Residual feed intake does not predict efficiency of limit-fed ewe lambs

R.R. Redden[*], L.M.M. Surber[†], B.L. Roeder[†], and R.W. Kott[†]

*Department of Animal Sciences, North Dakota State University, Fargo, ND

†Department of Animal and Range Science, Montana State University, Bozeman, MT

The objective of this research was to evaluate the performance of ewe lambs on a limit-fed ration that were divergently selected from high, medium, and low residual feed intake (RFI) groups. We did not find any difference in growth, feed efficiency, or tissue deposition among RFI grouped ewe lambs. Therefore, we caution the use of RFI values as indicators of efficiency in any setting other than the environment by which animals were tested.

INTRODUCTION

A reduction in feed intake without compromising biological or economic efficiency could have a significant positive impact on the sheep industry. The concept of developing an alternative feed efficiency measurement that is independent of growth traits was first proposed by Koch et al. (1963). Residual feed intake is the difference between actual feed intake and predicted feed intake based upon maintenance of BW and production by linear regression. Numerous research efforts have shown that there is considerable individual animal variation in RFI in cattle (reviewed by Archer et al., 1999 and Herd et al., 2003) and sheep (Snowder and Van Vleck, 2003 and Cammack et al., 2005). However, most RFI testing has been conducted post-weaning on medium-to-high energy diets and has been related to potential feed savings in the feedlot (Snowder and Van Vleck, 2003). Research from our laboratory found no phenotypic correlation between RFI that was determined on a pelleted grower ration and RFI from lambs fed a chopped hay diet at maintenance (Redden, unpublished); however, we could not attribute the lack of RFI relationship to diet or rate of growth. Therefore, our objective was to measure the production differences of ewes previously been determined to be highly efficient (low RFI) or highly inefficient (high RFI) when limit-fed the same diet.

PROCEDURES

Targhee ewe lambs (n = 49) were selected randomly from the Red Bluff Research Ranch 2009 spring-born lamb crop. Use of animals was approved by Montana State University Animal Care and Use Committee.

Determination of RFI. On January 28, 2010, a 49-d experiment was conducted to determine RFI during active growth using the GrowSafe feed intake system (GrowSafe Systems Ltd., Airdrie, AB, Canada). Ewes were housed together in one pen (30 X 30 ft) with 4 GrowSafe pods at the Montana State University Nutrition Center. Elevated platforms and false bottoms were constructed to modify GrowSafe beef cattle stanchions and feed bunks, respectively, for sheep. Ewes

were given ad libitum access to a pelleted grower diet (75% TDN, 16% CP) and water. After a 2 week acclimation period, individual feeding events and feed disappearance recordings were initiated. Feed samples were collected weekly and stored for later analysis. Ewe BWs were measured weekly with two consecutive day weights recorded at the start and end of the experimental period. Growth rates of individual ewes were modeled by linear regression of 7-d BW by using a PROC GLM procedures of SAS (SAS Inst. Inc.), and regression coefficients were used to compute ADG, initial and final BW, and metabolic BW (**MBW**; midtest $BW^{0.75}$) as described by Lancaster et al. (2009). Ewe RFI was calculated for each individual as the difference between actual feed intake and expected feed intake. Expected feed intake was calculated by regressing the actual feed intake against MBW and ADG during the trial (Koch et al., 1963). To further characterize RFI, ewes were classified into low, medium, and high RFI groups that were <0.5, ±0.5, and >0.5 SD, respectively, from the mean RFI.

Limit-Fed Experiment. After the conclusion of the RFI determination experiment, ewes were removed from the GrowSafe testing facility and limit fed for 35 d. Twelve ewes per RFI grouping were selected for the limit-fed experiment. Ewe lambs that had the largest negative, largest positive and closest to zero RFI were assigned to low, high, and medium RFI groups, respectively. Three ewes from a RFI group were placed in each pen (12 x 48 ft). Twelve feedlot pens were used in this experiment and pen was the experimental unit. Ewes were fed twice daily at a rate that NRC (2008) predicted gain of 0.10 lb/d. Ewe BW were measured weekly with two consecutive day weights recorded at the start and end of the experimental period. Growth rates of individual ewes were modeled by linear regression of 7-d BW as described previously. Rib-eye area and backfat depth were determined at the beginning and end of the limit-fed experiment to estimate lean and fat deposition.

RESULTS AND DISCUSSION

Figure 1 illustrates the diversity in residual feed intake of ewes tested in this experiment. Black, blue, and red bars are the high, medium, and low efficiency groups, respectively. During the RFI determination experiment, ewes in the low-RFI group consumed 16% less feed ($P < 0.01$) than ewes in the high -RFI group, while ewe MBW and ADG were similar among RFI groups (Table 1). A similar percent in feed reduction between high- and low-RFI groups in beef cattle was reported by Lancaster et al. (2009).

Limit-fed Experiment. There were no detectable differences ($P > 0.19$) among RFI groups for average daily gain, rib-eye area growth, or back-fat deposition (Table 1). Similarly, Redden et al. (unpublished) found that RFI determined on a grower pelleted diet did not predict RFI determined on a chopped hay roughage diet. In general, an RFI difference among animals has been theorized to be a reduction in maintenance, growth requirements, or both. However, it appears that RFI is a measure of intake differences rather than physiological status of an animal. Therefore, we conclude that once ewe lambs are removed from an ad libitum diet RFI no longer predicts ewe lamb efficiency.

IMPLICATIONS

Measuring residual feed intake has the potential to significantly reduce production costs of livestock operations. However, producers must be aware that RFI should not be used to estimate efficiency savings in production settings other than those similar to the test environment. This research warrants further investigation of the relationship between RFI and efficiency savings in settings other than the RFI test.

LITERATURE CITED

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Table 1. Relationship between RFI determined efficiency groups on limit-fed ewe lamb performance

Item[1]	RFI Groups – Hay Diet (Exp. 2)			SE	*P*-value
	High Efficiency	Medium Efficiency	Low Efficiency		
No. of ewes	12	12	12		
RFI Traits[2]					
RFI, lb/d	0.44	0.00	-0.44	0.04	<0.01
ADG, lb/d	0.65	0.66	0.63	0.04	0.78
BW, lb	113	113	111	0.62	0.73
DMI, lb/d	4.72	5.07	5.55	0.15	<0.01
Limit-Fed Performance[3]					
No. of pens	4	4	4		
DMI, lb/d	2.9	3.0	2.9		
ADG, lb/d	0.08	0.07	0.07	0.02	0.86
REA, in^2					
Initial	2.12	2.05	2.16		
Final	2.71	2.74	2.73		
Change	0.59	0.70	0.57	0.31	0.19
BF, in					
Initial	0.18	0.18	0.19		
Final	0.22	0.23	0.25		
Change	0.04	0.06	0.07	0.01	0.39

[1]RFI = residual feed intake; ADG = average daily gain; BW = body weight; DMI = dry matter intake; REA = rib-eye area; BF = back fate depth.
[2]RFI traits were determined during a 49 d ad libitum feeding trial and feed intake data was collected via GrowSafe Technologies.
[3]Limit-fed performance traits were determined during a 35 d feeding trial. Ewes were fed the same diet at was fed during the RFI trial; however, they were limit-fed to gain BW at 0.1 lb per day.

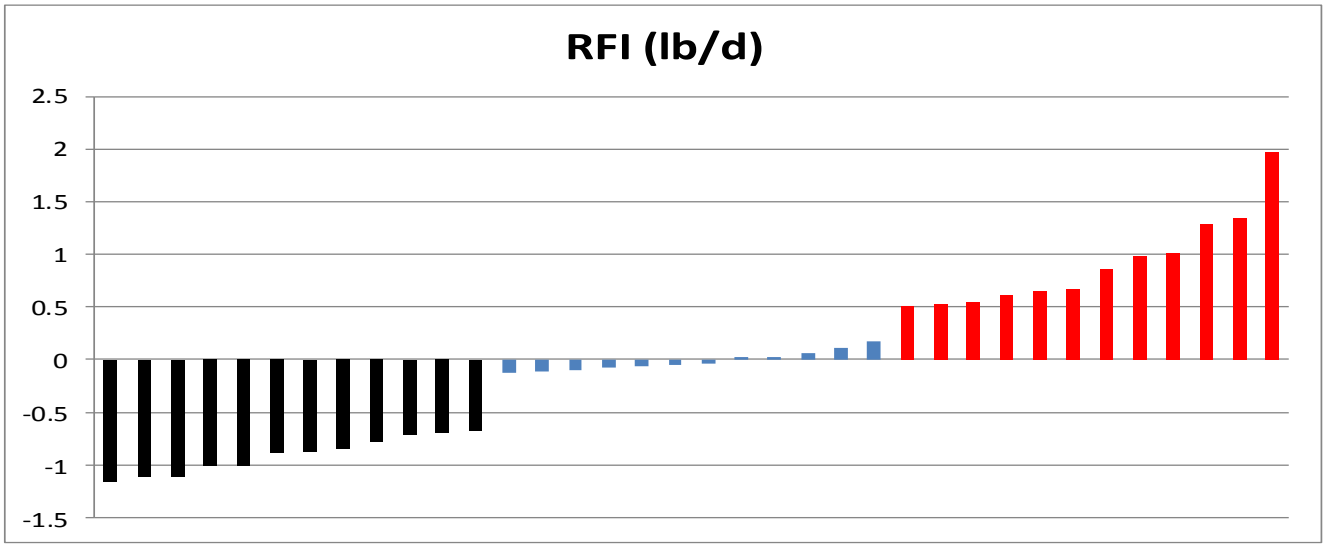

Figure 1. Distribution of residual feed intake (RFI) of ewes ranked from lowest to highest. Each ewe's RFI (kg) value is represented by a bar. Black, blue, and red bars are the high, medium, and low efficiency groups, respectively.

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