Pooled Analysis of Individually Fed Finishing Trials

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Summary with Implications

A pooled analysis of 21 finishing trials (2002–2016; 1530 animals) with cattle individually fed in Calan gate barns was conducted. Mixed model regression analysis following random coefficient methodology was used to evaluate relationships between performance variables and carcass characteristics. Gain had a greater effect on efficiency (R^2 = 0.72) compared to intake (R^2 = 0.02). The relationship between gain and efficiency was cubic, while intake had a quadratic relationship. The cubic response of gain relative to efficiency was continually increasing with relatively slight curves in the line heavily influenced by points that lay on the ends of the data. Efficiency also had cubic relationships with fat thickness and marbling of carcasses; however, the regressions had low R^2 values of 0.01. There was a significant relationship between efficiency and fat thickness and marbling, but the variation around the trend line was high. Efficiency alone is a poor predictor of fat thickness and marbling.

Introduction

Feeding cattle in a pen setting limits data collection on individual animal performance. In pen fed studies, the experimental unit is the pen. When cattle are individually fed, dry matter intake (DMI) and average daily gain (ADG) are collected on the individual, which makes the experimental unit the animal instead of the pen. When using data from individually fed animals the variation due to animal is more apparent and can be compared to the variation from a pen of animals.

The purpose of this analysis was to examine: 1) the effect of DMI and ADG on feed to gain (F:G), 2) the effect of F:G on fat thickness and marbling. This analysis was done with individually fed cattle which gives a better understanding of how individual animals perform.

Procedure

A pooled analysis of 21 previous studies performed at the University of Nebraska–Lincoln Eastern Nebraska Research and Extension Center, near Mead, NE, was conducted. The data were collected at the individually fed barns equipped with the Calan gate system. Trials selected were finishing trials conducted from 2002 through 2015. There were 5 trials with intact heifers, 1 trial with spayed heifers, and 15 trials with steers. Initial body weight (BW) ranged from 496 to 1195 lb with a mean starting weight of 822 lb. Initial BW was taken after a 5 day limit feeding period in all trials and cattle were weighed 3 consecutive days with the exception of 1 trial which started as a growing trial and cattle were stepped up directly to a finishing diet. Fifteen of the trials utilized 60 animals, 5 trials utilized 120 animals, and 1 trial utilized 30 animals (n = 1530). Diets for each trial were replicated 5 to 40 times with 18 of the trials having 10 to 20 replications per treatment. Animals were on feed for 93 to 189 days.

All cattle were shipped to the same abattoir (Greater Omaha Packing Co., Omaha, NE) for harvest and carcass data collection. Hot carcass weight (HCW) and liver scores were collected at the time of harvest. Marbling score, 12^{th} rib fat thickness (FT), and longissimus muscle (LM) area were collected following a 48 hour chill. Final BW was calculated from HCW using a common 63% dressing percentage. Cattle ADG and F:G were calculated from this adjusted final BW.

Mixed model regression analysis following random coefficient methodology was used to evaluate relationships between variables. Factors of interest were: impact of DMI and ADG on F:G and relationships between F:G of cattle and FT or marbling.

For each analysis, there was a dependent and independent variable with the linear, quadratic, and cubic terms in the model. If the type 3 fixed effect for the cubic term was not significant ($P > 0.10$), the model was reduced to just the quadratic and then the linear term. If the model was reduced to the linear term and there was no significance, then it was assumed that no correlation existed between the dependent and independent variables.

When statistics indicated a model was significant ($P < 0.10$), the estimates from the fixed effects were used as coefficients to create regression lines. The significance of term was used to determine if the coefficient of each term was different from zero. Residuals from random effects were then added to the regression line prediction from each independent variable to calculate trial adjusted dependent variables.

Results

Effect of DMI and ADG on Feed Conversion

Feed conversion is described as the amount of feed consumed per equal unit of body weight gained (F:G = DMI/ADG). Typically, as DMI increases in finishing animals, ADG increases at a decreasing rate; ADG increased quadratically as DMI increased in the current dataset. However, the relationship between DMI and F:G or ADG and F:G is not as well understood. Because DMI and F:G were measured in individually fed animals in the current analysis, these relationships can be observed.

The relationship between F:G and DMI was quadratic ($P < 0.01$; R^2 = 0.02; Figure 1). However, the relationship between F:G and ADG was cubic ($P < 0.01$; R^2 = 0.71; Figure 2). The linear relationship between F:G and ADG ($P < 0.01$; R^2 = 0.55) may be more biologically relevant as data at the ends of the range are likely overly influencing the response. Cattle with very high F:G may have been sick or internally injured.

More variation in F:G was accounted for by ADG (R^2 = 0.71) compared to DMI (R^2 = 0.02). This indicates that ADG is more influential at determining F:G in finishing beef cattle than DMI. In the current analysis, F:G continually improved as ADG increased.

Effect of Performance on Fat Thickness and Marbling

Relationships between F:G and carcass characteristics are not well documented. It is not clear if more efficient animals also have greater FT or marbling. The relationship between F:G and FT was quadratic (P < 0.01; R^2 = 0.01; Figure 3) and the relationship between F:G and marbling score was cubic (P < 0.01; R^2 = 0.01; data not shown). Although statistics indicated a significant trend, using F:G alone is still a poor predictor of how an animal will deposit subcutaneous (R^2 = 0.01) and intra-muscular fat (R^2 = 0.01).

The relationship between FT and marbling was a quadratic response (P < 0.01; R^2 = 0.14; Figure 4). As FT increased, marbling score increased at a decreasing rate. This quadratic response is heavily influenced by only a few animals that had greater than 0.83 in of FT.

Conclusion

This analysis provides evidence that cattle gain has more influence on efficiency of cattle than intake. Feed efficiency of animals had little effect on carcass traits, within feedlot diets with typical energy content. However, marbling score increased with increased back fat thickness.

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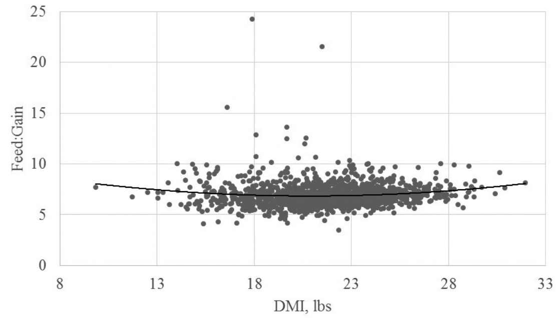

Figure 1. Relationship between feed to gain (F:G) and dry matter intake (DMI) of individually fed finishing cattle.
F:G = 0.01 ± 0.07 × DMI^2–0.415 ± 0.065 × DMI + 11.17 ± 3.22 (R^2 = 0.02).

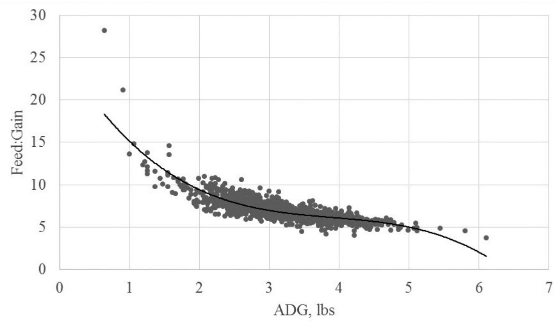

Figure 2. Relationship between feed to gain (F:G) and average daily gain (ADG) of individually fed finishing cattle.
F:G =-0.287 ± 0.041 × ADG^3 + 3.35 ± 1.81 × ADG^2–13.78 ± 2.65 × ADG + 25.8 ± 14.1 (R^2 = 0.71)

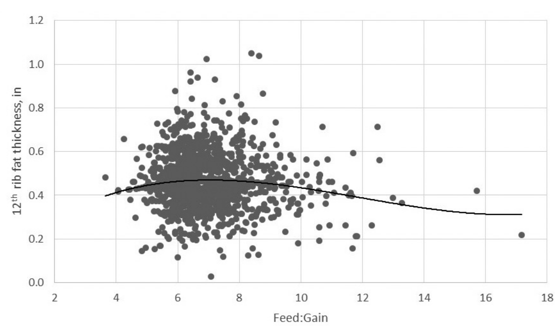

Figure 3. Relationship between feed to gain (F:G) and 12th rib fat thickness (FT) of individually fed finishing cattle.
FT, in = 0.0003 ± 0.0001 × $F{:}G^3$–0.013 ± 0.006 × $F{:}G^2$ + 0.124 ± 0.064 × F:G + 0.095 ± 0.087 (R^2 = 0.01)

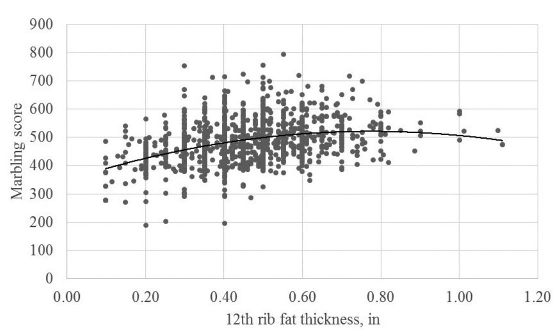

Figure 4. Relationship between 12th rib fat thickness (FT) and marbling score of individually fed finishing cattle. Marbling score: 300 = slight, 400 = small, 500 = modest, etc.
Marbling score =-289.01 ± 62.01 × FT^2 + 447.83 ± 65.41 × FT + 374.75 ± 19.92 (R^2 = 0.14).