Initial Evaluation of a Model to Optimized Digestible Lysine Levels When Ractopamine is Fed

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Ractopamine is a new feed additive which results in increased lean growth and improved feed system efficiency. Pigs fed ractopamine require higher dietary levels of essential amino acids to achieve optimal performance levels and economic returns. The marketing system's premium for carcass leanness also impacts the optimal dietary lysine as higher dietary levels are required to maximize carcass leanness versus live weight growth. The optimal digestible lysine levels are those which maximize daily returns above feed costs. The daily gross return is the sum of the daily carcass lean gain and carcass fat gain times their respective value per unit weight. Daily feed costs include the costs of all ingredients, processing costs, and the cost of ractopamine premix.

Material and Methods

To describe the response of protein accretion on digestible lysine intake, a three phase function was developed (Table 1). The function has a constant marginal efficiency of digestible lysine of .70 until approximately 84% maximum protein accretion is achieved. From 84 to 100% maximum protein accretion, the marginal efficiency decreases from .70 to zero. The optimal digestible lysine intake is at the point in which daily net returns are maximized. This is also the point in which marginal daily dietary cost equals marginal daily return.

The optimal digestible lysine intakes were determined for 200 lb. gilts fed four different levels of ractopamine (0, 5, 10, or 20 ppm) starting at 154 lbs. live weight. The maximal protein accretion rates were 137.1, 161.8, 170.3, and 181.8 g/day at 0, 5, 10, and 20 ppm dietary lysine. Feed intake was 5.53 lb per day and 8.29 Mcal ME per day for the control pigs.

Feed costs included the cost of corn ($2.00/bushel), 48% soybean meal ($200/ton) and ractopamine premix ($2.50/lb, 1 lb/ton equals 1 ppm). A $23.04 cost per ton included all other ingredient costs (limestone, dicalcium phosphate, salt, vitamin, trace mineral, synthetic lysine) and feed processing costs.

Three marketing systems were evaluated with lean:fat price ratios of 1:1, 2:1, and 4:1 based on a live weight price of $0.45 per pound with a base carcass composition of 50% fat-free lean and 32% total carcass fat tissue. The 1:1 price ratio, $0.7316 per pound for both lean and fat represents payment for carcass weight with no premium for lean percentage. The 2:1 lean to fat price ratio, $0.908 and $0.454 per pound, represents pork processors which utilize carcass fat and loin depth measurements to predict carcass lean percentage. Analysis of prediction equation biases, indicate that such prediction equations only partially account for differences in carcass composition caused by the effects of dietary lysine, dietary ractopamine and genetic populations. The 4:1 lean to fat price ratio, $1.034 and $0.258 per pound, is representative of a vertically integrated or coordinated production system which fully captures the true increased carcass value produced by genetic and dietary changes.

Growth performance, carcass compositional growth, and economic returns were predicted for the optimal dietary lysine level at each ractopamine level and lean:fat price ratio.

Results and Discussion

The model predicted growth, feed conversion, and digestible lysine requirements. The gilts were modeled as being fed ractopamine for 46 lbs. of live weight gain. At this point, the ractopamine response has decreased from the maximal response observed for the first 14 days or approximately 25-30 lbs live weight gain on ractopamine.

Dietary ractopamine increased daily gross revenue and feed costs. Net profits increased with dietary ractopamine as the relative lean:fat values increased. At this point of feeding ractopamine (46 lbs or approximately 21-23 days), only the 5 ppm ractopamine level is cost effective based on net profit at the 1:1 lean to fat value ratio. At the 2:1 lean to fat value ratios, both the 5 and 10 ppm levels are cost effective. At the 4:1 lean to fat price ratio, all three levels of ractopamine are cost effective.

The optimal percent digestible lysine ranged from .512 for control pigs marketed on a 1:1 lean to fat price ratio to .971 for the gilts fed 20 ppm ractopamine with a 4:1 lean:fat price ratio. The optimal portion of maximal protein accretion achieved (PAP) was primarily affected by the lean:fat ratio values; not the ractopamine level fed. The optimal (PAP) ranged from .867 to .887 for the 1:1 lean to fat value system to .981 to .984 for the 4:1 lean:fat value system. Accurate payment for lean value increases the optimal lysine level which increases average daily gain, feed conversion, and daily protein accretion.

Implications

The optimal lysine levels are substantially affected by the relative value of lean gain to fat gain and the dietary ractopamine level. Additional modeling is needed to optimize the dietary ractopamine and lysine levels for specific economic situations.

Table 1. Equations relating protein accretion to digestible protein intake

If $DP < 1.2$ then $PAP = -.007520 + .7\ (DP)$

If $DP \geq 1.2$ and < 1.6 then $PAP = 1.002611456 - (2.232428 \times DP) + [2.786097 \times (DP)^2] - .869906 \times (DP)^3]$.

If $DP \geq 1.6$ then $PAP = 1.0$

Where PAP = actual protein accretion (PA) divided by the maximum achievable protein accretion, the proportion of maximum protein accretion achieved

DP = digestible lysine intake/lysine accretion at maximal protein accretion; efficiency of utilization is (PA/DP)

Table 2. Modeled optimal digestible lysine level, growth performance and economic returns

	Ractopamine Level, ppm											
	0			5			10			20		
Lean:Fat	**1:1**	**2:1**	**4:1**	**1:1**	**2:1**	**4:1**	**1:1**	**2:1**	**4:1**	**1:1**	**2:1**	**4:1**
Protein Accretion g/day	118.9	132.1	134.6	142.4	156.2	158.8	150.7	164.9	167.6	161.2	176.0	178.8
PAP[a]	.867	.963	.981	.882	.967	.983	.885	.968	.983	.887	.968	.984
% Digestible Lysine	.512	.636	.669	.643	.784	.821	.695	.844	.883	.766	.928	.971
ADG lb/d	2.01	2.10	2.11	2.14	2.24	2.25	2.18	2.28	2.30	2.23	2.33	2.34
Feed/Gain	2.75	2.63	2.61	2.60	2.50	2.48	2.56	2.46	2.44	2.53	2.42	2.40
$ Gross Revenue	.780	.824	.843	.849	.956	1.02	.871	1.00	1.08	.895	1.06	1.17
$ Daily Feed Cost	.301	.341	.352	.367	.413	.425	.411	.459	.472	.488	.540	.554
$ Net Profit	.479	.482	.491	.482	.543	.593	.459	.544	.612	.407	.525	.617

[a]PAP = Portion of maximal protein accretion achieved