# Increasing grain in finishing diets improves feed efficiency in Rambouillet lambs

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*Feed accounts for the highest cost of finishing lambs, making feed efficiency critical to profitability. Increasing grain inclusion improved feed efficiency without changing growth performance or methane emitted per unit of feed consumed, supporting the use of higher-energy finishing diets to improve production efficiency.*


## Summary

Sheep are raised under diverse management systems, ranging from intensive confinement to more extensive pasture-based operations, which may influence how lambs utilize dietary energy for growth. To better understand the impact of dietary composition on performance, feed efficiency and methane intensity, three diets differing in grain-to-roughage ratio (GRR; high-grain, 50:50 and high-roughage) were evaluated. We found that grain-to-roughage ratio did not affect average daily gain or methane intensity but did improve feed efficiency.


## Introduction

Feed is the largest expense in finishing lamb production, making feed efficiency a key factor influencing both profitability and production sustainability. Increasing the grain-to-roughage ratio is a common management practice used to increase dietary energy density and improve animal performance, but changes in dietary composition may also affect enteric methane production and overall energy utilization. Understanding these responses can help producers make informed feeding decisions that balance biological performance with feed costs and resource efficiency. The objective of this study was to evaluate the effects of three grain-to-roughage ratios on growth performance, feed efficiency and enteric methane emissions in finishing Rambouillet lambs. We hypothesized that increasing dietary grain inclusion would improve feed efficiency while reducing methane production by more efficient utilization of dietary energy.

## Procedures

This study was approved by the Institutional Animal Care and Use Committee at North Dakota State University. Twenty-six finishing Rambouillet lambs were enrolled in this trial and assigned to one of three diets (Table 1): high-grain (HG; 80:20 GRR; n=7), half and half (MIX; 50:50 GRR; n=10) and high-roughage (HR; 20:80 GRR; n =9). Each diet differed in nutrient composition, most notably in fiber content (Table 2). All lambs were adapted to an automated feed intake monitoring system and used to evaluate the impact of dietary composition on finishing lamb growth performance and feed efficiency over a 35-day trial. Average daily gain was calculated using two-day body weights collected and averaged at the beginning of the growth testing period (days -1 and 0) and at the end of the growth test period (days 34 and 35). As an indicator of dietary energy utilization and resource efficiency, enteric $CH_4$ emissions were measured using an automated gas-capture system (GreenFeed; C-Lock Inc., Rapid City, South Dakota) over the five-week trial. Growth performance, feed efficiency and $CH_4$ intensity were

**Table 1. Ingredient composition of experimental diets fed to Rambouillet lambs**

| | Treatment[2] | | |
|---|---|---|---|
| Ingredient[1] | HG | MIX | HR |
| Corn, % | 40 | 25 | 10 |
| Oats, % | 40 | 25 | 10 |
| Market lamb supplement, % | 20 | 20 | 20 |
| Alfalfa, % | 0 | 30 | 60 |

[1]Ingredient inclusion expressed as a percentage of dietary dry matter.
[2]HG – 80% grain, 20 % roughage; MIX – 50% grain, 50% roughage; HR = 20% grain, 80% roughage.

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analyzed using ANOVA (SAS 9.4; SAS Institute Inc.), with experimental diet, sex and their interaction included as fixed effects. Weekly $CH_4$ emissions were analyzed using a repeated measures mixed model, with animal as the subject and week, diet, sex and their interactions as fixed effects. Statistical significance was declared at $P \leq 0.05$, and tendencies toward significance were declared at $0.05 < P \leq 0.10$.

**Table 2. Nutrient Composition of treatment diets fed to Rambouillet lambs**

| | Treatment[2] | | |
|---|---|---|---|
| Nutrient[1] | HG | MIX | HR |
| CP, % | 16.80 | 16.90 | 21.60 |
| ADF, % | 11.10 | 22.30 | 32.20 |
| Ash, % | 5.28 | 7.50 | 10.50 |
| ME, Mcal/lb | 0.69 | 0.64 | 0.58 |
| NEm, Mcal/lb | 0.41 | 0.37 | 0.33 |
| NEg, Mcal/lb | 0.27 | 0.25 | 0.21 |

[1] Values expressed on a dry matter basis.
[2] HG – 80% grain, 20 % roughage; MIX – 50% grain, 50% roughage; HR = 20% grain, 80% roughage.

## Results and Discussion

No diet × sex interactions were observed for growth performance or $CH_4$ emissions; therefore, results are presented across sexes. Lambs fed the high-grain (HG) diet were more feed efficient than lambs fed the high-roughage (HR) diet, while lambs fed the 50:50 (MIX) diet were intermediate (Table 3). Final body weight, total weight gain, average daily gain, and dry matter intake did not differ among dietary treatments. However, the relatively small sample size did produce numerical differences in feed intake among treatments, which may have influenced the gain-to-feed ratio. These findings indicate that increasing grain inclusion in finishing diets can improve feed efficiency without compromising lamb growth performance, providing producers with an opportunity to improve biological efficiency during the finishing phase. Lambs consuming the HG diet produced less $CH_4$ per day than lambs fed the HR diet, while $CH_4$ production was intermediate for lambs consuming the MIX diet (Table 4). However, $CH_4$ emissions expressed relative to feed intake were similar among treatments, indicating that the reduction in daily $CH_4$ production was primarily associated with lower feed consumption rather than a reduction in methane produced per unit of feed consumed. Collectively, these results suggest that increasing grain inclusion can improve feed utilization without increasing $CH_4$ intensity (emissions per pound of feed intake), although additional research is needed to determine whether dietary grain can consistently reduce enteric $CH_4$ emissions and to better understand its relationship to feed intake.

**Table 3. Effects of grain inclusion on lamb performance, dry matter intake and G:F**

| | Treatment[1] | | | |
|---|---|---|---|---|
| Item | HG | MIX | HR | *P*-value[2] |
| Final BW, lb | 147.93 ± 4.10 | 140.06 ± 3.15 | 147.93 ± 3.57 | 0.20 |
| BW gain, lb | 18.54 ± 2.43 | 16.84 ± 1.87 | 16.38 ± 2.12 | 0.78 |
| ADG, lb/d | 0.53 ± 0.07 | 0.49 ± 0.04 | 0.46 ± 0.07 | 0.78 |
| DMI, lb | 147.7 ± 14.93 | 163.85 ± 11.51 | 183.23 ± 13.03 | 0.13 |
| G:F | 0.13 ± 0.01[a] | 0.10 ± 0.01[ab] | 0.09 ± 0.01[b] | 0.04 |

[1]HG – 80% grain, 20 % roughage; MIX – 50% grain, 50% roughage; HR = 20% grain, 80% roughage.
[2]*P*-value for the overall F test of the treatments (n = 7, 10 and 9 for HG, MIX and HR respectively)
[a-b] Least squares means within a row with different superscripts differ ($P \leq 0.05$). Least square means were separated when *P*-values were < 0.05 for treatment.

**Table 4. Effects of grain inclusion on CH4 emissions treatment in Rambouillet lambs**

| | Treatment[1] | | | |
|---|---|---|---|---|
| $CH_4$ Emissions | HG | MIX | HR | *P*-value[2] |
| $CH_4$, g/d | 34.80 ± 4.83[a] | 52.47 ± 3.55[ab] | 50.29 ± 3.30[b] | 0.02 |
| $CH_4$, g/kg DMI | 9.80 ± 2.04 | 12.74 ± 1.25 | 11.82 ± 1.36 | 0.48 |

[1]HG – 80% grain, 20 % roughage; MIX – 50% grain, 50% roughage; HR = 20% grain, 80% roughage.
[2]P-value for the overall F test of the treatments (n = 7, 10, and 9 for HG, MIX, and HR, respectively)
[a-b] Least squares means within a row with different superscripts differ ($P \leq 0.05$). Least square means were separated when *P*-values were < 0.05 for treatment.

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