier among ewes with high milk scores ($P < 0.05$) for all breeds. Between the ages of 1 and 3 yr, Columbia, Polypay, Rambouillet, and Targhee ewes with an average milk score weaned heavier ($P < 0.05$) litters (average differences of 10, 9, 13, and 12%, respectively) than ewes with low milk scores. For all breeds at all ages, individual lamb weaning weights were heavier ($P < 0.05$) when they were reared by ewes with high milk scores compared to lambs reared by ewes with low milk scores. Results suggest that milk score is an economically important trait in these four breeds and should be considered in management and breeding objectives; at a minimum, the incidence of low milk scores should be kept as small as possible.

Key Words: Ewes, Growth, Lactation, Lambs, Management, Milk

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Introduction

The significant influence of ewe milk production on preweaning weight gain of their lambs has been clearly defined (Neidig and Iddings, 1919; Burris and Baugus, 1955; Boyazoglu and Treacher, 1978). Increased milk production is associated with increased lamb survival and growth, especially during early lactation (Torres-Hernandez and Hohenboken, 1980). However, a practical and effective method of measuring milk production in commercial range sheep has not been identified.

For many years at the U. S. Sheep Experiment Station, Dubois, ID, a subjective milk score has been assigned to each ewe within a few hours after lambing.

This milk score is used as a management tool in making decisions to graft or orphan lambs. Annual milk scores are maintained as a part of each ewe's lifetime production record. Commercial shed lambing operations also typically evaluate ewe milking ability shortly after lambing for management purposes, although only rarely is an attempt made to assign or record a milk production score. The present study investigated the relationship between a ewe's early postpartum milk score and her productivity measured by lamb survival and weight of lamb weaned. If the relationship is sufficiently high, this method of assigning a milk score could easily be adopted by commercial and purebred producers to aid in management decisions and could possibly serve as a selection criterion to improve lamb survival and weaning weight.

Materials and Methods

Traits Measured and Management. This study used post facto data collected at the U. S. Sheep Experiment

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Station from 1977 to 1988 under management conditions similar to those used in many western range sheep production systems. Lambs were typically born from late March through early May. Ewes with newborn lambs were removed from an outside drop lot and placed inside a covered lambing shed in a 1.5-m² pen, typically for 2 d, before being moved to larger outside mixing pens with other ewe and lamb(s) pairs. Within a few hours of birth, lambs were categorized by their sex, weighed, and ear-tagged. Each ewe was given a milk score (subjectively assigned by the scorer after milking the teats, palpating the udder, and noting the fill of newborn lambs) in the range of 0 to 5. A 0 indicated a dry or small udder with little or no milk and a 5 indicated a healthy udder producing abundant milk. Almost all milk scores were assigned by the same individual during the study period.

Preliminary statistical analyses showed that milk scores were distributed differently among age of dam groups. This problem was resolved by converting the scale with six codes into three categories of milk production: scores 0 through 2 were converted to “low,” score 3 to “average,” and scores 4 and 5 to “high.” A trimodal scoring system (low, average, and high) may also be more practical for commercial sheep operations than a scale with six codes. Examples of milk scores are depicted in Figure 1.

Milk score was considered by the lambing crew in making decisions about whether lamb(s) should remain with a ewe, be grafted to a different ewe judged to have adequate milk to raise a foster lamb, or, if a foster dam was not available, to be orphaned. Litter size per ewe was always restricted to a maximum of two lambs; therefore, excess lambs were either grafted or orphaned (i.e., no ewe was released from the lambing shed with more than two lambs).

Records were of Rambouillet, Targhee, Columbia, and Polypay ewes (1 yr through 5 yr of age) present in selection lines during the period 1977 through 1988 (three lines each of Rambouillets, Targhees, and Columbias and two lines of Polypays, each line maintained at approximately 140 mature ewes and 50 replacement ewe lambs). Genetic lines were described by Ercanbrack and Knight (1998). Only scores on ewes ($n = 6,202$) giving birth to lambs born alive and receiving a milk score were included in the data set (Table 1).

In early May of each year, lambs were moved with their dams to spring grazing on sagebrush-grass range. Ewes were shorn in mid to late May. In late June, ewes with their lambs were assigned to one of three grazing bands of approximately 1,000 ewes. Bands were separately trailed to mountain summer ranges, where they grazed amid coniferous forests and on high open slopes and meadows at elevations ranging from 2,000 to 2,900 m during July and August under traditional herded conditions. Weaning data were obtained on the summer range in mid-August when lambs were approximately 120 d of age. Ewes and lambs were gathered in the early morning (approximately 0600) and confined in a

large corral at weaning. Ewes and lambs were identified by ear tag number and weighed individually on a portable electronic scale.

In addition to milk scores and lamb weaning weights, several other ewe production traits were measured to determine their relationship with milk score. Animal size was characterized by BW of the ewe in the spring as measured immediately after shearing. Body weights of ewes were adjusted to a 365-d standard by calculating the average daily difference between consecutive an-

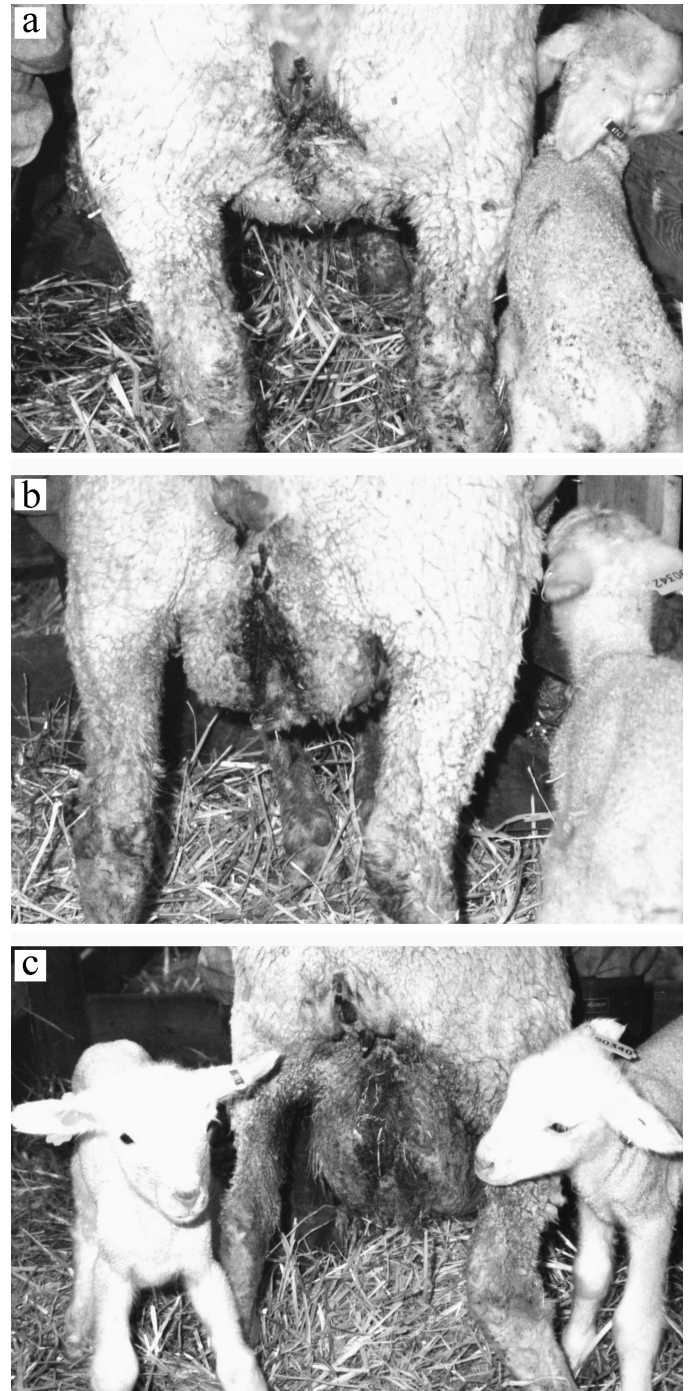


Figure 1. Examples of a) low, b) average, and c) high subjective milk scores.

Table 1. Number of ewes lambing and live-born lambs by milk score, breed, and age (yr) of dam

Breed and age of dam	Ewes lambing			Live-born lambs		
	Low ^a	Avg ^a	High ^a	Low ^a	Avg ^a	High ^a
Columbia (1,731 total individual ewes)						
1	433	164	10	502	181	11
2	219	573	259	314	796	379
3	136	422	328	214	669	532
4	100	351	259	165	602	424
5	79	258	224	135	453	369
Polypay (1,129 total individual ewes)						
1	695	231	5	960	328	8
2	254	329	58	450	615	115
3	132	285	117	253	567	235
4	109	235	92	221	494	193
5	95	153	85	185	310	177
Rambouillet (1,704 total individual ewes)						
1	811	96	2	906	109	2
2	452	414	97	628	604	142
3	223	435	193	365	717	322
4	151	378	217	266	661	378
5	106	301	207	187	557	372
Targhee (1,638 total individual ewes)						
1	627	84	3	676	90	4
2	395	479	148	516	634	217
3	219	440	234	329	698	388
4	120	370	207	199	627	358
5	106	262	170	178	458	282

^aEwe's milking potential as subjectively measured within 24 h postpartum.

nual weights and multiplying by 365. Prolificacy (number of lambs born), number of lambs born alive, number of lambs weaned, and total litter weight weaned were determined for each ewe that lambled. Birth weight was recorded for each lamb born.

Because fostering is known to affect weaning weight of lambs (Snowder and Knight, 1995), grafted lambs, as well as orphaned lambs, were excluded (and their dams if no lamb was raised) from the analyses of traits that were milk-score-dependent: weaning weight, total lambs weaned, and total litter weight weaned. This rule eliminated all lambs born to dams with a milk score of 0 and 35% of all lambs born to dams with a milk score of 1. These eliminations permitted an assessment of the effects of milk score on production traits without the bias of other attendant circumstances contributing to a low milk score (i.e., disease or other stress-related problems). Poor milk scores, such as a 0, are often associated with short-term gestations in ewes less physiologically prepared for lactation and that exhibit less mammary development than full-term gestating ewes (Rattray et al., 1974). Generally, lambs born to short-term gestating ewes are less viable and have lighter birth weights (LeFeuvre and Jordan, 1979). These factors influence the decision to graft or orphan lambs.

The management system that included evaluating the udder and condition of the lamb(s) and ewe to determine the potential number of lambs a ewe may rear may have imposed a bias. The system increased the

probability that the lambs a ewe suckles will survive. Also, because litter size was artificially restricted to a maximum of two lambs, the ability of a ewe with average or high milk scores to rear litters greater than two lambs cannot be examined. Under commercial range production systems, the practice of artificially limiting litter size based on subjective evaluation of the udder and condition of lamb(s) and ewe is common. Because the limitations imposed on this data set are typical of western range production systems, the results may apply only to similar or related production systems.

Statistical Analysis. The distribution of milk scores was not the same for all ages (Table 1) because the size and function of the mammary gland are affected by age and(or) parity. For example, within the breeds studied very few high milk scores were assigned to young ewes. Therefore, the milk score \times age of ewe interaction could not be appropriately statistically tested. Confounding of ewe \times age interaction with year, the fact that not all ewes lamb every year, and that ewes are removed from the flock at different ages did not permit satisfactory statistical analyses of repeated measures. Analyzing the data within age of ewe was deemed a reasonable approach. The maximum age for ewes was limited to 5 yr because numbers within older age groups were small.

The effects of milk score on ewe BW, prolificacy, number of lambs born alive, lamb birth weight, number of lambs weaned, and lamb weaning weight were determined by least squares procedures separately for each

Table 2. Distribution of milk scores (%) by breed and age (yr) of ewes with live lambs

Age of ewe	Columbia			Polypay			Rambouillet			Targhee		
	Low	Avg	High	Low	Avg	High	Low	Avg	High	Low	Avg	High
1	71.3	27.0	1.6	74.7	24.8	0.5	89.2	10.6	0.2	87.8	11.8	0.4
2	20.8	54.5	24.6	39.6	51.3	9.0	46.9	43.0	10.1	38.6	46.9	14.5
3	15.3	47.6	37.0	24.7	53.4	21.9	26.2	51.1	22.7	24.5	49.3	26.2
4	14.1	49.4	36.5	25.0	53.9	21.1	20.2	50.7	29.1	17.2	53.1	29.7
5	14.1	46.0	39.9	28.5	45.9	25.5	17.3	49.0	33.7	19.7	48.7	31.6
Mature ^a	14.5	47.7	37.8	26.1	51.1	22.8	21.2	50.3	28.5	20.5	50.46	29.2

^aMature is the unweighted average of all ewes older than 2 yr of age.

breed and age of dam group. Harvey's LSMLMW PC-2 version (1990) computer program was used, which is appropriate for obtaining generalized least squares results from data characterized by unequal subclass numbers. Fixed effects included milk score (low, average, or high), year (1977 through 1988), genetic line (number of lines varied within breed, range of two to three lines), litter size at birth (one to three), litter size at rearing (single or twin), and sex of lamb (ram, wether, or ewe). Preliminary statistical analyses found primary interactions not to be significant ($P > 0.10$) for every model; therefore, they were not included in final analyses.

The effect of milk score on ewe BW was analyzed with a model that included fixed effects for milk score, genetic line, number of lambs born, and year. The effect of milk score on lamb birth weight was analyzed using the above described model plus the effect of sex of the lamb. Models for prolificacy (number of lambs born per ewe lambing) and percentage of lambs born alive included effects of year, genetic line, and milk score.

Survival of lambs to weaning was based only on lambs born alive without consideration of other factors (e.g., cause of death or age at death). Lamb survival (i.e., live or dead) was modeled with fixed effects for milk score, year, genetic line, sex of lamb, grazing band (1, 2, or 3)

Table 3. Least squares means for ewe BW and individual lamb birth weight by milk score, breed, and age (yr) of dam

Breed and age of dam	Ewe BW, kg ^a				Lamb birth weight, kg			
	Low ^b	Avg ^b	High ^b	SE range	Low ^b	Avg ^b	High ^b	SE range
Columbia								
1	59.5	61.2	ND ^c	1.3–1.6	3.9 ^g	4.3 ^h	ND	0.1–0.3
2	62.9 ^d	63.2 ^d	65.2 ^e	0.3–0.5	4.7 ^g	4.9 ^h	5.1 ⁱ	0.1
3	69.0	68.4	69.0	0.3–0.7	4.8 ^g	5.0 ^{gh}	5.1 ^h	0.1
4	71.0	71.4	71.8	0.4–0.9	4.7 ^g	5.0 ^h	5.2 ⁱ	0.1
5	68.9 ^d	72.8 ^e	72.9 ^e	0.5–1.0	4.9 ^g	5.2 ^h	5.4 ⁱ	0.1
Polypay								
1	52.0	53.3	52.6	0.4–0.6	3.6 ^g	3.8 ^h	ND	0.1
2	59.5	59.4	59.1	0.3–0.7	3.9 ^g	4.1 ^h	4.1 ^h	0.1
3	63.5 ^d	64.6 ^{de}	65.6 ^e	0.5–0.6	4.2 ^g	4.5 ^h	4.5 ^h	0.1
4	66.0 ^{de}	65.5 ^d	67.5 ^e	0.6–0.8	4.2 ^g	4.4 ^h	4.6 ⁱ	0.1
5	63.9 ^d	65.9 ^e	68.1 ^f	0.7–0.8	4.0 ^g	4.3 ^h	4.5 ⁱ	0.1
Rambouillet								
1	52.7	52.1	ND	1.3–1.8	4.1 ^g	4.5 ^h	ND	0.1
2	60.1	59.3	60.4	0.3–0.6	4.4 ^g	4.7 ^h	4.7 ^h	0.1
3	64.4 ^d	64.9 ^{de}	65.9 ^e	0.3–0.5	4.7 ^g	4.9 ^h	4.9 ^h	0.1
4	66.6	66.9	67.0	0.4–0.6	4.7 ^g	5.0 ^h	5.1 ^h	0.1
5	66.4 ^d	67.5 ^{de}	68.2 ^e	0.4–0.7	4.7 ^g	5.0 ^h	5.2 ⁱ	0.1
Targhee								
1	57.2	56.9	ND	1.9–2.7	4.0 ^g	4.5 ^h	ND	0.1
2	60.7 ^d	60.5 ^d	62.0 ^e	0.3–0.6	4.5 ^g	4.8 ^h	4.9 ^h	0.1
3	65.3	65.5	65.4	0.4–0.5	4.7 ^g	4.9 ^h	5.2 ⁱ	0.1
4	66.7 ^d	67.9 ^{de}	68.9 ^e	0.4–0.7	4.8 ^g	5.1 ^h	5.1 ^h	0.1
5	67.2 ^d	68.6 ^{de}	69.5 ^e	0.5–0.9	4.8 ^g	5.1 ^h	5.1 ^h	0.1

^aWeight at approximately 4 wk postpartum.

^bEwe's milking potential as subjectively measured within 24 h postpartum.

^cNot determined because of low ewe numbers; see Table 1.

^{d,e,f}Within a row, means for ewe BW without a common superscript letter differ ($P < 0.05$).

^{g,h,i}Within a row, means for lamb birth weight without a common superscript letter differ ($P < 0.05$).

and type of rearing (single or twin). The model for number of lambs weaned per ewe lambing included fixed effects for year, genetic line, milk score, and grazing band.

Individual lamb weaning weights were analyzed with a model that included fixed effects of milk score, grazing band, year, type of birth and rearing code (11, 21, 22, 31, or 32; 21 denotes a lamb born a twin and reared as a single, etc.), genetic line, and sex of lamb. Age of lamb (d) at weaning was a covariate.

Total litter weight weaned was the sum of adjusted individual lamb weights at weaning for the ewe. Individual lamb weights were preadjusted to 120 d of age for fixed effects of grazing band, sex of lamb, and a covariate for Julian day of birth. No correction was made initially for age of dam and type of birth and rearing because these factors are known to affect ewe milk production (Slen et al., 1963; Torres-Hernandez and Hohenboken, 1980; Snowden and Glimp, 1991); these effects were included in the adjustment model so that their effects would be accounted for. The effect of milk score on total litter weight weaned was analyzed with a model that included fixed effects of milk score, year, type of rearing (single or multiple), and genetic line. Tests of linear contrasts of differences among least squares means by milk score category were performed

within a breed by age or parity groups. Significance was defined at the 0.05 level.

Results and Discussion

Besides the effects of milk score, most of the other fixed effects (year and number of lambs born or reared) were generally significant for all reproductive and BW traits analyzed. The effects of selection lines, however, were not generally significant but were always included in each model. These effects will not be discussed in detail except where relevant for the biological interpretation of the data related to milk score. No interactions were significant.

Milk Score Distribution. Milk scores were not distributed equally within or across age groups (Table 2). For yearling ewes, milk score was generally characterized as low (71 to 89%). Few yearling ewes were characterized with a high milk score (0.2 to 1.6%). At age 2 yr, milk scores improved, and 43 to 55% of the ewes were evaluated as average and 21 to 47% as low. At older ages (3 yr and older), the distribution of milk scores was similar across age groups and breeds; approximately 50% of the ewes were scored as average, 14 to 29% as low, and 21 to 40% as high milk producers.

As yearlings, Rambouillets and Targhees had the highest percentage of low milk scores (89 and 88%,

Table 4. Least squares means for prolificacy and lambs born alive by milk score, breed, and age (yr) of dam

Breed and age of dam	Prolificacy, %				Lambs born alive, %			
	Low ^a	Avg ^a	High ^a	SE range	Low ^a	Avg ^a	High ^a	SE range
Columbia								
1	114.0	112.1	ND ^b	2.0–3.0	81.1 ^e	93.1 ^f	ND	1.8–2.7
2	141.0	141.7	147.1	2.0–3.1	78.2 ^e	93.7 ^f	97.8 ^f	0.9–1.4
3	159.9	162.6	160.8	2.5–3.7	76.5 ^e	94.0 ^f	97.1 ^f	0.9–1.4
4	160.8 ^c	175.5 ^d	169.1 ^{cd}	2.8–4.5	80.6 ^e	94.4 ^f	94.6 ^f	1.0–1.7
5	172.5	172.4	172.3	4.0–6.3	84.0 ^e	97.1 ^f	96.9 ^f	1.0–1.6
Polypay								
1	137.5	144.0	ND	1.8–3.3	84.9 ^e	94.4 ^f	ND	0.9–1.7
2	180.7 ^c	190.4 ^d	188.8 ^d	3.0–7.1	87.1 ^e	94.0 ^f	98.3 ^f	1.0–2.5
3	196.8	204.2	206.8	3.7–5.6	90.7 ^e	96.3 ^f	97.1 ^f	0.9–1.4
4	204.0	213.5	210.5	4.3–6.0	96.5	97.7	97.3	0.8–1.2
5	201.6	212.7	216.1	5.4–7.7	91.2 ^e	94.8 ^{ef}	96.6 ^f	1.3–1.8
Rambouillet								
1	110.9	109.9	ND	1.2–3.4	85.6 ^e	96.6 ^f	ND	1.1–3.0
2	140.2 ^c	147.1 ^d	152.1 ^d	2.1–5.1	85.8 ^e	94.5 ^f	98.5 ^f	0.9–2.3
3	162.3 ^c	166.0 ^{cd}	171.8 ^d	2.4–3.8	84.8 ^e	95.0 ^f	97.3 ^f	0.9–1.4
4	174.1	176.7	177.7	2.7–4.1	89.0 ^e	96.4 ^f	96.4 ^f	0.7–1.1
5	177.2	186.1	183.8	3.0–4.9	88.1 ^e	96.9 ^f	97.1 ^f	0.7–1.2
Targhee								
1	107.0	105.8	ND	1.4–3.2	88.5 ^e	97.1 ^f	ND	1.4–3.1
2	132.3 ^c	134.8 ^c	144.0 ^d	2.1–4.0	89.0 ^e	94.3 ^f	98.0 ^g	0.9–1.0
3	152.8 ^c	158.9 ^{cd}	165.5 ^d	2.4–3.3	85.6 ^e	95.9 ^f	97.0 ^f	0.8–1.2
4	168.9	171.5	172.7	2.6–4.5	88.2 ^e	96.6 ^f	97.3 ^f	0.8–1.3
5	171.5	176.0	168.8	3.2–4.9	84.3 ^e	97.0 ^f	97.1 ^f	1.0–1.5

^aEwe's milking potential as subjectively measured within 24 h postpartum.

^bNot determined because of low ewe numbers; see Table 1.

^{c,d}Within a row, means for prolificacy without a common superscript letter differ ($P < 0.05$).

^{e,f,g}Within a row, means for lambs born alive without a common superscript letter differ ($P < 0.05$).

respectively) compared to Columbias and Polypays (71 and 75%, respectively). As mature ewes, Columbias had the highest percentage of high milk scores (38%) compared to the other breeds (23 to 29%). The larger percentage of high milk scores among Columbia ewes may be true only in early lactation, because a previous study by Snowder and Glimp (1991) found no differences in milk production among Columbia, Polypay, and Rambouillet ewes from 28 to 84 d postpartum. Differences in milking ability among other non-dairy sheep breeds during early lactation (1 to 8 wk) have been documented (Slen et al., 1963).

Association of Milk Score with Ewe and Lamb Traits. Associative differences in ewe BW, prolificacy, percentage of lambs born alive, lamb birth weights, and lamb survival to weaning age due to milk score categories were examined (Tables 3, 4, 5, 6, and 7).

Milk score may be positively related to a ewe's BW (Table 3). At 1 and 2 yr of age, ewe BW did not differ ($P > 0.05$) across milk score categories except for 2-yr-old Columbia and Targhee ewes, among which ewes with high milk scores were heavier than ewes with average or low milk scores ($P < 0.05$). At older ages, ewes with high milk scores generally weighed more ($P < 0.05$) than ewes with low milk scores. Heavier BW have been previously associated with ewes of better condition and higher milking capability (Peart, 1968; Gibb and Treacher, 1982). Although the ewes in the present study were given ad libitum access to feed sources, the level of nutrition can also affect ewe milk production (Treacher, 1983).

For all breeds, ewes with low milk scores gave birth to lambs with lighter birth weights than ewes with average or high milk scores ($P < 0.05$; Table 3). Birth weights of lambs born to ewes with average milk scores were intermediate. The heaviest birth weights ($P < 0.05$) tended to be associated with ewes with high milk scores, especially for mature Polypays. The lighter lamb birth weights from ewes with low milk scores are a concern because lamb mortality is negatively correlated with lamb birth weight (mortality rate increases as birth weight decreases; Walker and Hunt, 1980). Our data suggest that a contributing cause to higher mortality rates among lambs with lighter birth weights may be an association with the dam's low milking performance.

Ewe prolificacy was not generally associated with subsequent milk score (Table 4). The few significant differences in prolificacy associated with milk score within age groups were randomly distributed, except that 2- and 3-yr-old Rambouillet and Targhee ewes with low milk scores exhibited lower ($P < 0.05$) prolificacy compared to ewes with high milk scores. Increased size and subsequent function of the mammary gland during the last trimester of gestation have been associated with number of fetuses. Delouis et al. (1980) reported that as the number of fetuses increases there is an accompanying increase in placental size, resulting in elevated levels of placental estrogen and lactogen enhancing mammary gland development.

Table 5. Least square means for lamb survival (%) to weaning at 120 d of age by milk score, breed, and age (yr) of dam

Breed and age	Low ^a	Avg ^a	High ^a	SE range
Columbia				
1	79	76	ND ^b	3-5
2	88	87	88	2-3
3	79 ^c	87 ^d	90 ^d	2-4
4	93	93	91	3-4
5	88	93	90	2-4
Polypay				
1	83	82	ND	1-2
2	76	78	81	3-6
3	86	87	89	3-4
4	95	93	94	3-4
5	82 ^c	93 ^d	94 ^d	2-5
Rambouillet				
1	82	88	ND	2
2	81	82	88	1-3
3	75	77	78	3-4
4	93	91	92	2-3
5	87	92	93	1-2
Targhee				
1	82	85	ND	1-4
2	87	87	88	2-3
3	76	82	82	2-3
4	85	89	88	4
5	72 ^c	79 ^d	87 ^e	2-3

^aEwe's milking potential subjectively measured within 24 h postpartum.

^bNot determined because of low ewe numbers.

^{c,d,e}Within a row, means without a common superscript letter differ ($P < 0.05$).

Percentage of live-born lambs (Table 4) reflected the same trend as birth weight and was clearly associated with milk score. The percentage of live-born lambs was generally less ($P < 0.05$) among ewes with low milk scores than among ewes with average or high milk scores. However, this trend was less evident among Polypay ewes 3 yr of age and older, for which the percentage of live-born lambs born to ewes with low milk scores tended to be higher than for other breeds. The higher survival of Polypay lambs may be related to its original genetic background of one-quarter Finnsheep. Previous studies have shown that lambs with varying degrees of Finnsheep breeding had a higher percentage of being born alive and higher survival to weaning than purebred and other crossbred lambs (Snowder et al., 1986; Iman and Slyter, 1996). Also, Gama et al. (1991) reported that Finnsheep crossbred lambs have a better probability of survival than lambs of most other breeds when the effect of litter size is statistically removed.

Survival of live born lambs to weaning age (120 d) was not strongly associated with improved milk scores (Table 5). Survival rates of lambs reared by ewes with low milk scores from birth to weaning did not generally differ from those of lambs reared by ewes with average or high milk scores. Statistically lower survival rates of lambs reared by ewes with low milk scores were observed only for 5-yr-old Polypay and Targhee ewes

and 3-yr-old Columbia ewes ($P < 0.05$). The lack of statistical differences in lamb survival rates among milk score groups may not suggest that milk score is unimportant to lamb survival, but rather that the management imposed on this data set by grafting or orphaning lambs from ewes with low milk scores was successful. The objective of the grafting and orphaning process was to give all lambs an equal opportunity for survival to weaning. Commercial producers may be able to increase lamb survival by appraising milk score and lamb vitality.

Ewes with low milk scores weaned fewer lambs at approximately 120 d of age than ewes with average or high milk scores ($P < 0.05$; Table 6). This difference is obviously biased by the management system that purposefully restricted the number of lambs a ewe with a low milk score was allowed to rear under range conditions. The differences in the number of lambs weaned between ewes with average or high milk scores were small ($P > 0.05$). This result indicates that lambing shed crews were effective in identifying which lambs could survive to weaning by remaining with their dams within average and high milk score groups. Although the management practice of fostering lambs from ewes subjectively evaluated as incapable of raising an extra lamb may have biased the estimate of the underlying

association between milk score and lamb survival, the management represented normal production practices.

Total litter weight weaned was influenced by the ewe's milk score (Table 6). Ewes with low milk scores weaned less total weight than ewes with better milk scores across all age groups for all breeds ($P < 0.05$). Lighter litter weights from ewes with low milk scores were also linked to lighter birth weights and fewer weaned lambs. At 2 and 3 yr of age, Columbia and Polypay ewes with high milk scores weaned heavier ($P < 0.05$) total litter weights compared to ewes with average milk scores. Ewes with average milk scores weaned heavier ($P < 0.05$) litters (average differences of 10, 9, 13, and 12%, respectively) than ewes with low milk scores within each breed and age group. This result suggests that milk score in these four breeds is an economically important trait and should be considered in breeding and management objectives, at least to the extent that the incidence of low milk scores should be kept to a minimum.

Further support for the economic importance of milk score was the strong association between ewe milk score and individual lamb weaning weight within each ewe age group (Table 7). Differences in individual lamb weaning weights according to milk score by age groups indicate a direct relationship between ewe milk score

Table 6. Least squares means for number of lambs weaned and total litter weight weaned per ewe lambing by milk score, breed, and age (yr) of dam

Breed and age of dam	Lambs weaned				Litter weight, kg			
	Low ^a	Avg ^a	High ^a	SE range	Low ^a	Avg ^a	High ^a	SE range
Columbia								
1	1.01	1.03	ND ^b	0.01–0.05	32.5 ^f	34.5 ^g	ND	0.44–0.60
2	1.14 ^c	1.27 ^d	1.27 ^d	0.02–0.03	40.5 ^f	45.1 ^g	47.3 ^h	0.53–0.86
3	1.21 ^c	1.41 ^d	1.48 ^d	0.03–0.05	42.4 ^f	48.8 ^g	51.4 ^h	0.70–1.27
4	1.23 ^c	1.52 ^d	1.43 ^d	0.03–0.05	43.0 ^f	51.3 ^g	49.9 ^g	0.79–1.48
5	1.21 ^c	1.55 ^d	1.47 ^d	0.03–0.06	41.5 ^f	52.3 ^g	52.7 ^g	0.94–1.80
Polypay								
1	1.13 ^c	1.26 ^d	ND	0.02–0.03	35.2 ^f	39.2 ^g	ND	0.39–0.66
2	1.47 ^c	1.55 ^d	1.70 ^e	0.03–0.07	47.9 ^f	51.1 ^g	57.0 ^h	0.87–2.08
3	1.51 ^c	1.69 ^d	1.75 ^d	0.03–0.05	49.3 ^f	54.5 ^g	58.1 ^h	0.99–1.47
4	1.47 ^c	1.76 ^d	1.75 ^d	0.03–0.05	47.1 ^f	56.7 ^g	58.1 ^g	0.98–1.50
5	1.43 ^c	1.71 ^d	1.71 ^d	0.04–0.06	45.2 ^f	55.9 ^g	56.7 ^g	1.25–1.75
Rambouillet								
1	1.01 ^c	1.08 ^d	ND	0.01–0.02	31.3 ^f	34.4 ^g	ND	0.24–0.57
2	1.15 ^c	1.32 ^d	1.40 ^d	0.02–0.05	37.9 ^f	43.4 ^g	46.5 ^h	0.55–1.24
3	1.25 ^c	1.47 ^d	1.45 ^d	0.02–0.04	39.3 ^f	46.9 ^g	46.9 ^g	0.63–0.99
4	1.32 ^c	1.50 ^d	1.62 ^e	0.03–0.04	41.1 ^f	47.2 ^g	50.8 ^h	0.68–1.16
5	1.24 ^c	1.58 ^d	1.61 ^d	0.02–0.05	38.8 ^f	48.6 ^g	50.9 ^g	0.78–1.42
Targhee								
1	1.00	1.04	ND	0.01–0.01	30.9 ^f	32.7 ^g	ND	0.31–0.60
2	1.06 ^c	1.21 ^d	1.29 ^e	0.02–0.03	36.6 ^f	41.4 ^g	44.2 ^g	0.50–0.94
3	1.20 ^c	1.43 ^d	1.48 ^d	0.02–0.04	38.7 ^f	46.3 ^g	48.7 ^g	0.65–0.95
4	1.31 ^c	1.52 ^d	1.49 ^d	0.03–0.05	42.4 ^f	48.9 ^g	47.6 ^g	0.75–1.36
5	1.16 ^c	1.48 ^d	1.45 ^d	0.03–0.06	38.1 ^f	47.5 ^g	47.6 ^g	0.85–1.55

^aEwe's milking potential subjectively measured within 24 h postpartum.

^bNot determined because of low cell count numbers; see Table 1.

^{c,d,e}Within a row, means for lambs weaned without a common superscript letter differ ($P < 0.05$).

^{f,g,h}Within a row, means for litter weight without a common superscript letter differ ($P < 0.05$).

Table 7. Least squares means for individual lamb weaning weights (kg) by milk score, breed, and age (yr) of dam

Breed and age of dam	Low ^a	Avg ^a	High ^a	SE range
Columbia				
1	31.1 ^c	33.0 ^d	ND ^b	0.23–0.36
2	33.2 ^c	33.9 ^e	35.5 ^d	0.24–0.36
3	34.8 ^c	36.1 ^d	37.0 ^e	0.26–0.49
4	36.0 ^c	36.8 ^c	38.0 ^d	0.19–0.39
5	36.3 ^c	36.6 ^c	38.2 ^d	0.32–0.65
Polypay				
1	30.4 ^c	31.4 ^c	ND	0.18–0.28
2	32.3 ^c	32.8 ^{cd}	33.5 ^d	0.26–0.51
3	33.6 ^c	33.6 ^c	34.7 ^d	0.30–0.39
4	33.2 ^c	34.3 ^d	35.1 ^e	0.33–0.43
5	33.4 ^c	35.4 ^d	36.5 ^e	0.40–0.49
Rambouillet				
1	29.0	31.2	ND	0.60–0.83
2	30.5 ^c	32.2 ^d	33.1 ^d	0.24–0.49
3	32.0 ^d	33.2 ^d	33.8 ^d	0.23–0.35
4	32.3 ^c	33.2 ^d	34.2 ^e	0.16–0.26
5	32.7 ^c	33.2 ^c	34.2 ^d	0.28–0.47
Targhee				
1	30.2	31.9	ND	1.15–1.15
2	31.0 ^c	32.3 ^d	33.5 ^e	0.25–0.46
3	31.9 ^c	34.1 ^d	35.4 ^e	0.24–0.35
4	32.9 ^c	34.2 ^d	35.4 ^e	0.18–0.31
5	33.8 ^c	34.3 ^{cd}	35.0 ^d	0.30–0.55

^aEwe's milking potential subjectively measured within 24 h postpartum.

^bNot determined because of low number of ewes.

^{c,d,e}Within a row, means without a common superscript letter differ ($P < 0.05$).

and individual lamb growth. In all ages and breeds, ewes with high milk scores reared heavier ($P < 0.05$) lambs than did ewes with low milk scores. Individual lamb weights from ewes with average milk scores were intermediate to weights of lambs from ewes with low or high milk scores. With increasing lactations from 1 to 3 yr of age there was an increase in individual lamb weaning weights within all milk score classifications. Because the time period when milk production most significantly influences lamb growth occurs before 6 wk postpartum (Slen et al., 1963; Snowder and Glimp, 1991), differences between milk score groups for lamb weaning weights may have been greater if weaning were at 40 or 60 d rather than 120 d.

Implications

Milk production of a ewe has an important effect on the preweaning survival and growth of her lambs. Subjectively scoring a ewe for her potential milking ability provides producers with a way to predict her ability to rear lambs successfully. Results of this study clearly show that an early postpartum, subjectively assigned milk score can be a useful management tool for deciding whether to orphan or foster lambs to improve

lamb survival and growth. Improved milk scores would result in heavier lamb weights and greater total litter weight weaned per ewe lambing. Therefore, milk score should be considered for improving animal management at lambing and possibly as a selection trait to improve productive performance.

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