Evaluation of an Updated Model to Describe the Compositional Growth of Pigs Fed Paylean®

A. P. Schinckel, B. T. Richert, and M. E. Einstein
Department of Animal Sciences, Purdue University

Introduction

Pork producers have the goal to efficiently produce lean, quality pork to compete with alternative animal products. The implementation of lean value carcass pricing systems has led to the selection of pigs with increased lean growth rates, increased carcass lean percentages, and improved lean feed conversion. Health, nutrition, and facility management strategies have been implemented to increase commercially achievable lean growth rates. Paylean (ractopamine hydrochloride by Elanco) is a feed additive that has the potential to further increase the rate and efficiency of muscle tissue growth. Paylean has been approved to be fed at levels of 4.5 to 18 grams per ton (5-20 ppm) from 150 to 240 lbs live weight (last 90 lbs of live weight gain prior to market). Numerous Paylean research trials were conducted for 1987 to 1991. Because genetic selection has changed the pigs, the response to Paylean may have changed. The objective of this research was to utilize new Paylean research data and develop an updated daily growth model to describe the daily compositional growth of pigs fed alternative levels of Paylean. Future research can utilize this model to evaluate alternative nutrition, management, and marketing strategies.

Modeling the Paylean Response

Six parameters were taken into account when modeling the effects of Paylean.

- Data from six recent trials were used to model the increase in protein accretion as a function of dietary Paylean level. A 24% increase in daily empty body protein accretion over the last 90 lbs of live weight gain was assumed. Data from recent trials indicate that current high lean gain terminal cross pigs have a greater response to the lower levels of Paylean (4.5 to 9.0 g/ton) relative to the maximal 18 g/ton level than pigs of a decade ago. The percent increase in daily protein accretion was modeled as $.24\ RR\ (PL/18)^{.228}$ where PL is the level of Paylean (g/ton). The new nonlinear function predicts 72.8 and 85.2% of the maximal 18 g/ton protein accretion response with the 4.5 and 9.0 g/ton levels.
- The ractopamine response (RR) was modeled to describe the rapid increase and subsequent decline in the Paylean response with either increasing time or weight gain on ractopamine. The Paylean response was predicted from weekly or biweekly serial real time ultrasound and live weight measurements or based on the weekly response of Paylean to increase gain:feed and average daily gain. The relative response can be modeled as a response of live weight gain on Paylean (WTGN, lbs) $RR = 1.75 + .0035198\ (WTGN) - .00036\ (WTGN)^2 + .000001587 \times (WTGN)^3$; or as a response of days on Paylean (DAYS): $RR = 1.73 + .01456\ (DAYS) - .00361\ (DAYS)^2 + .000059\ (DAYS)^3$. Both methods resulted in very similar predicted Paylean response curves. The Paylean response observed in recent trials has become shorter in duration than observed in trials of a decade ago.
- The reduction in feed intake was modeled as $.04\ (PL/18)^{.7}$ times the feed intake for the first 45 lbs of live weight gain on Paylean then increasing to approximately 8% at 90 lb live weight gain on Paylean. This reduction in feed intake is supported by past research trials.

- The ratio of fat-free lean gain to empty body protein gain was modeled to increase by an average of 12% with 18 g/ton of Paylean.
- The equations were changed to incorporate the effect of Paylean to increase weight gain.
- Equations predicting fat depth, loin eye area, fat-free lean, and carcass fat mass were modified. Paylean changes lean distribution such that carcass measurements only partially account for the extra lean mass produced by Paylean. Paylean increases loin eye area and muscle depth to a greater extent and backfat thickness to a lesser extent than predicted by the increase in lean mass and percentage it causes.

The compositional growth of gilts fed Paylean was predicted for gilts reared in two environments: (1) SEW, high health management in modern facilities and (2) an older continuous flow facility (Kendall et al., 2000). Compositional growth curves were developed from serial real-time scans and live weights. The Paylean response was modeled for four levels of Paylean, 0, 4.5, 9, and 18 g/ton level from 160 to 240 lbs live weight. The predicted values assume that dietary levels of essential amino acids are adequate for maximum Paylean response.

Results

The predicted performance for the gilts fed the four levels of Paylean from 160 to 240 lbs are presented in Table 1. Paylean at the 9 g/ton level increased average daily gain by 10% and fat-free lean gain by 37% in both environments. Paylean (9 g/ton) reduced daily carcass fat gain 31% in the SEW environment and 35% in the continuous flow environment.

The predicted carcass measurements are presented in Table 2. Gilts fed 9 g/ton Paylean for 28 d achieved a 8.8 lb advantage for fat-free lean over the non-Paylean pigs. The predicted values are similar to summarized research results (Schinckel et al., 2000). The performance of the continuous flow gilts was much closer to average commercial conditions. For this reason, only the predicted daily growth variable of Paylean fed gilts reared in the continuous flow environment is presented.

The live weight growth response to Paylean increases rapidly, approximately .35 lb/day for the first seven days, and then declines (Figure 1). As the live weight gain on Paylean approaches 84 lbs, the Paylean growth response decreases to below the controls.

Paylean was predicted to substantially increase fat-free lean growth (Figure 2). Daily predicted fat-free lean gains were approximately 50% greater than pigs not fed Paylean at the point of maximum Paylean response (1-15 lbs live weight gain or 1-7 days on Paylean). Daily predicted protein accretion also increased rapidly with Paylean feeding (Figure 3). Carcass fat gain was substantially reduced by feeding Paylean (Figure 4). The 9 g/ton level results in substantial reduction in carcass fat gain especially at the time of maximal Paylean response. All levels of Paylean reduced carcass fat gain for the entire feeding period. The marginal growth of fat-free lean to carcass weight is the percent lean with each additional pound of carcass weight gain at each live weight (Figure 5). Paylean was predicted to substantially increase carcass lean/gain percentage. The response was predicted to be greater at the higher levels of Paylean and during the time of maximal Paylean response. Because the marginal rate of fat-free lean to carcass weight was predicted to be greater for pigs fed Paylean, it is expected the advantage for carcass percent lean for Paylean fed pigs versus non-Paylean fed pigs will continue to increase with the duration of Paylean use.

Pork producers are also concerned with the feed efficiency. The predicted feed:gain ratios are presented in Figure 6. These predicted feed conversion ratios assume minimal levels of feed wastage and a thermal neutral environment. Typically feed intake measured as feed disappearance is 10-15% greater than feed intake predicted from the energetic costs of growth and maintenance. The feeding of Paylean was predicted to substantially reduce feed conversion for the first 50 lbs of live weight gain or in this environment, approximately 28 days of feeding.

Lean feed conversion is the pounds of feed required per pound of fat-free lean gain (Figure 7). Again, the model assumes minimal feed wastage, thermal neutral conditions, and nonlimiting dietary levels of essential amino-acids. Lean feed conversion is substantially improved by the feeding of Paylean as the rate of fat-free lean is increased overall and to a lesser extent feed intake decreased. In the gilts not fed Paylean, lean feed conversion increased as the ratio of fat-free lean gain to carcass fat gain decreased.

Implications

The development of a daily compositional growth model of Paylean response will allow the optimization of management, nutrition, and marketing strategies. Since Paylean primarily increases muscle mass and changes muscle distribution, the relationships between the carcass measurements and carcass composition are changed when Paylean is fed. The greater extent to which Paylean is fed, level and duration of the use, the greater extent the relationships are expected to change. Additional new research on lean genotypes in different environments can further refine the growth model.

References

Kendall, D. C., B. T. Richert, T. E. Weber, K. A. Bowers, S. A. DeCamp, A. P. Schinckel, and P. Matzat. 2000. Evaluation of pig genotype, strategic use of antibiotics and grow-finish management effects on lean growth rate and carcass characteristics. Purdue University Swine Day Report. p. 60.

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Table 1. Predicted performance for four levels of Paylean in two environments

Paylean Level g/ton	Average Daily Gain	Fat-free Lean Gain (lb/day)	Total Carcass Fat Gain (lb/day)	Protein Accretion (g/day)	Ratio Fat-free Lean : Protein Gain
SEW - three sites					
0	2.16	.718	.418	134.9	2.41
4.5	2.35	.954	.305	164.3	2.63
9	2.37	.993	.287	168.7	2.67
18	2.38	1.048	.261	175.0	2.72
Continuous Flow – older facility					
0	1.65	.553	.311	103.8	2.42
4.5	1.77	.726	.216	125.0	2.63
9	1.80	.760	.200	129.1	2.67
18	1.81	.802	.180	133.7	2.72

Table 2. Predicted carcass measurements for gilts fed four levels of Paylean in two environments when fed from 160 to 240 lb

Paylean Level g/ton	Tenth Rib Fat Depth (in.)	Loin Muscle Area (in^2)	Percent Fat-free Lean	Dressing Percent
SEW - Three sites				
0	.77	6.10	50.20	75.00
4.5	.68	6.74	52.93	76.02
9	.66	6.83	53.33	76.25
18	.64	6.95	53.90	76.46
Continuous Flow				
0	.76	6.11	50.02	75.00
4.5	.67	6.73	52.79	76.04
9	.65	6.89	53.28	76.22
18	.63	6.97	53.84	76.45

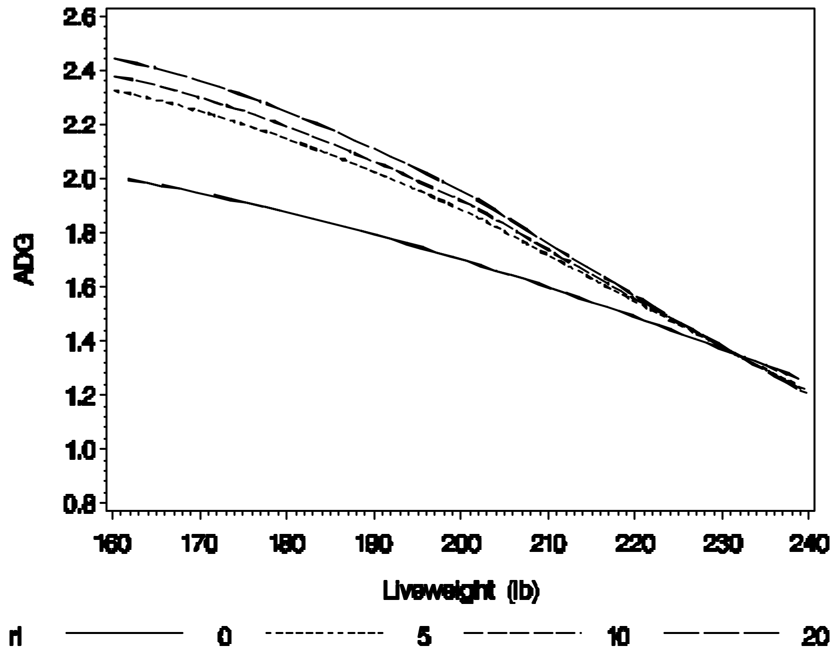

Figure 1. Predicted impact of Paylean to increase average daily gain (lb/d) of gilts reared with continuous flow management

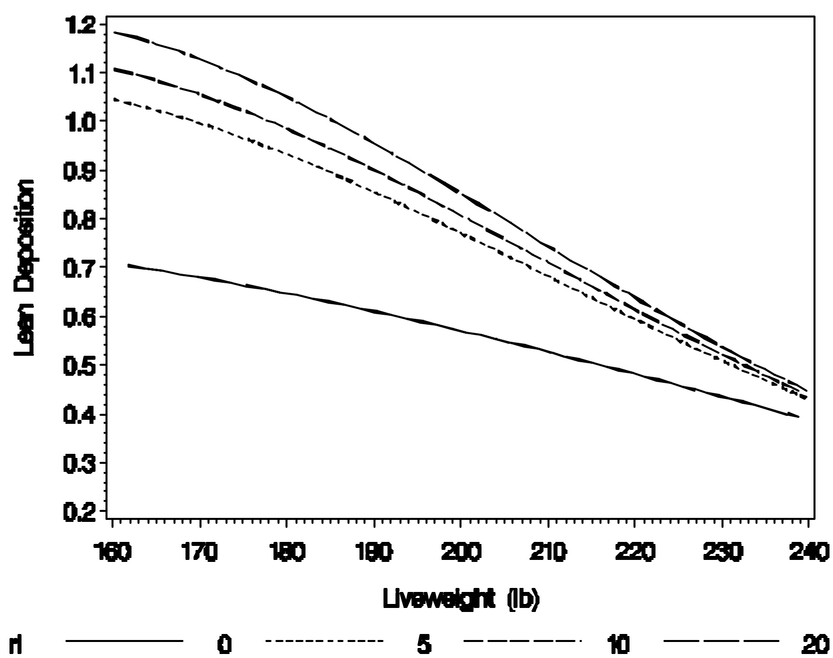

Figure 2. Fat-free lean gain (lb/d) of gilts reared in a continuous flow environment

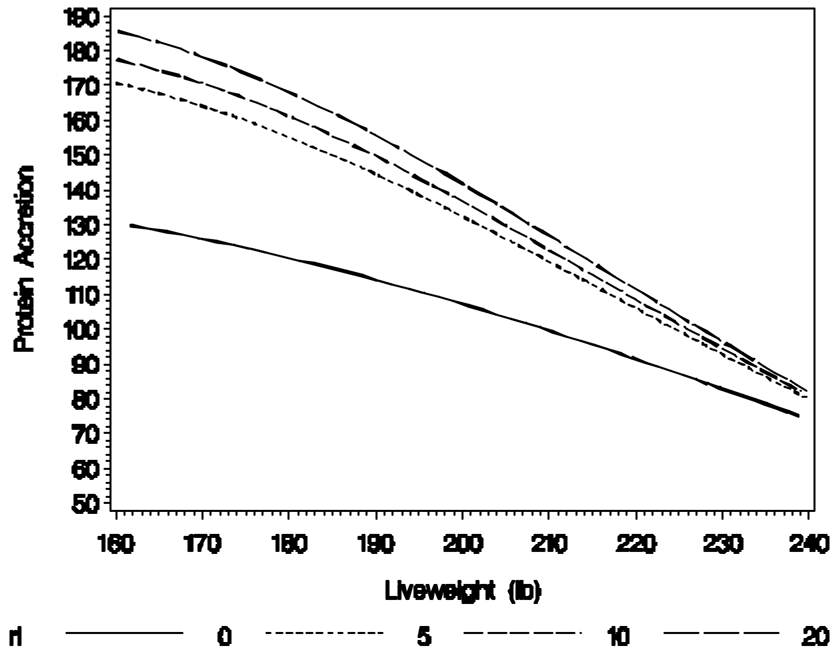

Figure 3. Predicted daily protein accretion (g/d) of gilts reared with continuous flow management

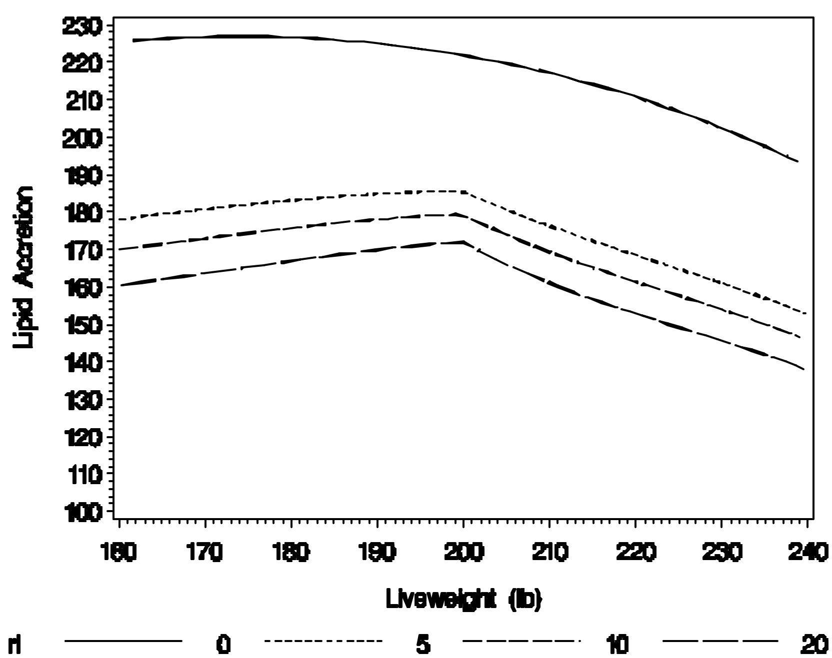

Figure 4. Predicted lipid accretion (g/d) of gilts reared in a continuous flow environment

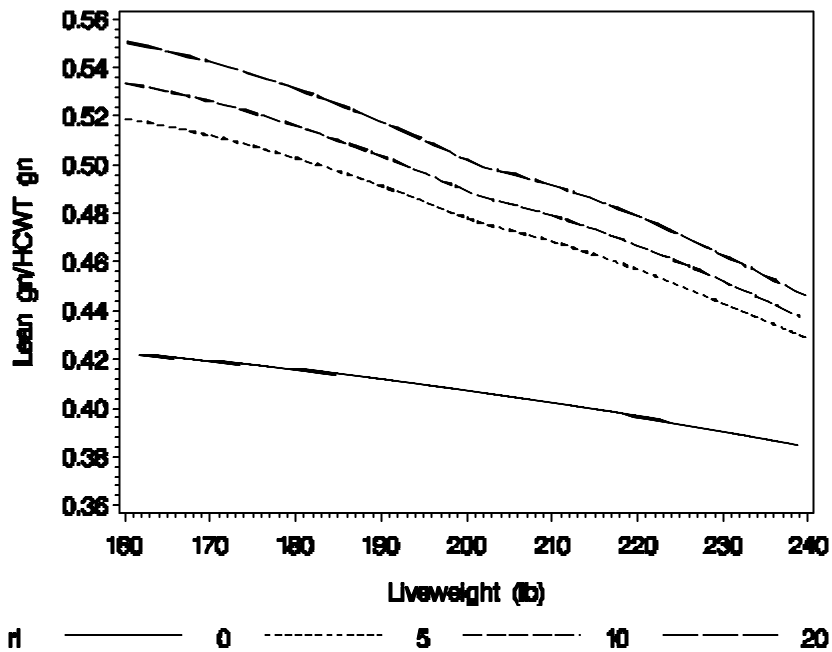

Figure 5. The predicted marginal growth of fat-free lean relative to hot carcass weight gain

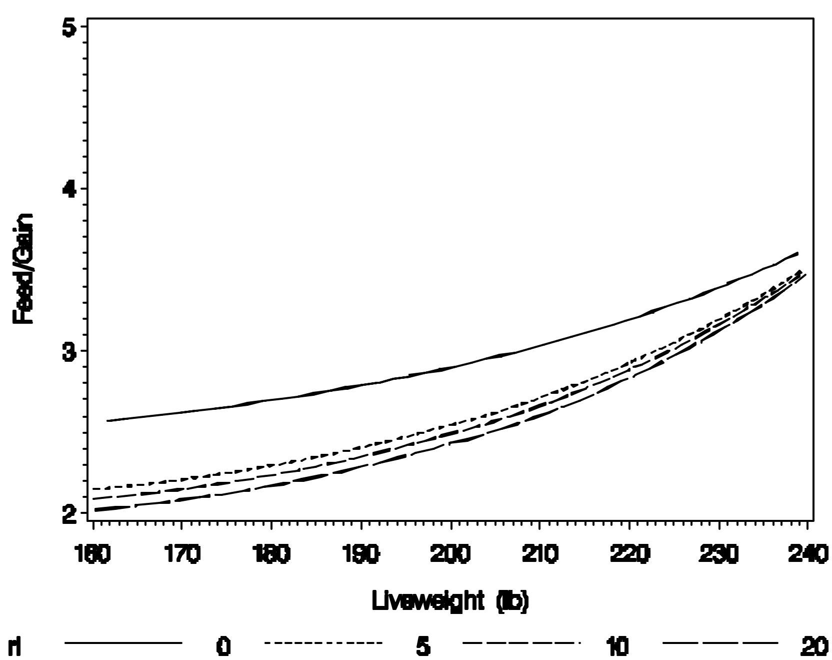

Figure 6. Predicted feed : gain ratio for gilts fed four alternative levels of Paylean (assume no feed wastage, thermal neutral environment and optimal essential amino-acid levels)

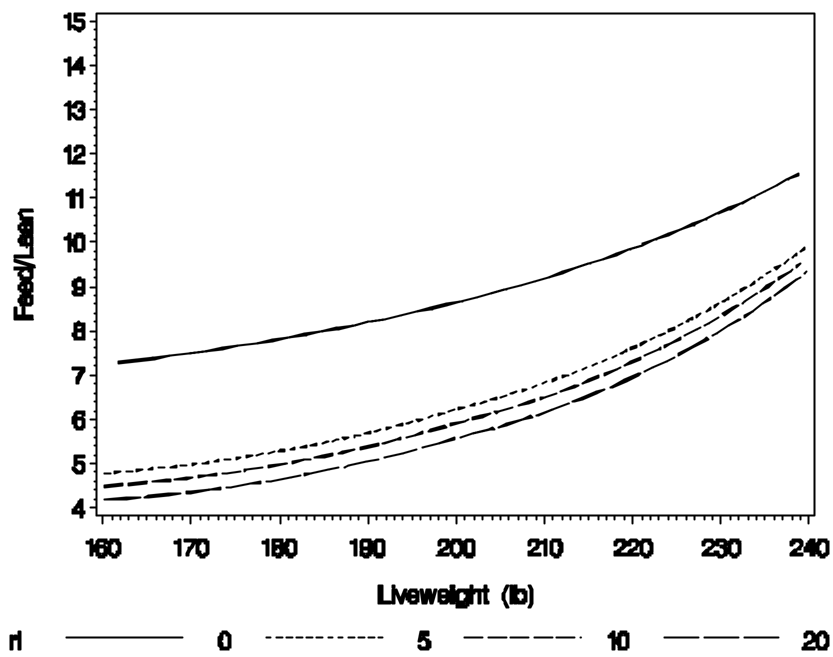

Figure 7. Lean feed conversion ratio (lb feed:lb fat-free lean gain) of predicted daily fat-free lean gain to daily feed intake for gilts fed four alternative levels of Paylean