Sheep & Goat Research Journal
Volume 23, 2008

Post-weaning Management of Lambs Alters Subsequent Feedlot Performance and Tissue Deposition[1]

R. R. Redden[2,3], R. W. Kott[2], L.M.M. Surber[2], J. A. Boles[2], A. W. Layton[4], and P. G. Hatfield[2]

[1] *Research was funded by the Montana Sheep Institute, Bozeman, MT*

[2] *Department of Animal and Range Sciences, Montana State University, Bozeman, MT 59717;*

[3] *Corresponding author: reid_redden@yahoo.com*

[4] *Montana Department of Livestock, Bozeman, MT 59717*

Summary

Backgrounding lambs on forage-based diets after weaning may provide producers with alternatives to traditional marketing of lambs directly to feedlots. Our objective was to evaluate feedlot performance of lambs from different backgrounding treatments. Seventy-two crossbred lambs were randomly assigned to one of four backgrounding treatments. Treatments were imposed after traditional, range-weaning practice (140 d of age). Treatments were: 1) drylot ad libitum access to 80:20 alfalfa:barley pellets (PELLET); 2) cool-season, grass-paddock grazing (GRASS); 3) unweaned, dormant-range grazing (LATE WEAN); and 4) weaned, dormant-range grazing (RANGE). After 29 d of backgrounding, lambs within backgrounding treatment were assigned to feedlot pens (3 pens/treatment). Lamb-BW and ultrasound measurements were taken at weaning (d-29), after backgrounding (d 0), after transition to 70 percent grain diet (d 19), and at the end of the feedlot period (d 68). Lambs backgrounded on PELLET had greater BW *($P < 0.10$)* at d 0 and d 68 than lambs assigned to other treatments. Feedlot DMI of PELLET lambs was greater than all other treatments, and feedlot ADG of PELLET lambs was greater than LATE WEAN and RANGE lambs *($P < 0.10$)*. At the end of the feedlot period (d 68), ultrasound measures of LM were greater *($P < 0.05$)* for GRASS than either LATE WEAN or RANGE when BW on d 68 was included as a covariable. No differences *($P > 0.10$)* in 12th-rib-fat thickness were detected among treatments at d 68. Results from our 2007 study indicate that 29-d-background treatments on dormant range diminished subsequent-feedlot performance; however, GRASS backgrounding had similar feedlot performance to PELLET backgrounding.

Key Words: Backgrounding, Feedlot Performance, Tissue Deposition, Lamb

Introduction

Western-range-sheep producers typically sell lambs immediately after weaning, and the majority of these lambs go directly to feedlots. The USDA National Animal Health Monitoring System (2004) reported that 17 percent of the feedlot lambs per year had been weaned two weeks prior to shipping to the feedlot. Maintenance of lambs on forage-based diets post-weaning prior to feedlot entry (backgrounding) has the potential to improve feedlot performance (Turgeon et al., 1986), carcass merit (McClure et al. 1995), and producer profitability (Blackburn et al., 1991). Moreover, Mathis et al. (2008) reported that steers backgrounded on range had lower feedlot mortality rates, similar feedlot productivity, and were more profitable than steers backgrounded in a drylot.

However, there is limited published research reporting the effects of different backgrounding systems on subsequent lamb-feedlot performance. Therefore our objective was to evaluate the effects of dormant range, improved pasture, and drylot backgrounding vs. late weaning on lamb-feedlot performance and tissue deposition.

Table 1. Chemical composition (DM basis) of feedlot diet ingredients.[1]

	Feedlot Diet[2]		
	Whole Corn	Alfalfa: Barley Pellet	Supplemental Pellet
DM, %	85	90	86
CP, %	9.96	17.80	22.80
CF, %	3.97	1.40	2.30
ADF, %	3.48	30.50	19.10
Ash, %	1.32	8.35	10.40
TDN, %	91.90	71.20	73.20
Sulfur, %	0.12	0.32	0.44
Phosphorus, %	0.29	0.30	0.66
Potassium, %	0.36	2.20	1.39
Magnesium, %	0.13	0.36	0.36
Calcium, %	0.01	1.96	1.38
Sodium, %	<0.01	0.06	1.29
Iron, ppm	24	133	276
Manganese, ppm	8	40	108
Copper, ppm	4	6	15
Zinc, ppm	21	20	86
Bovatec, mg/kg			264

[1] Chemical analysis conducted by Midwest Laboratories Inc. (Omaha, Neb.).

[2] Feedlot diets consisted of 80 percent alfalfa: 20percent barley pellets, whole corn, and a supplemental pellet designed to be fed at 0.227 kg/(lamb•d) on an as-fed basis. Diets were hand mixed and placed in self-feeders, which allowed ad libitum access. Diets started at 30-percent concentrate (corn and barley) and moved up 10 percentage points in concentrate for every 26.7 kg of pen intake (~4.45 kg/lamb; as fed basis). Finishing-lamb diets were held constant at 70 percent concentrate.

Materials and Methods

The Institutional Animal Care and Use Committee at Montana State University approved activities involving the live animals.

Animals, Treatments, and Research Sites

Seventy-two (Black-face X Western white-face) wether and ewe lambs were randomly selected at weaning (average BW, 31 kg ± 0.67 kg, respectively) from the Red Bluff Research Ranch ewe flock. Lambs were assigned to treatments in such a manner that average-lamb BW and the number of wethers and ewe lambs were similar in all backgrounding treatments (18 lambs per treatment). All background treatments lasted 29 d, starting when lambs were 140 ± 5.9 d of age and lasting until the beginning of the feedlot period. Treatments were: 1) lambs not separated from their dams at Red Bluff Research Ranch (LATE WEAN); 2) lambs removed from the ewes for 4 d then returned to graze with the ewe flock at Montana State University Red Bluff Research Ranch (RANGE); 3) lambs weaned and moved to grass paddocks at Montana State University Fort Ellis Research and Teaching Farm (GRASS); 4) lambs weaned and allowed ad libitum access to an 80 percent alfalfa: 20 percent barley pellet (Table 1) in a drylot at Fort Ellis Research Farm (PELLET).

Montana State University Red Bluff Research Ranch (latitude 45°35' N, longitude 111°38' W) elevation ranges from 1,402 m to 1,889 m, and annual precipitation ranges from 35.5 cm to 43.1 cm. Vegetation is a typical, foothill-bunchgrass type. Bluebunch wheatgrass (*Pseudoroegneria spicata*) and Idaho fescue (*Festuca idahoensis*) are the major grasses. Rubber rabbit brush (*Ericameria nauseosus*), prairie sagewort (*Artemisia frigida*), lupine (*Lupinus spp.*), milkvetch (*Astragalus spp.*), and western yarrow (*Achillea millefolium*) are commonly occurring shrubs and forbs (Harris et al., 1989). Previous literature determined the chemical composition of this dormant range to be approximately 5.7 percent CP, 68.8 percent NDF, and 45.6 ADF percent (Soder et al., 1995).

Montana State University Fort Ellis Research and Teaching Farm (latitude 45° 38' N, longitude 110° 58' W, altitude 1505 m) received 61 cm of precipitation in 2007 (NCDC, 2009). Sheep pastures were predominantly smooth brome (*Bromus inermis*), crested wheat (*Agropyrom cristatum*), and Kentucky blue (*Poa pratensis*) grasses. Prior to the experiment, paddocks A and B (0.53 ha and 1.42 ha, respectively) were grazed by sheep in the spring and summer. Fall regrowth produced most of the forage available for the GRASS backgrounded lambs. Previous literature conducted on the same paddocks at a similar time of year determined the paddocks to be approximately 13.8 percent CP, 63.5 percent NDF, and 33.4 percent ADF (Hatfield et al., 2002).

Backgrounding

On September 6, 2007 all lambs except LATE WEAN were moved from Red Bluff to Fort Ellis (56 km). At Fort Ellis, PELLET, RANGE, and GRASS treatment lambs were placed on paddock B for 4 d. Then on September 10, RANGE lambs were returned to the ewe herd at the Red Bluff Research Ranch, PELLET lambs were moved to a drylot pen with self-feeders containing 80 percent alfalfa: 20 percent barley pellets (Table 1), and GRASS lambs were moved to paddock A. Lambs remained on their respective treatments for 29 d.

Feedlot

On October 9, 2007 all lambs were removed from their respective backgrounding treatment, orally drenched with an anthelmintic (Valbazen; Pfizer Animal Health, Exton, Pa.), vaccinated against Clostridial perfringens C and D (Bar-Vac CDT; Boehringer Ingelheim Vetmedica, Inc., St. Joseph, Mo.), and allowed to graze paddock B for 48 h. On October 11 (d 0) lambs were then removed from feed and water for 12 h and shrunk BW were obtained. Lambs within backgrounding treatments were randomly assigned to pens (6 lambs per pen and 3 pens per treatment). Feedlot diets consisted of 80 percent alfalfa: 20 percent barley pellets, whole corn, and a supplemental pellet (Table 1) designed to be fed at 0.227 kg/(lamb•d) on an as-fed basis. Each ingredient was sampled and composited over time. Feed samples were stored in a dry location at room temperature. Proximate analysis and mineral concentrations were determined by Midwest Laboratories, Inc (Omaha, Neb.; Table 1). Diets were hand mixed and placed in self-feeders, which allowed ad libitum access. Diets started at 30-percent concentrate (whole corn and barley fraction of pellet) and moved up 10 percentage points in concentrate for every 26.7 kg of pen intake (≈4.45 kg/lamb; as-fed basis). Finishing-lamb diets were held constant at 70-percent concentrate.

After all pens had reached the 70-percent-concentrate diet (October 30, 2007; d 19 post start of feedlot period), the step-up period was concluded. On d 19, all lamb-unshrunk BWs were recorded and lambs were vaccinated against Clostridial perfringens C and D (Bar-Vac CDT; Boehringer Ingelheim Vetmedica, Inc., St. Joseph, Mo.). On December 18 (d 68), ultrasonography (Aloka Co., LTD, Wallingford, Conn.) determined that more than half of the lambs had achieved the target 0.5 cm 12th-rib-fat thickness and the feedlot period was concluded. Lambs were removed from the feedlot pens and weighed. Lambs were then held off feed and water over night and shrunk BW were measured. Percent shrink was averaged on each lamb, and a pencil shrink was applied to d 19 lamb BW.

On d 19 and d 68, feed refusals were removed from the self-feeders and weighed. Pen intakes during the step-up, finishing and total feedlot periods were determined by subtracting feed refusals from feed offered.

Lamb health was monitored during the feedlot period. Lambs showing signs of acidosis were drenched with sodium bicarbonate saturated in water. One RANGE lamb died during the step-up period, and its data were removed from the study.

Carcass and Ultrasound Evaluation

At the conclusion of the feedlot period, 20 lambs (5 lambs/treatment) of similar BW (average 53 ± 4 kg) were selected for slaughter. On December 20, slaughter lambs were taken to a local abattoir (96 km) and harvested the next morning. After an approximate 24 h chill, carcass weight, kidney fat, 12th-rib-fat thickness, and LM (longissimus muscle) area were recorded.

Ultrasound measurements of LM area and 12th-rib-fat thickness were taken at 12th/13th rib transverse using an Aloka SSD-500V real-time ultrasound device with a 3.5 MHz, 12.5-cm linear array transducer and standoff guide. On d-29, d 0, d 19, and d 68, lamb LM area was measured using ultrasonography. On d 19 and d 68, lamb-fat thickness was measured using ultrasonography. All ultrasound measurements were collected and interpreted by the same technician. Technician bias was -0.018 cm and 0.12 cm for LM area and 12th-rib-fat thickness, respectively. Standard error of prediction was 0.63 and 0.17 cm for LM area and 12th-rib-fat thickness, respectively. Standard error of repeatability was 0.55 cm and 0.07 cm for LM area and 12th-rib-fat thickness, respectively.

Statistical Analysis

Data were analyzed as a completely random design using the GLM procedure of SAS (SAS Inst. Inc., Cary, N.C.). Means were separated by the LSD procedure, and differences were considered different at $P < 0.10$. Pen was the experimental unit for growth and feed intake data, with 3 pens per treatment. Lamb was the experimental unit for ultrasound and carcass data. The main effect for all analysis was backgrounding treatment. Body weight at the time of scan was added as a covariable for all ultrasound data to identify tissue deposition independent of BW.

Results and Discussion

Lamb Growth

Lambs backgrounded on the PELLET treatment had the greatest ($P \leq 0.06$) BW among treatments (Table 2) at the start of the feedlot period (d 0). After lambs were stepped up onto the 70 percent concentrate diet (d 19), PELLET and GRASS lambs had greater BWs ($P \leq 0.05$) than RANGE and LATE WEAN lambs. At d 68, PELLET lambs weighed more ($P \leq 0.02$) than lambs with other backgrounding treatments.

Feedlot Performance

No differences ($P > 0.35$) among backgrounding treatments (Table 3) were detected for DMI, ADG, or G:F during the step-up (d 0 to d 19) or finishing (d 19 to d 68) periods. Differences were detected for the total-feedlot period (d 0 to d 68). Lambs backgrounded on PELLET treatments had the greatest DMI ($P \leq 0.08$). Average-daily gain was greater ($P \leq 0.10$) for PELLET than RANGE and LATE WEAN lambs. Feed efficiency was greater ($P = 0.08$) for GRASS than RANGE lambs.

Ultrasonography Data

After backgrounding (d 0), PELLET and GRASS lambs had greater ($P \leq 0.01$) LM areas than RANGE and LATE WEAN lambs (Table 4). After the step-up period (d 19), no differences ($P > 0.30$) were detected for LM areas. At the conclusion of the feedlot period (d 68),

Table 2. Effects of backgrounding treatment on feedlot lamb BW.[1,2]

	Treatment				
	GRASS	LATE WEAN	PELLET	RANGE	SE
No. of Pens	3	3	3	3	
Weaning BW, kg	32	31	31	31	
Feedlot BW, kg					
d 0	33^{a}	33^{a}	35^{b}	33^{a}	0.59
d 19	36^{b}	35^{a}	36^{b}	34^{a}	0.60
d 68	48^{a}	47^{a}	51^{b}	46^{a}	0.87

[ab] Row means with different superscripts differ (*P < 0.10*).

[1] Treatments were applied to lambs for 29 d after weaning.
GRASS lambs were maintained on grass paddocks at the Fort Ellis Research Center.
LATE WEAN lambs were not weaned from dams during background period.
PELLET lambs were self-fed alfalfa:barley pellets.
RANGE lambs were weaned from dams for 4 d and returned to range with ewe flock.

[2] *Weaning* (d -29) represents removal of lambs from ewes when lambs were 140 ± 5.9 d; except LATE WEAN lambs.
d 0 lambs were removed from backgrounding treatments and began step-up diets.
d 19 lambs finished the transition period and began the finishing diet.
d 68 was the conclusion feedlot period.

Table 3. Effects of backgrounding treatment on lamb DMI, ADG, and G:F during feedlot periods.[1]

	Treatment[2]				
	GRASS	LATE WEAN	PELLET	RANGE	SE
No. of Pens	3	3	3	3	
Step-up					
DMI, kg	1.31	1.24	1.34	1.15	0.08
ADG, kg/d	0.16	0.10	0.08	0.06	0.05
G:F	0.120	0.079	0.049	0.048	0.024
Finishing					
DMI, kg	1.66	1.68	1.79	1.65	0.06
ADG, kg/d	0.24	0.25	0.28	0.25	0.02
G:F	0.144	0.148	0.156	0.152	0.009
Total					
DMI, kg	1.56^{a}	1.56^{a}	1.67^{b}	1.51^{a}	0.04
ADG, kg/d	0.22^{ab}	0.20^{a}	0.23^{b}	0.20^{a}	0.01
G:F	0.139^{a}	0.132^{ab}	0.135^{ab}	0.131^{b}	0.003

[ab] Row means with different superscripts differ (*P < 0.10*).

[1] Step-up was 19 d period during which lambs were adjusted from 30 to 70% concentrate diets.
Finishing was 47-d period that lambs remained on the 70 percent concentrate diet.
Total was 68 d-feedlot period.

[2] Treatments were applied to lambs for 29 d after weaning.
GRASS lambs were maintained on grass paddocks at the Fort Ellis Research Center.
LATE WEAN lambs were not weaned from dams during the background period.
PELLET lambs were self-fed alfalfa:barley pellets.
RANGE lambs were weaned from dams for 4 d and returned to range with ewe flock.

GRASS lambs had greater *(P ≤ 0.05)* LM areas than RANGE and LATE WEAN lambs; however, PELLET lambs did not differ *(P ≥ 0.28)* from all other treatments.

PELLET lambs had the greatest *(P < 0.01)* 12th-rib-fat thickness among treatments at the end of the step-up phase (d 19). At the conclusion of the feedlot, there were no differences *(P > 0.21)* in 12th-rib-fat thickness among treatments.

Carcass data

No differences *(P > 0.18)* were detected among backgrounding regimens for chilled carcass weight, LM area, or kidney fat (Table 5). Lambs from GRASS, RANGE, and LATE WEAN treatments had greater 12th-rib-fat thickness *(P ≤ 0.10)* than PELLET lambs.

Discussion

After the 29 d backgrounding period, PELLET lambs had greater lamb BW than did all other treatments. Similarly, Mathis et al. (2008) reported that steers backgrounded in a drylot were heavier than steers backgrounded on native range for 45 d after weaning. After the feedlot step-up period, both PELLET and GRASS lambs were heavier than RANGE and LATE WEAN lambs. Similarly, Mathis et al. (2008) reported that range-backgrounded steers had lower interim steer BW than drylot-backgrounded steers. At the conclusion of the present study, PELLET lambs had greater lamb BW than did GRASS, LATE WEAN, and RANGE lambs. In contrast, Mathis et al. (2008) reported similar final steer BW between background treatments. One reason for the difference in final BW could be that Mathis and others supplemented protein to the background treatment, whereas, our dormant-range treatments were not supplemented.

In the present study, lamb backgrounding treatment did not affect step-up DMI or G:F. However, Drouillard et al. (1991) restricted lamb growth for 35 d with either deficiencies in protein or energy prior to feedlot entry. They reported that d 0 to d 14 feedlot DMI was less in the unrestricted treatment than both energy- and protein-restricted treatments and feedlot G:F was greater

Table 4. Ultrasound measurements of LM area and 12th-rib fat thickness of backgrounded lambs.[1]

	Treatment[2]				
	GRASS	LATE WEAN	PELLET	RANGE	SE
No. of Lambs	18	18	18	17	
LM area, cm^2					
Weaning	8.08	7.66	7.96	7.81	0.23
d 0	9.52^{a}	8.62^{b}	9.61^{a}	8.64^{b}	0.24
d 19	10.87	10.57	10.91	10.67	0.24
d 68	16.50^{a}	15.65^{bc}	16.02^{ac}	15.57^{bc}	0.32
12th-rib fat thickness, cm					
d 19	0.28^{a}	0.28^{a}	0.35^{b}	0.27^{a}	0.01
d 68	0.53	0.51	0.49	0.51	0.02

[ab] Row means with different superscripts differ (*$P < 0.10$*).

[1] *Weaning* (d -29) represents removal of lambs from ewes when lambs were 140 ± 5.9 d.
d 0 lambs were removed from backgrounding treatments and began step-up diets.
d 19 lambs finished the transition period and began the finishing diet.
d 68 was the conclusion feedlot period.

[2] Treatments were applied to lambs for 29 d after weaning.
GRASS lambs were maintained on grass paddocks at the Fort Ellis Research Center.
LATE WEAN lambs were not weaned from dams during the background period.
PELLET lambs were self-fed alfalfa:barley pellets.
RANGE lambs were weaned from dams for 4 d and returned to range with ewe flock.

[3] Lamb BW at time of ultrasound measurement was added as a covariable to analyze LM and FD independent of BW.

Table 5. Effects of backgrounding treatment on lamb carcass characteristics taken after a 68 d feedlot period.

	Treatment[1]				
	GRASS	LATE WEAN	PELLET	RANGE	SE
No. of lambs	5	5	5	4	
Chilled carcass wt, kg	26.4	26.3	26.6	25.8	0.47
LM area, cm2	17.4	16.1	16.0	15.8	0.76
12th-rib fat thickness, cm	0.48^{a}	0.48^{a}	0.33^{b}	0.46^{ab}	0.06
Kidney fat, kg	1.14	0.97	1.16	1.00	0.11

[ab] Row means with different superscripts differ *($P < 0.10$)*.

[1] Treatments were applied to lambs for 29 d after weaning.
GRASS lambs were maintained on grass paddocks at the Fort Ellis Research Center.
LATE WEAN lambs were not weaned from dams during the background period.
PELLET lambs were self-fed alfalfa:barley pellets.
RANGE lambs were weaned from dams for 4 d and returned to range with ewe flock.

in protein than energy-restricted lambs (Drouillard et al. 1991). Their restricted treatments lost BW during the 35-d period, whereas, the RANGE, LATE WEAN, and GRASS lambs maintained BW during the backgrounding period. Therefore, lamb-BW change during background could very well affect feedlot performance during the first few weeks upon feedlot finishing.

During the 68-d feedlot period, RANGE, LATE WEAN, and GRASS lambs had less feedlot DMI. Drouillard et al. (1991) found that protein- and energy-restricted lambs had lower d 0 to d 42-feedlot DMI than unrestricted lambs, but total feedlot was not different among treatments (approximately 110 d). Therefore, intensity and duration of lamb restriction appears to influence subsequent feedlot DMI.

Lambs on the RANGE and LATE WEAN treatments had lower feedlot ADG than PELLET lambs; whereas, GRASS lambs were similar among treatments. Mathis et al. (2008) found higher initial feedlot ADG in range than drylot backgrounding; however, no difference in total-feedlot ADG was found between range- and drylot-backgrounded steer treatments. It is not clear why the present study's range background treatments did not have compensatory ADG. However, Turgeon et al. (1986) found that greater duration and intensity of growth restriction prior to feedlot entry was associated with higher levels of compensatory gain.

Ultrasound measurements of LM area indicate that LATE WEAN and RANGE treatments had less LM areas than GRASS and PELLET lambs at the start of the feedlot period. In addition, GRASS lambs maintained larger LM areas to the conclusion of the feedlot period. Drouillard et al (1991) reported that restricted lambs (35 d) had less protein tissue than unrestricted lambs after the restriction period and that difference in protein tissue between treatments was not regained during the feedlot period. However, Turgeon et al. (1986) reported higher rates of protein deposition during the feedlot period in restricted (100 d and 200 d) vs. unrestricted lambs. Differences in carcass LM area among studies are most likely due to length and intensity of background restriction prior to feedlot entry.

Fat thickness on d 19 was lower in RANGE, LATE WEAN, and GRASS lambs than PELLET lambs; however, upon feedlot completion all treatments reached a similar fat thickness. Similarly, Drouillard et al. (1991) and Turgeon et al. (1986) reported that restricted lambs had less fat than unrestricted lambs after the restriction period; however, after feed restriction ceased, fat was deposited at a greater rate in the previously restricted lambs.

Lambs of similar BW were selected for harvest, and comparison of treatment among similar BW can be made. Although, PELLET lambs had less carcass-fat thickness than all other treatments, ultrasound measurement of fat thickness across the entire treatment group was not different among treatment. Indicating that selection of similar BW among treatments may have artificially selected the leanest lambs from the PELLET treatment. Carcass weight, LM area, and kidney fat were all similar among treatments. Similarly, Mathis et al. (2008) reported similar carcass weight, LM area, and fat thickness between steer-background treatments.

Conclusions

Lambs on the PELLET-background treatment allowed for greater feedlot ADG, as compared to RANGE- and LATE WEAN-backgrounding treatments. The study also showed that GRASS lambs had similar feedlot ADG to PELLET lambs and higher G:F ratios than RANGE lambs. In addition, GRASS lambs had similar BW to RANGE and LATE WEAN lambs after backgrounding; however, GRASS lambs deposited more LM during the backgrounding and feedlot phases. Although, PELLET lambs deposited more LM than RANGE and LATE WEAN during the background treatment, feedlot LM deposition was similar among PELLET, LATE WEAN, and RANGE lambs. All lamb treatments reached a similar FD at the conclusion of the feedlot phase. In conclusion, results from this study conducted in 2007 showed that different background-management strategies will alter feedlot-lamb performance and LM deposition. Producers must factor in cost of backgrounding in relation to improvements in feedlot performance.

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