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Abstract
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Keywords
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PREDICTING LYSINE REQUIREMENTS USING PROTEIN AND LIPID ACCRETION CURVES FOR GROWING-FINISHING GILTS[1]

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Summary

A total of 240 growing-finishing gilts (60 to 260 lb) was used to model accretion rates and the lysine:calorie ratio requirement based on lipid and protein growth. Real-time ultrasound measurements were used to estimate lipid and protein contents. These estimates then were translated into feed intake and lysine requirements. Gilts were fed one of eight different diet regimens, consisting of four increasing lysine:calorie ratios and two levels of fat (0 and 6%). Lipid and protein deposition rates could effectively model feed intake when pigs were fed lysine:calorie ratios close to their requirement. The modeled accretion rates effectively predicted the differences between treatments in agreement with the growth performance data. The modeled lysine:calorie ratio requirement accurately predicted the lysine:calorie ratios that maximized growth, evaluated by either the predicted or the actual data.

(Key Words: Real-Time Ultrasound, Lipid Accretion, Protein Accretion, Lysine:Calorie Ratio, Fat, Lysine, Finishing Pigs.)

Introduction

The estimation of on-farm protein and lipid accretion curves is a valuable tool to calculate the lysine requirement for growing-finishing pigs reared under specific environments. The daily energy intake can be calculated from the daily protein and lipid accretion estimates with an allowance for the maintenance energy requirement. The lysine requirement in grams per day divided by the daily energy intake results in an estimate of a lysine:calorie ratio. Using the ratio ensures that the right amount of lysine is provided in diets that vary in energy density. Several studies have been conducted to predict the lysine requirement from protein accretion estimations. However, the lysine:calorie ratios predicted from serial ultrasound estimates have not been compared to those estimated from conventional lysine titration experiments. Therefore, the objective of this study was to compare lysine:calorie ratio requirements modeled from real-time ultrasound data to requirements estimated by the more traditional lysine titration technique.

Procedures

A total of 240 gilts (PIC C22 × 337) with an initial weight of 60 lb was used in this experiment.

Treatments consisted of corn soybean meal-based diets (Table 1) arranged in a 2 × 4 factorial with two levels of fat (0 and 6% choice white grease) and four lysine:calorie ratios in each phase. More detailed descriptions of the diets, building characteristics, pen dimensions, and ventilation system are found in paper discussing growth performance results of this study (p. 88).

[1]Appreciation is expressed to Global Ventures for the use of pigs and facilities; to Pipestone Research Partners for partial financial support; and to Marty Heintz, Steve Rops, and Robert Powell for technical assistance.

[2]Food Animal Health and Management Center.

[3]Northeast Area Extension Office, Manhattan, KS.

The 240 gilts used in the study were selected randomly from a total of 1,200 pigs that were housed in 48 pens at the rate of 25 pigs per pen. Five pigs/pen were selected, tagged, weighed, and scanned within 1 week of placement in the finishing barn and every 3 weeks after, until they were marketed at the end of the study.

The growth and real-time ultrasound data (backfat depth and loin eye area) were used to calculate daily body gain and lipid and protein accretion rates, based on the concepts developed by Dr. Allan Schinckel at Purdue University.

The daily lysine requirement in grams per day was calculated using the following formula:

$$\text{Total lysine g/day} = \frac{M + \frac{P \times L}{E}}{D}$$

Where M is the lysine needed for maintenance (.036 × Wt, $kg^{.75}$); *P* is the daily body protein accretion; L is the lysine content of body protein (6.6%); E is the postabsorptive efficiency of lysine utilization (60%); and D is the true digestibility of lysine in the diet (88%).

Predicted daily feed intake was calculated by dividing the metabolizable energy requirement by the energy content of the diet. The metabolizable energy required to drive the observed protein and lipid accretion (with an allowance for the maintenance energy requirement) was calculated using the following formula:

Metabolizable energy requirement = (.255 × weight in $kg^{.60}$) + (8.84 × protein accretion) + (11.4 × lipid accretion)

The lysine:calorie ratio requirement was calculated by dividing the requirement of total lysine in grams/day by the requirement of metabolizable energy in Mcal/day.

Results and Discussion

The modeled ADG is presented in Figure 1. Average daily gain was predicted to be greater for the third and fourth lysine:calorie ratios (treatments C,G and D,H) than for the lower lysine:calorie ratios. Also, adding fat to the diets resulted in improved predicted gains within each lysine:calorie ratio. These results agree with the growth performance data (p. 88). The ADG was increased by increasing the lysine:calorie ratio and by adding fat to the diets during phases 1 and 2 and for the overall trial.

Protein and lipid accretion rates (Figures 2 and 3) were greater for treatments C,G and D,H (third and four lysine:calorie ratios). The increase in protein accretion rate for the third and fourth lysine:calorie ratios compared to the first and second was greater than the increase in lipid accretion. In other words, treatments C,G and D,H, deposited more protein in relation to fat than treatments A,E and B,F (first and second lysine:calorie ratios). These results were reflected in the carcass composition analysis (p. 88). Percent lean and fat-free lean index were increased and backfat was decreased with increasing lysine:calorie ratio.

Adding fat to the diets did not appear to influence protein accretion (Figure 2). However, a tendency for greater lipid accretion (Figure 3) can be detected within each lysine:calorie ratio for diets containing fat. Again, this agrees with the carcass composition results.

The increased ADG and protein accretion (Figures 1 and 2) observed for treatment H (highest lysine level fed) during phases 3 and 4 suggest that the actual requirement was close to or above the ratio fed. This conclusion agrees with the linear response observed for ADG during phases 3 and 4 (p. 88).

Predicted ADFI was similar for all treatments at the beginning of the growing period (Figure 4), with a slight intake advantage for treatments with no added fat. After approximately 170 lb, predicted ADFI for treatments A and B decreased, and for the overall period, ADFI followed lipid and protein accretion rates, with treatments C,G, and D,H (third and fourth lysine:calorie ratios) showing the highest predicted intake. However, the growth performance data (p. 88) did not show decreases in feed intake for treatments A and B. In contrast, ADFI for treatments A and B was higher than that of treatments G and H and similar to that of treatments C and D. This means that based on the actual intake data, feed intake was driven mainly by the energy content of the diet and the weight of the pig, rather than by the lysine content of the diet or by the lipid and protein accretion rates. This implies that the formulas to calculate feed intake based on lipid and protein deposition are more accurate when pigs are fed close to their requirement. When pigs are fed lysine levels below their requirement, the formulas underestimate feed intake.

The modeled lysine requirement in g/day (Figure 5) followed protein accretion. The greatest lysine requirement was predicted for treatments C,G and D,H (third and four lysine:calorie ratios).

The predicted lysine:calorie ratio requirements for the different treatments are presented in Figure 6. The treatments with greater protein accretion and, thus, with greater requirements for total lysine (C,G and D,H) also demonstrated an increased lysine: calorie ratio requirement in comparison to treatments A,E and B,F. These results agree with the lysine:calorie ratios fed during the growth performance experiment (p. 88), where treatments C,G and D,H corresponded to the highest lysine:calorie ratios fed.

Treatment D was selected to compare the predicted lysine:calorie ratio vs. the actual requirement observed in the growth performance experiment (companion paper). This comparison is presented in Figure 7. The modeled lysine:calorie ratio requirement accurately predicted the actual lysine:calorie ratio requirement observed in the growth performance experiment. In both cases (predicted and actual), treatment D (fourth lysine:calorie ratio) increased growth performance when compared to treatments A,E and B,F (first and second lysine:calorie ratios).

In summary, real-time ultrasound can be used to accurately predict growth and the lysine:calorie ratio requirement of growing–finishing gilts reared in specific environments. Also, it can be used to model feed intake based on lipid and protein depositions. However, the formulas to calculate feed intake appear to be more accurate when pigs are fed close to their requirement. This implies that when lysine requirements derived using ultrasound measurements are in excess of the dietary levels fed, the requirement may actually be higher than the modeled estimate.

Table 1. Dietary Treatments

	Lysine:Calorie Ratio (g lysine/Mcal ME)							
	0% Fat				6% Fat			
Item	A	B	C	D	E	F	G	H
Phase 1 (60-100 lb)	2.96	3.26	3.56	3.86	2.96	3.26	3.56	3.86
Phase 2 (100-165 lb)	2.25	2.50	2.75	3.00	2.25	2.50	2.75	3.00
Phase 3 (165-220 lb)	1.64	1.84	2.04	2.24	1.64	1.84	2.04	2.24
Phase 4 (220-260 lb)	1.12	1.32	1.52	1.72	1.12	1.32	1.52	1.72

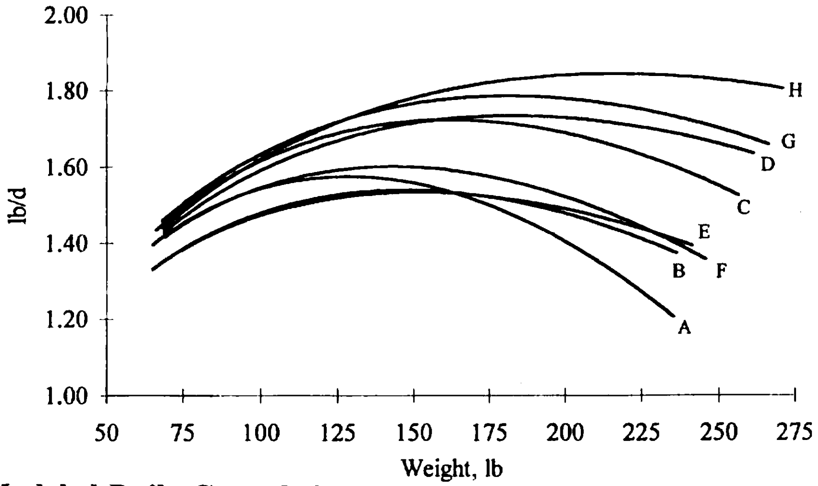

Figure 1. Modeled Daily Growth for Gilts Fed Diets with Increasing Lysine:Calorie Ratios and Two Dietary Fat Levels.

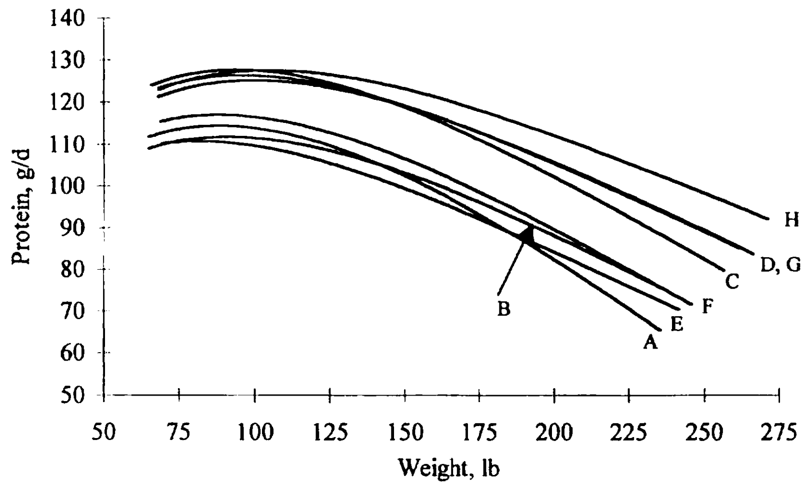

Figure 2. Modeled Daily Protein Accretion for Gilts Fed Diets with Increasing Lysine: Calorie Ratios and Two Dietary Fat Levels.

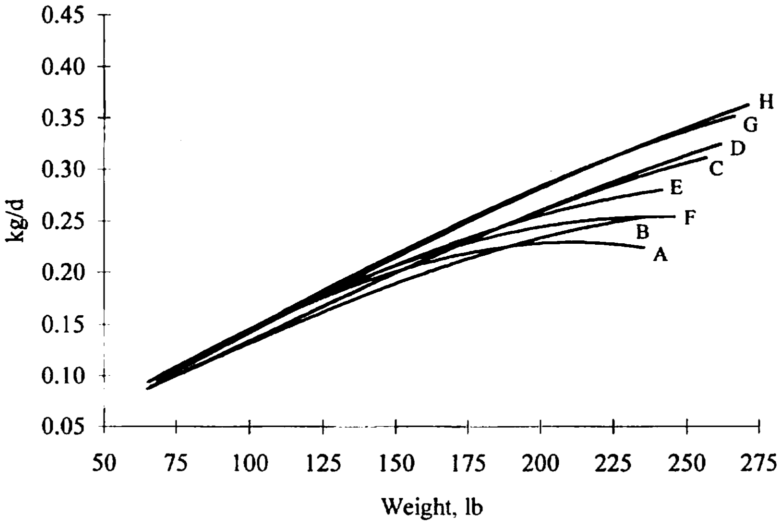

Figure 3. Modeled Daily Lipid Accretion for Gilts Fed Diets with Increasing Lysine: Calorie Ratios and Two Dietary Fat Levels.

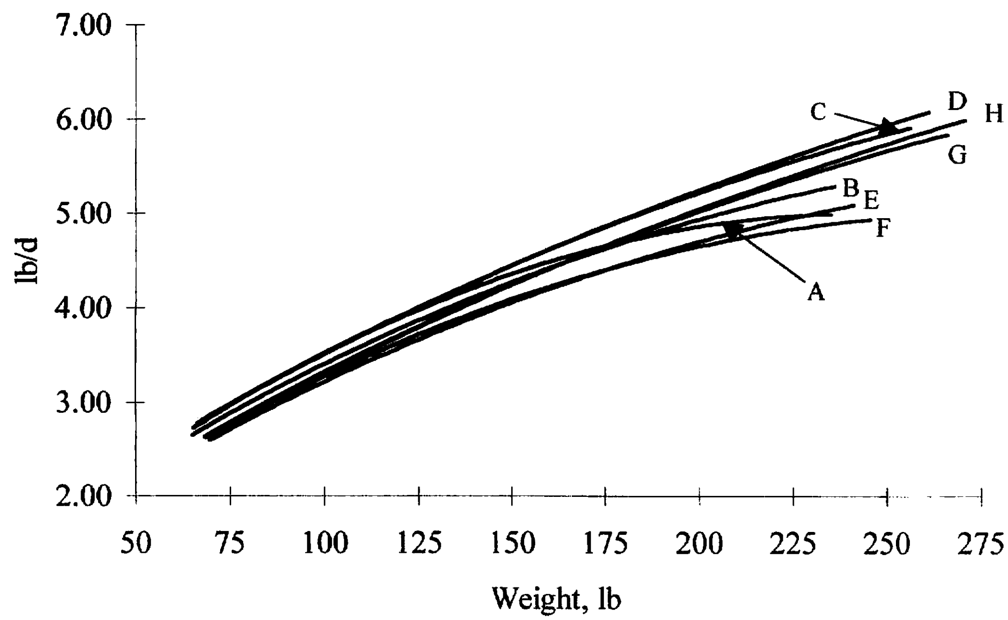

Figure 4. Modeled Daily Feed Intake for Gilts Fed Diets with Increasing Lysine: Calorie Ratios and Two Dietary Fat Levels.

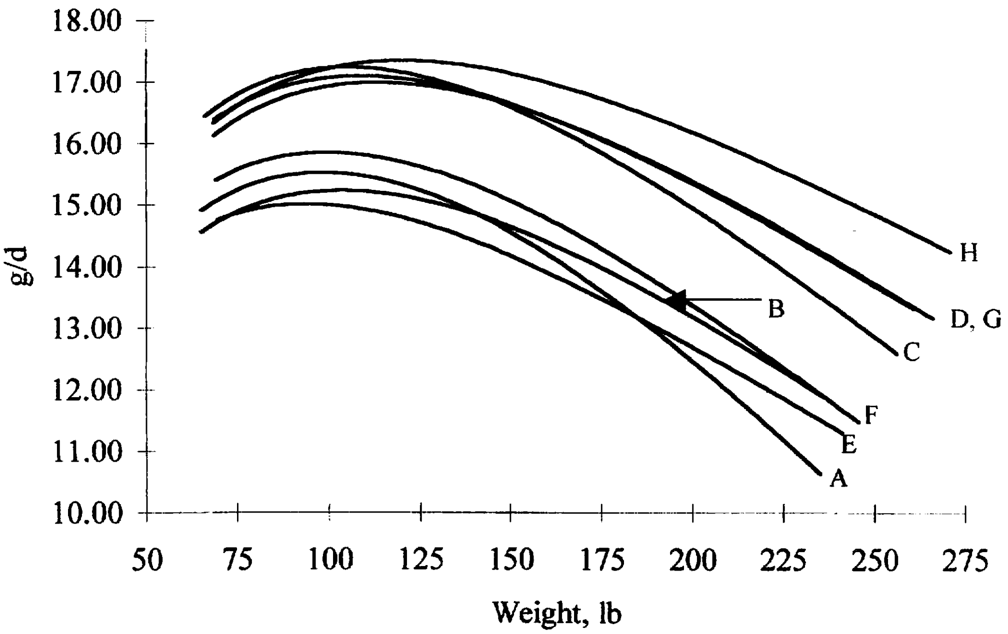

Figure 5. Predicted Daily Total Lysine Requirement for Gilts Fed Diets with Increasing Lysine:Calorie Ratios and Two Dietary Fat Levels.

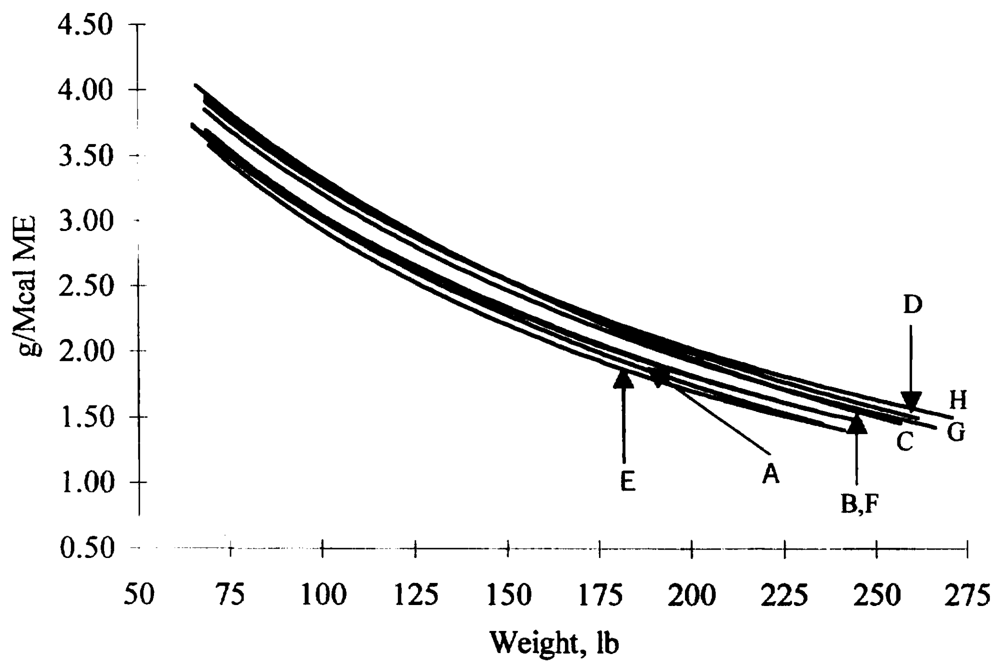

Figure 6. Predicted Lysine:Calorie Ratio Requirement for Gilts Fed Diets with Increasing Lysine:Calorie Ratios and Two Dietary Fat Levels.

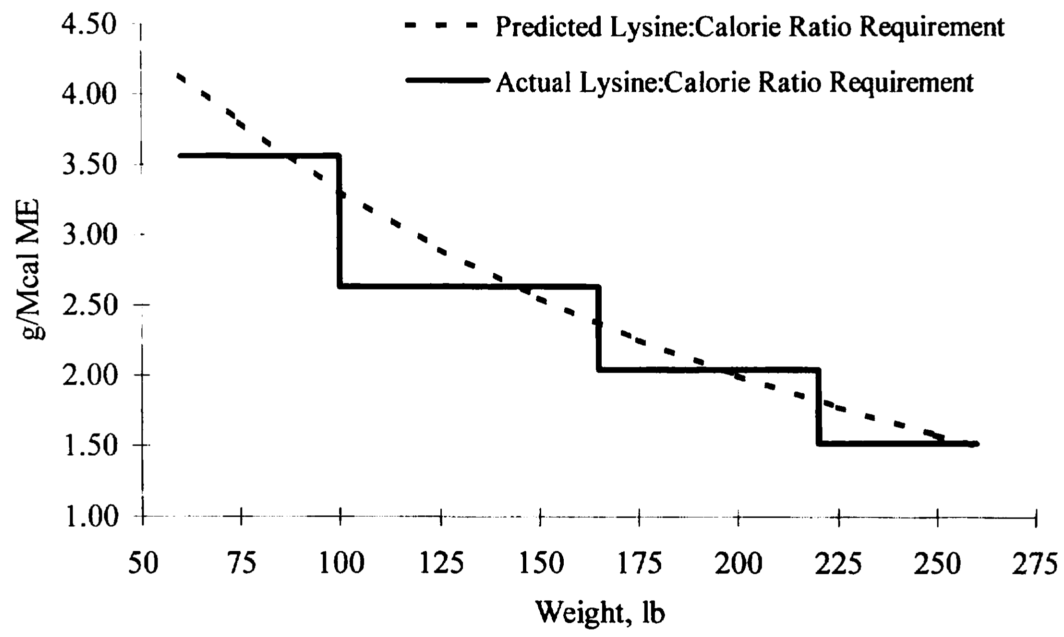

Figure 7. Comparison between Predicted and Actual Lysine:Calorie Ratio Requirements for Growing-Finishing Gilts.