USING A STOCHASTIC MODEL TO EVALUATE SWINE MANAGEMENT WITH PAYLEAN®

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ABSTRACT

A bio-economic stochastic model was developed, which incorporates the economic optimization principles of pig replacement, growth under limited dietary lysine intake, and growth response to Paylean. The net returns from using Paylean increased as payment for carcass lean percentage increased and were estimated to be from $5,624 to $16,368 per year for a 1000-head grow-finish facility. The net returns from using Paylean ranged from $1.77 per pig with no payment for carcass lean percentage to $4.93 per pig with full payment for carcass lean percentage. The optimal Paylean concentration ranged from 5 to 9.5 ppm, which increased as payment for carcass lean percentage increased. The optimal average Paylean feeding duration of all marketed pigs varied slightly across payment schemes, ranging from 24 to 29 days for the four payment schemes. Pigs on tight schedules had relatively higher optimal Paylean concentrations than those with loose schedules. The net returns per dollar spent on Paylean were higher for tight schedules than for loose schedules.

INTRODUCTION

The economically optimal use of ractopamine (RAC, Paylean) had been examined using a growth model for a single pig with population average growth (Li et al., 2002). However, with all-in/all-out management, the turnover of the barn depends on the marketing day of the last batch of pigs, not the pig with the average growth rate. In this research, the management of pig production with Paylean was investigated for a group of pigs using a stochastic growth model, which allowed each individual pig to have a unique body weight growth and carcass composition growth curve (Schinckel et al., 2003a).

A bio-economic model was developed based on the stochastic growth model, which incorporates the economic optimization principles of pig replacement, growth under limited dietary lysine intake, and growth response to Paylean (Schinckel et al., 2003b). This model was used to derive the optimal production and marketing decisions for grow-finish swine production with Paylean.

Model Development and Assumptions

Seven parameters were taken into account when modeling the effects of RAC. The two key parameters are the increase in daily empty body protein accretion and relative response (RR).

A 25% increase in daily empty body protein accretion (PA) over the last 40.8 kg of live weight gain was assumed. The increase in PA was modeled as .25 x $(RC/20)^{0.228}$ where RC is the ractopamine concentration in ppm. The relative RAC response (RR) was modeled to describe the rapid increase and subsequent decline in the RR with either increasing time or weight gain on RAC. The response of RAC to increase average daily gain (ADG), and gain:feed (G:F) all decrease with the duration of feeding (Table 1). The greatest response occurs during the first 14 days and declines slowly thereafter. The RR was predicted from weekly serial real time ultrasound, live weight measurements, and based on the weekly response of RAC to increase gain:feed and average daily gain. An equal weighting of the body weight (BW) gain and days on ractopamine functions was used to describe the effect of ractopamine.

The model assumed all-in, all-out animal management. The objective function of the model was set as maximizing daily return for a 1000-head grow-finish barn. Model parameters were estimated for modern high lean pigs. The return was optimized under 10-year average prices and costs (Table 1). The price of Paylean was assumed to be $2.25 per gram, the market price of 2002.

The optimal management was derived for four payment schemes, including: (1) carcass payment with discounts on underweight and overweight carcasses; (2) carcass merit payment system adopted from Hormel's Carcass Lean Value Program; (3) lean to fat price ratio of 2:1, with discounts on underweight and overweight carcasses; and (4) lean to fat price ratio of 4:1, with discounts on underweight and overweight carcasses. The carcass weight discount grid for payment schemes 1, 3 and 4 were also adopted from Hormel's Carcass Lean Value Program. Payment schemes 1 and 2 reflected the marketing approaches by independent producers. Payment scheme 3 simulated the producers under limited coordination with packers, while payment scheme 4 reflected vertically integrated producers and captured the full benefit of the increase in carcass value.

The model optimized the return for 50-day-old feeder pigs to market. The optimization for dietary lysine and Paylean concentration management focused on the late finishing pigs starting at age 101 days (mean weight of 66 kg for gilts). Pigs were assumed to be fed with 3 diets from 101 days of age to market, with switching days for diet 2 and 3 optimized by the model. For RAC-treated pigs, the second and third diets contained the same concentration of Paylean.

It was assumed that pigs were marketed by semi-truck with a capacity of 170 head. Thus, the 1000 pigs were to be marketed in six truckloads. One or more truckloads can be marketed on the same day. The model specified that pigs must be marketed as long as the number of pigs heavier than the sort weight (also a variable optimized in the model) exceeded one truckload, except that pigs can be marketed in the last batch regardless of the weights.

The variables to be optimized in the model were: dietary lysine concentrations for three diets, the optimal starting days for diets 2 and 3, the optimal marketing days for each truckload, and an optimal sort weight. The RAC starting time was the same as diet 2.

Table 1. The effect of four ractopamine use programs on weekly ADG, ADFI, and feed efficiency in late finishing pigs.

	Control[d]	Constant[d]	4,2 Step-up[d]	3,3 Step-up[d]	2,2,2 Step-up[d]	Std. Error	Significance, P <		
							Diet	Sex	Diet x Sex
Number of pigs	54	54	54	54	53				
Initial BW, kg	70.4	70.6	70.5	70.4	70.1	0.621	0.980	0.048	0.960
Week 1									
ADG, g/d	925[b]	1075[ab]	1004[b]	1169[a]	1022[ab]	55.6	0.041	0.147	0.064
ADFI, kg/d	2.70[b]	2.75[ab]	2.65[b]	2.93[a]	2.70[b]	0.069	0.070	0.001	0.067
Gain/Feed, g/kg	371	396	365	434	380	27.1	0.384	0.743	0.347
Week 2									
ADG, g/d	1039	1125	1140	1155	1017	59.5	0.342	0.053	0.836
ADFI, kg/d	2.63[b]	2.77[ab]	2.69[ab]	2.85[a]	2.70[ab]	0.071	0.230	0.001	0.703
Gain/Feed, g/kg	395	404	426	406	379	20.4	0.565	0.841	0.944
Week 3									
ADG, g/d	1012	1047	1035	1020	1108	52.8	0.704	0.338	0.581
ADFI, kg/d	2.86	2.89	2.81	2.85	2.88	0.100	0.981	0.001	0.704
Gain/Feed, g/kg	355	364	372	358	386	15.2	0.570	0.009	0.080
Week 4									
ADG, g/d	885[b]	986[ab]	978[ab]	1016[a]	1014[ab]	46.3	0.255	0.052	0.346
ADFI, kg/d	2.94	2.91	2.83	2.98	2.76	0.106	0.550	0.001	0.911
Gain/Feed, g/kg	314[b]	343[ab]	347[ab]	346[ab]	378[a]	18.9	0.221	0.064	0.464
Week 5									
ADG, g/d	817[c]	925[b]	1050[a]	1019[ab]	961[ab]	38.6	0.001	0.402	0.199
ADFI, kg/d	3.15	2.97	3.11	3.09	3.04	0.104	0.764	0.002	0.056
Gain/Feed, g/kg	266[b]	311[ab]	343[a]	332[a]	323[a]	17.3	0.025	0.008	0.749
Week 6									
ADG, g/d	943[b]	958[b]	1013[ab]	1122[a]	978[ab]	55.0	0.152	0.047	0.722
ADFI, kg/d	2.95	2.88	2.87	3.01	2.97	0.081	0.713	0.001	0.228
Gain/Feed, g/kg	323	336	356	371	331	20.9	0.447	0.896	0.684
Final BW, kg	109.6[c]	113.1[ab]	113.8[ab]	115.8[a]	112.2[bc]	1.004	0.002	0.001	0.565

[a,b,c] Within a row, means without a common superscript letter differ ($P < 0.05$)

[d] Control: no RAC; Constant: 5-ppm RAC wk 0-6; 4,2 Step-up: 5-ppm RAC wk 0-4, 10-ppm RAC wk 5-6; 3,3 Step-up: 5-ppm RAC wk 0-3, 10-ppm RAC wk 4-6; 2,2,2 Step-up: 5-ppm RAC wk 0-2, 7.5-ppm RAC wk 3-4, 10-ppm RAC wk 5-6

Overall Analysis

For pigs fed Paylean, the optimal number of batches was two for payment schemes 2, 3 and 4, and three under payment scheme 1 (Table 2). Therefore, pigs were marketed in fewer numbers of batches when fed Paylean. The marketing ages for the last batch ranged from day 155 to 160, which was 5 to 7 days earlier than control pigs. The sort weights for control and Paylean-treated pigs were very close, indicating the payment grid was important in determining the optimal market weight.

Table 2. Predicted optimal return and management for SEW gilts with ractopamine (RAC; 1000 head/barn).

Payment system	Scheme 1	Scheme 2	Scheme 3	Scheme 4
Return, $/barn-day	245.60	281.89	314.96	346.65
RAC, g/ton	4.5	5.0	5.9	8.6
% lysine in diet 1	0.77	0.83	0.79	0.82
% lysine in diet 2	0.91	0.97	0.95	1.01
% lysine in diet 3	0.79	0.81	0.79	0.83
Diet 2 and Paylean start day	134	129	128	125
Diet 3 start day	146	144	144	141
Marketing age for 1st batch, d	152	152	152	149
Marketing age for 2nd batch, d	158	157	157	155
Marketing age for 3rd batch, d	160	-	-	-
Sort weight, lbs	271	271	271	266
Avg. slaughter age, day	158.3	156.2	156.2	154.0
Avg. days on RAC	24.3	27.2	28.2	29.0
Days on RAC (last batch)	26	28	29	30
Return over control, $/pig [a]	1.77	2.62	3.12	4.93
Under-weight carcasses, head	45	73	75	98
Sort loss from under-weight, $/barn	355.60	676.55	578.08	1164.42
Over-weight carcass, head	118	104	108	55
Sort loss from over-weight, $/barn	717.28	1291.08	833.74	498.77

[a] Return over control is calculated as the daily return of RAC-treated pigs minus that for control pigs under the same payment scheme, then the difference is multiplied by the number of days on feed for RAC pigs from a feeder pig of 50 days of age.

The net return from using Paylean was estimated to be from $5,624 to $16,368/year/barn (1000-head grow-finish facility). The net returns from using Paylean were $1.77 to $4.93 higher per pig than control pigs. The net returns from using Paylean increased from payment scheme 1 to 4, with high lean to fat price ratios resulting in higher net returns. Sort loss from pigs with Paylean-treatment was higher than that for control pigs under each payment scheme. The numbers of pigs receiving discounts due to under- or over-weight carcasses were also higher for Paylean treatment. This indicated that with Paylean adoption and its higher returns, it was economically optimal to sacrifice some sort loss in order to market the pigs at a younger age and have a faster barn turn-over.

The optimal Paylean concentration ranged from 5 to 9.5 ppm, which increased from payment scheme 1 to 4. Increased payment for carcass lean encouraged both increased Paylean and lysine concentrations. The optimal lysine concentration decreased as the Paylean response decreased. The optimal average Paylean feeding duration of all marketed pigs varied slightly across payment schemes, ranging from 24 to 29 days for the four payment schemes.

INVESTIGATING THE IMPACT OF OPTIMAL PAYLEAN START TIME

Currently, producers seem to have different management strategies regarding the Paylean onset weight or age. To evaluate the impact of Paylean onset ages on production returns, a stochastic model was employed to investigate the optimal return and management under alternative Paylean onset ages. In addition, swine producers face the problem of estimating the average weight of a group of pigs in order to start feeding Paylean at the right time point.

The model was used to optimize the return and management for alternative Paylean onset ages under payment scheme 3. Payment scheme 3 simulates an approximate linear relationship between return and lean mass. The model restricted Paylean to be fed either earlier or later than the optimal onset age, as well as fixed the Paylean concentration at 5.9 g/ton (6.5 ppm), while leaving the dietary lysine concentrations in each diet, time to switch to diet 3, and marketing management to be optimized.

The optimal return and management under alternative Paylean onset ages are reported in Table 3, where the first row lists the days earlier or later than the optimal onset age, with positive for shifted later and negative for shifted earlier. The optimal Paylean onset age was day 128, which corresponds to the zero value in Table 3. When Paylean feeding is delayed 28 days Paylean is not fed to the first batch of heaviest pigs.

The further away from the optimal Paylean onset age, the less return was obtained. It was found that when the Paylean starting day was shifted further from the optimal, the potential loss would increase at an accelerating rate (Figure 1). The loss of delaying Paylean onset by one week was $623/barn/year, and $2,672 if by two weeks. The curve of annual losses versus the numbers of days off the optimal Paylean starting age (Figure 1) resembles a quadratic function, but was non-symmetric with respect to zero value. The magnitude of the loss suggested that the acceptable window for Paylean onset to achieve approximately 94% of the maximum return to Paylean was around 14 days, 7 days ahead of optimal and 7 days behind.

Table 3. Optimal Paylean and marketing management for SEW gilts when Paylean is started at alternative ages (SEW gilts marketed under payment scheme 3 and fed 5.9 g/ton (6.5 ppm) of Paylean, 1,000 head/barn).

RAC onset day shifted [a]	-21	-14	-10	-7	-3	0	3	7	14	21	24	28
Return, $/barn/day	291.17	311.15	312.91	313.72	314.51	314.96	314.77	313.25	307.21	299.81	296.37	291.39
% of optimal return	92.4%	98.8%	99.3%	99.6%	99.9%	100.0%	99.9%	99.5%	97.5%	95.2%	94.1%	92.5%
Potential loss, $/year	8681.2	1389.3	748.1	452.4	160.8	0.0	68.1	623.2	2672.0	5527.4	6782.8	8601.6
Return over control, loss, $/year	1502	8794	9435	9731	10022	10183	10115	9560	7355	4656	3400	1581
Days on RAC (17% of pigs)	41[d]	33	29	26	26	24	21	17	10	5	4	0
Days on RAC (17% of pigs)	41[d]	39	35	32	30	29	26	22	15	10	9	3
Days on RAC (66% of pigs)	41[d]	41	37	36	30	29	26	25	18	14	13	8.5[c]
Average days on RAC	41.0	39.3	35.3	33.6	29.3	28.2	25.2	23.1	16.1	11.8	10.8	7.6
Average slaughter wt., lbs	246.9	257.1	257.3	259.6	259.5	262.7	262.6	266.2	264.7	268.1	271.6	268.1
Barn closeout time, pig age in days	148	157	155	157	155	157	157	160	160	163	165	165
RAC intake (gram/group)	665.66	650.20	590.31	565.88	501.28	484.72	436.86	413.64	288.49	215.82	208.70	128.71
Return Ratio of RAC ($/$)[e]	0.28	1.81	2.14	2.35	2.68	2.87	3.16	3.24	3.57	3.10	2.38	1.80
% under-wt carcass, head	28.5%	10.4%	10.4%	7.5%	10.0%	7.50%	7.50%	4.30%	5.30%	3.80%	3.00%	3.30%
% over-wt carcass, head	0.3%	2.2%	2.5%	3.0%	7.5%	10.80%	10.30%	10.20%	6.40%	10.30%	18.20%	6.30%

[a] Negative days denote Paylean onset day shifted earlier relative to optimal and positive for shifted later.

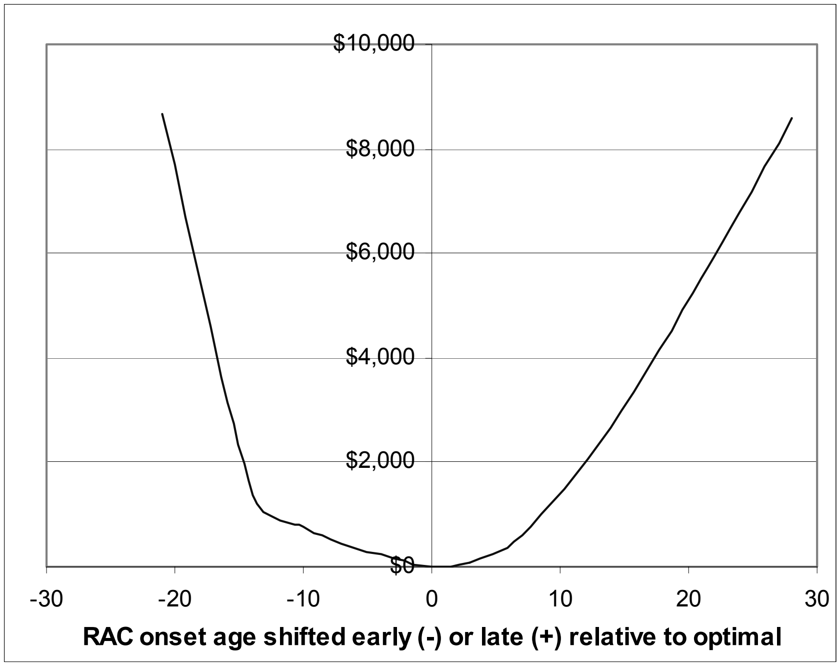
[b] Return over control pigs is calculated as the daily return of RAC-treated pigs minus that for control pigs under the same payment scheme, then the difference is multiplied by 365 days.

[c] Of the 66% of pigs, 17% is fed Paylean for 7 days, and 49% for 9 days, thus the weighed average days on Paylean is 8.5 days.

[d] The same numbers indicate that all of the 1,000 pigs are marketed within one day.

[e] "Return Ratio of RAC" is the ratio of net return of RAC divided by total cost of RAC, where the number is dollars received for one dollar spent on RAC.

Figure 1. **Potential loss when RAC starting days are off the optimal ($/year, 1000 head barn).**



The optimal numbers of batches was between one and four. When Paylean was started too early (such as 21 days ahead), it was optimal to market pigs in one day. On contrary, when Paylean feeding was started too late (28 days delayed), it was optimal to market the pigs in 4 batches, resulting in a longer barn turn-over period. In most cases, pigs were marketed in 2 or 3 batches.

PAYLEAN MANAGEMENT WITH FIXED SCHEDULE ENVIRONMENT

Modern swine producers often face a fixed schedule for barn closeout, either due to a contracted date for delivering market hogs or the arrival of a new group of feeder pigs. With a fixed schedule, producers have to adjust their management strategies in order to shift the growth rate of the animals and raise the hogs to the packer's desired weight range. Because Paylean has proved to be able to enhance swine growth rate, as well as change the lean growth rate, it is a potential tool for producers to handle a fixed schedule environment and increase returns of swine production. The economically optimal return and management strategies for swine production with the application of Paylean were investigated for alternative fixed schedule environments.

Pigs were assumed to be marketed under payment scheme 3. The alternative fixed schedule environments were simulated as restricted marketing dates for the last batch of pigs. Fixed schedules investigated here ranged from day 137 to 177, with a step size of 4 days and day 157 being the optimal marketing age of the last batch of pigs without any restrictions. Two types of Paylean management strategies were investigated: 1) fixing the dietary Paylean concentration at 5.9 g/ton (6.5 ppm), which was optimal without restrictions; and 2) optimizing the Paylean concentration under each fixed schedule.

Model predictions of optimal return and management under each fixed schedule are displayed in Tables 4 and 5 for fixed and optimized Paylean concentration management, respectively. In both tables, the first row denotes the days when the last batch has to be marketed, and again day 157 is the obtained optimal age without restrictions. Therefore, for those marketing days less than 157, pigs are raised and marketed on tight schedules; otherwise, pigs are on loose schedules.

When dietary Paylean concentrations were allowed to be optimized, pigs on tight schedules had relatively higher optimal Paylean concentrations than those with loose schedules. As expected, the net returns of the optimal Paylean concentrations were higher than or equal to those with a fixed Paylean concentration of 5.9 g/ton (6.5 ppm). The net returns per dollar spent on Paylean were higher for tight schedules than for loose schedules. The highest return ratio for Paylean was 5.86 and the lowest was 1.83. Thus, even Paylean was cost-effective for producers with the loosest schedules.

When pigs were marketed at their optimal weight or age, the numbers of underweight and overweight pigs were both small, close to 7-8%. However, in tight or loose schedules, either the underweight or the overweight pigs were higher than the optimal level. This indicated that the optimal marketing age was obtained by balancing the number of underweight pigs with overweight pigs. The total amount of sort loss was the least when there was no fixed schedule restriction. This indicated that the packer's discount grid was a critical factor in determining the revenue of production and the optimal marketing ages for each batch.

EFFECTS OF RACTOPAMINE ON PORK QUALITY

Recent and past research trials indicate that RAC has no significant impact on pork quality including color, marbling, firmness scores, and Hunter color values (Crome et al., 1996; Stites et al., 1994; Uttaro et al., 1993; Herr et al., 2000). Recent research also indicates that RAC has no significant impact on drip loss, loin purge loss, or loin chop cooking loss. The majority of trials have found no significant impact on 24h pH. Some research trials have found small increases in Warner-Bratzler shear force (Aalhus et al., 1990; Uttaro et al., 1993). Other researchers reported no consistent differences in either shear force or sensory tenderness scores for ham and loin samples from control and RAC fed pigs (McKeith et al., 1988; Jeremiah et al., 1994a and 1994b; Stites et al., 1994).

APPLICATION

The stochastic model indicated that pigs fed Paylean should be marketed at younger ages (5 to 7 days) than pigs without Paylean, as well as marketed in less batches. For swine production operations adopting Paylean, it is economically optimal to sacrifice some sort loss in order to market the pigs at a younger age, realize a faster barn turnover, and obtain a higher average

Table 4. Optimal Paylean and marketing management for alternative fixed schedules (SEW gilts marketed under payment scheme 3 and fed 5.9 g/ton (6.5 ppm) of Paylean, 1,000 head).

Fixed schedule day (pig age, days)	137	141	145	149	153	157	161	165	169	173	177
Return, $/barn,day	177.52	237.43	278.72	301.51	311.08	315.64	313.11	308.14	300.79	291.91	283.95
Return over control pig ($/head) [b]	12.00	10.13	10.02	6.55	4.86	4.02	3.09	2.57	2.21	1.79	1.65
Marketing batches	1	1	1	1	2	2	3	4	5	5	6
Days on RAC (first batch)	28	28	28	28	26	23	20	18	16	11	11
Days on RAC (last batch)	28	28	28	28	28	29	29	31	30	25	25
Average days on RAC [c]	28.0	28.0	28.0	28.0	27.7	28.0	26.8	26.9	26.7	22.3	23.1
RAC intake (gram/group)	910.04	924.62	938.06	950.04	473.70	484.72	463.98	466.50	460.76	389.19	400.87
Return Ratio of RAC ($/$) [d]	5.86	4.87	4.75	3.06	4.56	3.68	2.96	2.45	2.14	2.04	1.83
Avg. slaughter wt., lbs	234.5	234.6	242.1	249.8	256.7	262.7	267.3	270.9	271.6	274.9	275.9
% underweight carcass	76.0%	58.6%	40.2%	23.8%	13.5%	7.5%	3.8%	1.8%	1.1%	0.6%	0.2%
% overweight carcass	0.1%	0.4%	1.2%	4.3%	6.7%	10.8%	12.3%	14.0%	10.1%	15.9%	16.9%
Sort loss due to under-weight carcasses ($/1,000 head)	13,285	8,321	4,664	2,455	1,267	808	259	141	83	35	20
Sort loss due to over-weight carcasses ($/1,000 head)	24	51	116	319	574	485	883	900	644	880	931

[a] Fixed schedule day is the marketing day for the last batch.
[b] Return over control pigs is calculated as the daily return of RAC-treated pigs minus that for control pigs under the same payment scheme, then the difference is multiplied by the number of days on feed for RAC pigs from a 50 day old feeder pig, allowing 5 days with the barn empty in-between each group.
[c] Average days on RAC is computed as the weighed average of days for each batch of pigs fed on RAC.
[d] The ratio is the net return of RAC divided by total cost of RAC, which denotes the amount of dollars received for one dollar spent on RAC.

Table 5. Optimal Paylean and marketing management for alternative fixed schedules (SEW gilts marketed under payment scheme 3).

Fixed schedule day [a] (pig age in day)	137	141	145	149	153	157	161	165	169	173	177
RAC, g/ton	12.7	11.8	10.4	8.6	7.7	5.9	5.9	5.9	5.0	4.5	4.5
Return $/barn, day	182.96	241.77	281.06	302.29	311.97	315.64	313.11	308.14	301.20	292.32	284.40
Return over control pig ($/head) [b]	12.50	10.55	10.25	6.63	4.96	4.02	3.09	2.57	2.27	1.84	1.71
Marketing batches	1	1	1	1	2	2	3	4	5	5	6
Days on RAC (first batch)	26	27	27	28	26	23	20	18	16	12	12
(last batch)	26	27	27	28	29	29	29	31	30	32	36
Average days on RAC [c]	26.0	27.0	27.0	28.0	28.5	28.0	26.8	26.9	26.7	23.3	24.1
RAC intake(gram/group)	1,810.9	1,768.9	1,590.7	1,380.1	633.4	484.7	464.0	466.5	390.7	313.1	322.2
Return Ratio of RAC ($/$)[d]	3.07	2.65	2.87	2.13	3.48	3.68	2.96	2.45	2.58	2.61	2.35
% underweight carcass	74.3%	55.7%	38.5%	23.2%	13.3%	7.5%	3.8%	1.8%	1.1%	0.7%	0.3%
% overweight carcass	0.1%	0.5%	1.4%	4.4%	6.1%	10.8%	12.3%	14.0%	10.0%	14.7%	16.1%
Sort loss due to under-weight carcasses ($/1,000 head)	12,688	7,829	4,387	2,370	1,210	808	259	141	83	39	24
Sort loss due to over-weight carcasses ($/1,000 head)	24	55	124	330	469	485	883	900	602	861	922

[a] Fixed schedule day is the marketing day for the last batch.
[b] Return over control pigs is calculated as the daily return of RAC-treated pigs minus that for control pigs under the same payment scheme, then the difference is multiplied by the number of days on feed for RAC pigs from a 50 day old feeder pig, allowing 5 days with the barn empty between groups.
[c] Average days on RAC is computed as the weighed average of days for each batch of pigs fed on RAC.
[d] The ratio is the net return of RAC divided by total cost of RAC, which denotes the amount of dollars received for one dollar spent on RAC.

daily return for the facility. Producers should consider a week shorter feeding period and faster barn turn-over when Paylean is fed.

Paylean onset time determined the Paylean feeding duration to a large degree. Deviations from the optimal Paylean starting age greater than 7 days would incur losses in production return, and the further away from the optimal starting point, the higher the loss became.

Paylean had higher economic returns under tight marketing schedules than when pigs were marketed under the optimal marketing age or under tight schedules. With extremely tight schedules, the dietary concentration of Paylean should be increased, while with loose schedules, the Paylean concentration should be decreased slightly.

CONCLUSIONS

The feeding of Paylean with increased dietary concentrations of essential amino-acids and minor marketing changes can result in substantial increased net returns. The net returns from the feeding of Paylean increased as the payment for carcass lean percentage increased and as the fixed marketing schedules became relatively tighter. The optimal age of marketing Paylean pigs is 5 to 7 days less than pigs not fed Paylean.

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