Ractopamine, Response, Economics, and Issues

Allan P. Schinckel
Purdue University
Department of Animal Sciences

3/1/2000

Paylean™ - Ractopamine

- Feed additive;
- Feed 150 to 240 lbs. live weight (last 90 lbs. live weight gain);
- Feed at 4.5 to 18 grams/ton (5-20 ppm)

Paylean™ - Ractopamine

- Small compound;
- Partitions energy from fat growth to lean growth;
- Increases protein accretion and muscle growth;
- Increases muscle fiber diameter.

What is Ractopamine?

- β agonist;
- not a hormone;
- not a steroid;
- not “biotechnology.”

What does Ractopamine do?

20 ppm -- 18.5 g/ton for last 90 lbs. live weight gain.

• Increases fat-free lean growth	34.0%
• increases protein accretion	24.0%
• decreases feed intake	5.5%
• increases ADG	8.9%
• improves F/G	14.2%
• reduces backfat thickness	13.7%
• increases carcass lean mass	11.1%
• increases dressing percentage	1.5%

Impact of Ractopamine Level on Pig Growth and Carcass Measurement

	Ractopamine Level g/ton			
	0	4.5	9.0	18.0
ADG, lb/d	1.80	1.98	1.99	2.01
ADFI, lb/d	3.06	3.06	2.97	2.98
Feed/Gain	3.70	3.41	3.36	3.28
Dressing Percent	72.1	72.5	72.7	73.0
10th Rib fat depth, in.	.99	.94	.92	.87
LEA, in^2	5.15	5.55	5.70	5.84
% Dissected lean	52.8	55.5	--	58.2
Dissected Fat	27.1	25.2	--	23.0

Watkins et al., 1988, 6 trials, 888 pigs

Table 3. Effect of Paylean levels on carcass measurements.

Paylean Dosage g/ton	10^{th} Rib Backfat Depth, in	Midline Last Rib Backfat, in	Average Midline Backfat, in	10^{th} Rib Loin Eye Area, in^2
0	1.08	.99	1.21	5.08
4.5	1.06	1.00	1.23	5.51
9.0	.99	.98	1.19	5.68
18.0	.95	.97	1.17	5.80

Ractopamine Impact on Pork Quality

Visual color scores	no impact
Loin L	no impact
Loin A	slightly lower
Loin B	slightly lower
Firmness scores	no impact
Marbling scores	no impact/slight increase
Drip loss	no impact
Cooking loss	no impact
Ham processing yields	3-5% increase
24h Ph	no impact

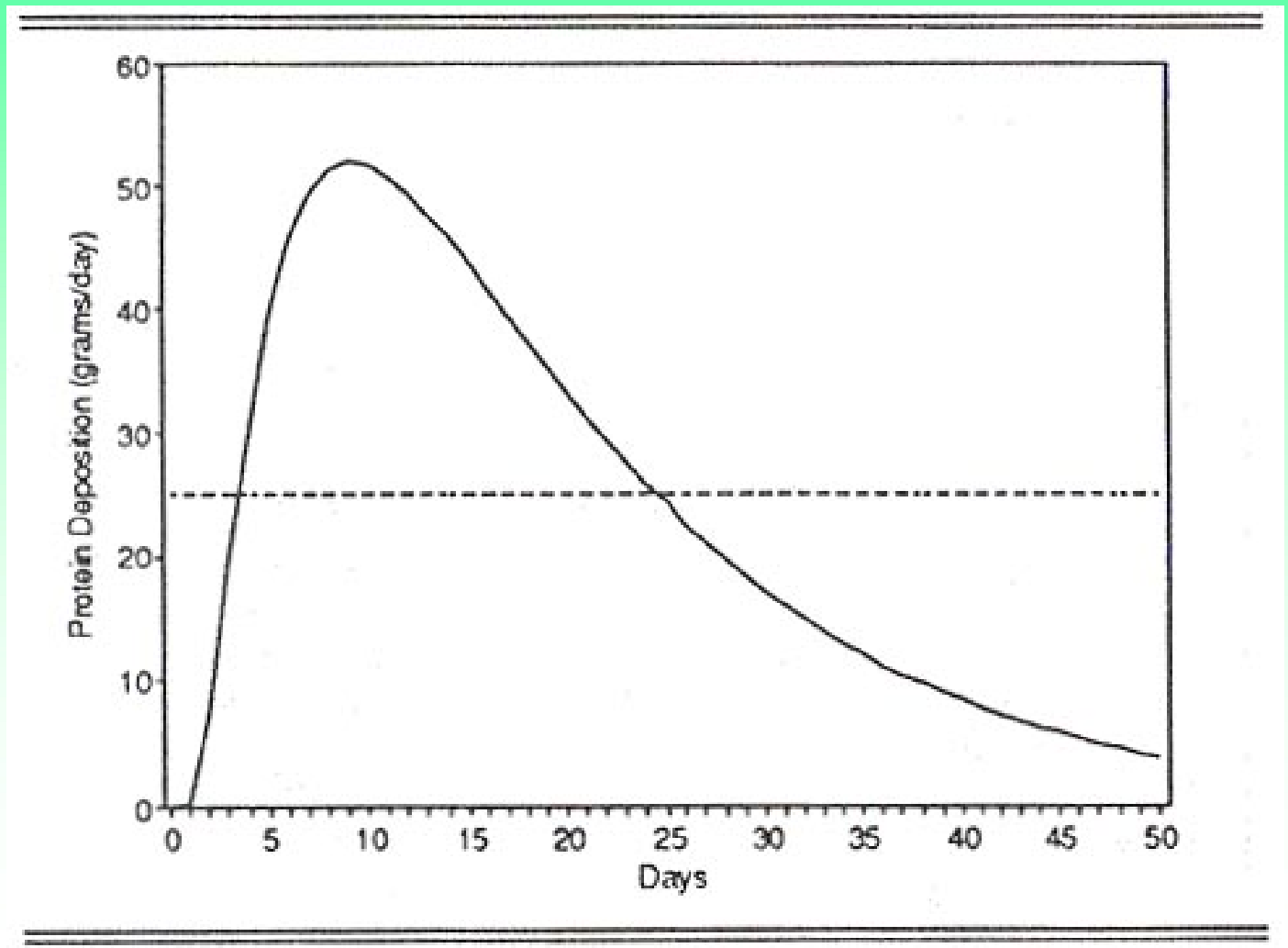
Ractopamine Sensory and Tenderness

Sensory Property	
Juiciness	no impact
Flavor	no impact
Tenderness	no impact
Warner Bratzler sheer	slight increase

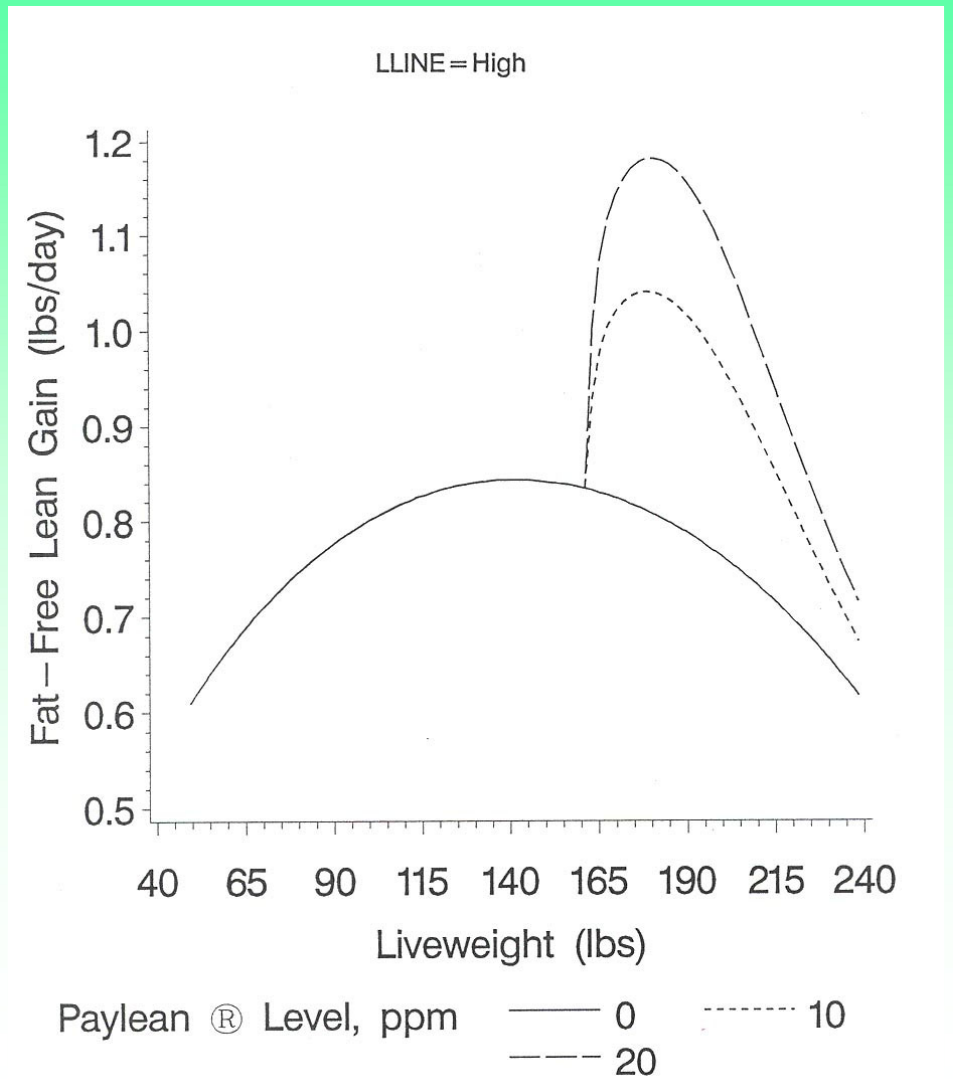
Ractopamine response . . .

- is not constant;
- increases rapidly -- reaches a maximum of 22-26 lbs live weight gain or 19-24 days on Paylean™ feed;
- Then the response decreases to 20% of the average response at 90 lbs on Paylean™ feed.

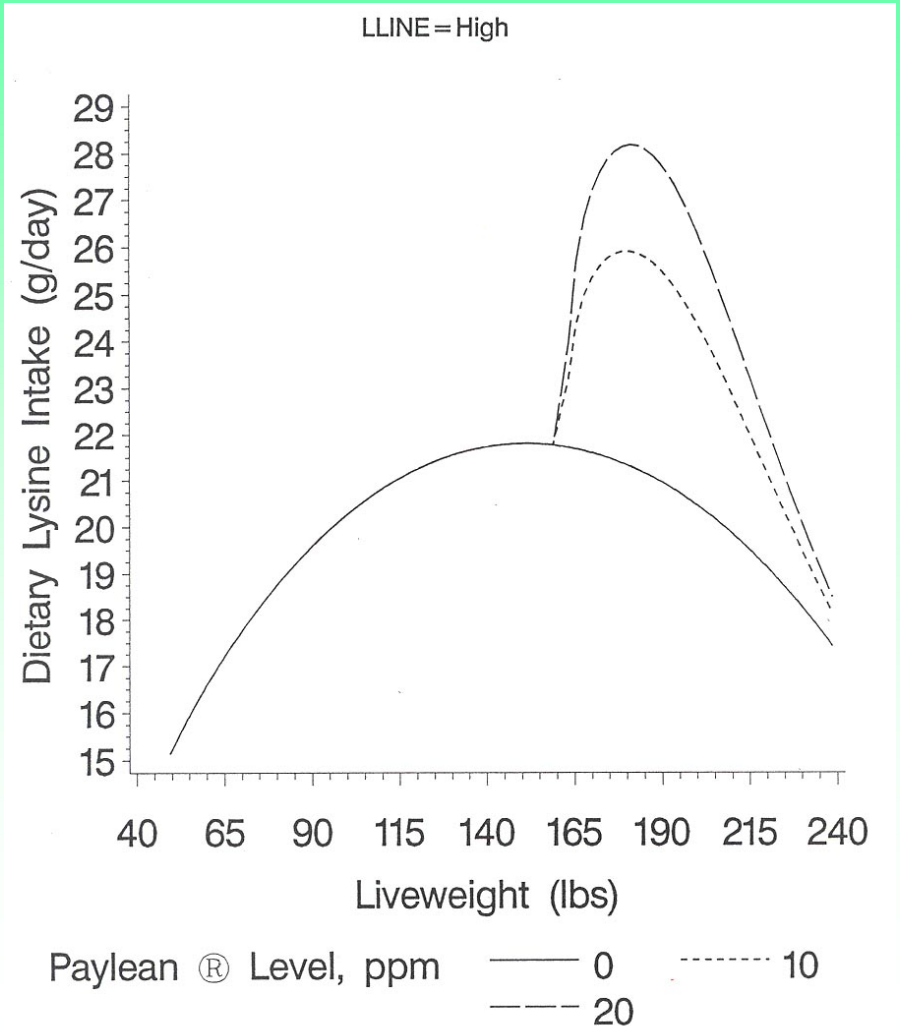
Figure 1. Increase in Maximum Protein Deposition Due to Ractopamine Fed at 20 ppm



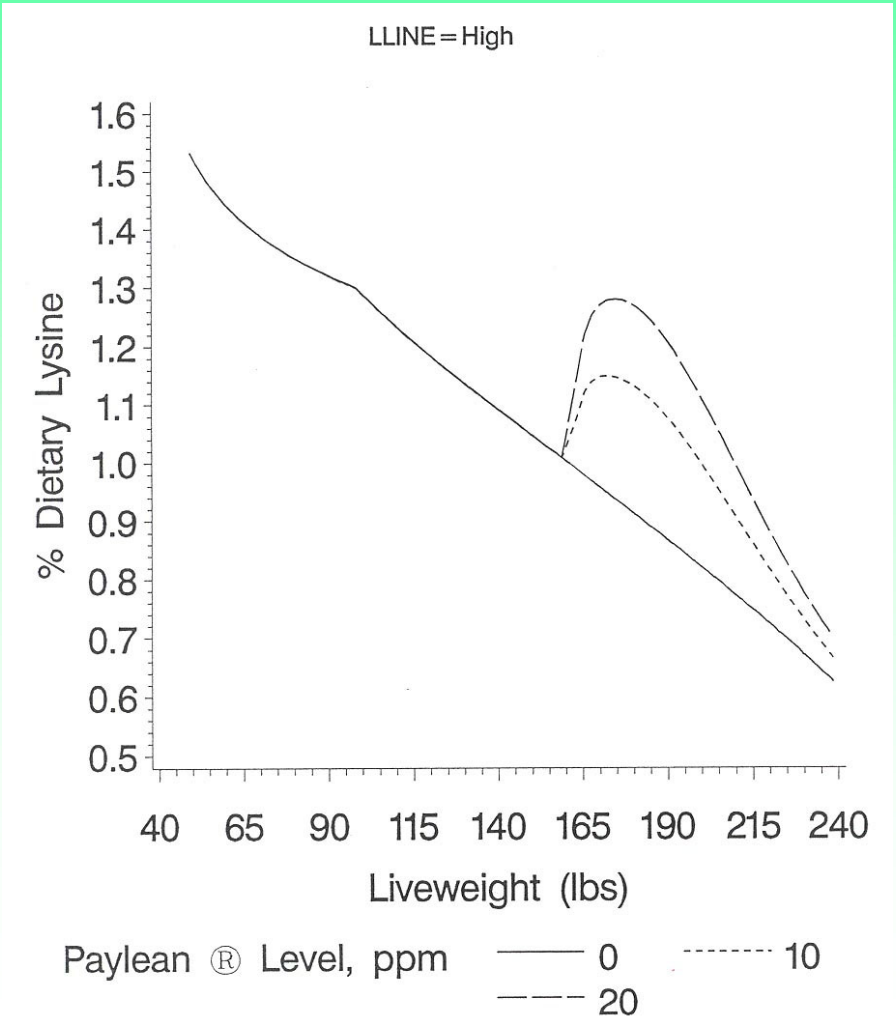
Fat-free lean gain of pigs receiving Paylean®



Dietary lysine requirements for pigs receiving Paylean®



Dietary lysine concentration for pigs receiving Paylean®



Value of 18 g/ton Ractopamine for the last 90 lbs. before market.

Growth 4.1 less days × $.15/day	.62
Feed Cost:	
337 lbs. of .6% lysine $.0503/lb.	16.95
289 lbs. of .78% lysine $.0539/lb.	15.58
48 lbs.	1.37
Dressing percentage 1.1% at 250 lbs. live weight	
2.75 lb at $.60/lb.	1.65
Total	**$3.64**

Ractopamine fed at 18 g/ton for the last 90 lbs. of live weight gain increases % dissected lean from 51.8 to 57.5%;

- 10.45 lbs more dissected lean.

How much will pork processor payment systems pay for an extra 10.45 lbs. of lean?

Depends . . .

- On accuracy of the equation and measurements used in the equation development;
- the accuracy of the measurements in the pork processing plants;
- technologies used to predict lean mass;
- Ractopamine causes a change in muscle distribution and increases lean in the ham, belly and shoulder.

Based on lean cut out-boneless loins and dissected ham lean. . .

- Each lb. of lean has a value of 1.00/lb (Ackridge et al., 1991);
- Based on lean cut out values . . . 18 g/ton (20 ppm) fed the last 90 lbs. will increase carcass value by approximately $10.45 per head.;

Carcass Measurements	% RAC Fat-free Lean Response detected
Midline last rib backfat, CW	15.2
Optical probe, CW	52.4
Tenth rib fat depth, loin eye area, CW	49.5
TOBEC, CW	74.1
Dissected ham lean, CW	95.4
TOBEC, fat depth, CW	82.1
Best TOBEC analysis fat depth, CW	99.0

How much will Paylean™ cost?

Price has not been set, initial indications are $4.50 to 6.00/pig.

1.5 to 2.0¢ per pound of feed

$30 to $40 per ton at 18 g/ton (20 ppm)

Ractopamine

- Optimal use (level and duration of use) is highly dependent on the payment for the additional lean;
- Modeling can predict the optimal use of Paylean™ for each individual producer.

Impact of Ractopamine Treatment Duration on Carcass Measurements.

Paylean™ Treatment[a]	Dressing Percent	Loin Eye Area	10th Rib Backfat, in	Carcass Lipid %
Control	71.8	5.36	.96	29.6
134	73.0	6.21	.82	25.2
104	73.0	6.15	.84	24.7
77	72.6	6.10	.86	25.4

[a]lb. of live weight gain before market to 230 lbs.

Impact of Ractopamine Level on Pig Growth and Carcass Measurement

	Ractopamine Level/ppm			
	0	5.0	10.0	20.0
ADG, lb/d	1.80	1.98	1.99	2.01
ADFI, lb/d	3.06	3.06	2.97	2.98
Feed/Gain	3.70	3.41	3.36	3.28
Dressing Percent	72.1	72.5	72.7	73.0
10th Rib fat depth, in.	.99	.94	.92	.87
LEA, in^2	5.15	5.55	5.70	5.84
% Dissected lean	52.8	55.5	--	58.2
Dissected Fat	27.1	25.2	--	23.0

Watkins et al., 1988, 6 trials, 888 pigs

Figure 1. Effect of Degree of Processing on Paylean Advantage in Lean Cut Yield

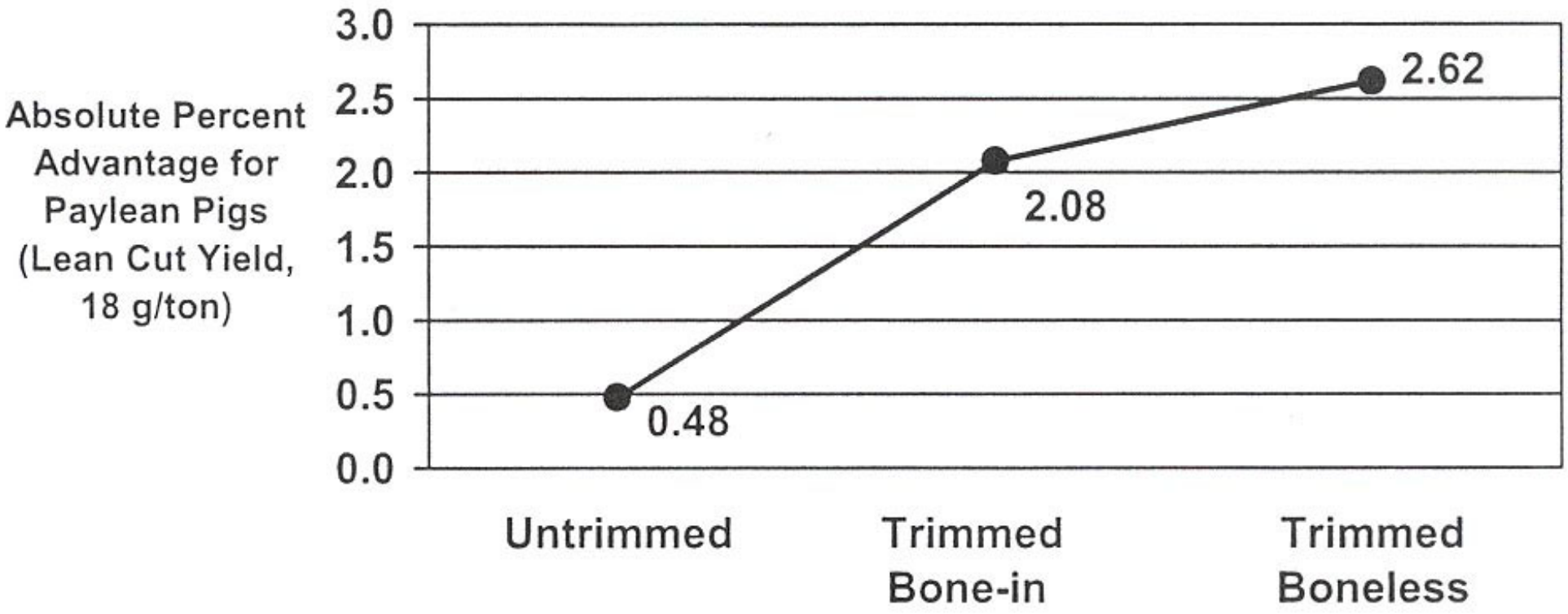


Table 11. Report Summary of Paylean's Effect on Muscle Color

		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Elanco, 1996	Visual color scores (1 to 5 scale)	2.8	2.8	2.8	2.7
Stites et al., 1994	Boneless loin chops (1=pale, 5=dark)	2.85	2.82	2.76	2.75
Uttaro et al., 1993	Fresh loin L* value	46.32	-	-	45.84
	Fresh loin a* value	7.59	-	-	6.48**
	Fresh loin b* value	3.14	-	-	2.42
	Cured ham L* value (semimembranosus)	62.40	-	-	60.92
	Cured ham a* value (semimembranosus)	11.0	-	-	10.72
	Cured ham b* value (semimembranosus)	8.51	-	-	8.96

Note. Least squares means; *P < .05; **P < .01

Table 12. Report Summary of Paylean's Effect on Muscle Firmness

		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Elanco, 1996	Firmness score (1=soft, 5= very firm)	3.0	2.9	3.0	3.0
Stites et al., 1991	Firmness	2.8	2.7	2.9	3.0
Zimmermann et al., 1989	Loin firmness	3.0	-	-	2.8

Note: Significant differences ($P < .05$) were not observed in any of the above studies.

Table 13. Report Summary of Paylean's Effect on Marbling

		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Elanco, 1996	Marbling score (1=traces, 5=abundant)	2.0	2.0	2.1	2.2
Watkins et al., 1990 (Study 1)	Marbling score (1=traces, 5=abundant)	2.1	2.1	2.2	2.3
Watkins et al., 1990 (Study 2)	Marbling score (1=traces, 5=abundant)	1.8	2.1*	2.2*	2.2*
Crome et al., 1996	Marbling score (1=traces, 5=abundant)	2.0	-	2.21	2.1
Stites et al., 1991	Marbling score (1=traces, 5=abundant)	2.9	3.0	3.0	3.0
Stites et al., 1994	Longissimus dorsi fat (%)	2.95	3.23	3.06	3.52

*P < .05

Table 14. Report Summary of Paylean's Effect on Water Holding Capacity

		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Aalhus et al., 1990	Loin chop drip loss over 48 hr, %	37.6	-	38.4	38.7
Dunshea et al., 1993	Loin drip loss over 72 hr (barrows), %	5.83	-	-	5.92
	Loin drip loss over 72 hr (gilts), %	6.59	-	-	7.43
Jeremiah et al., 1994	Bacon (cured) cooking loss, %	61.9	-	-	62.0
	Cured ham cooking loss, %	19.5	-	-	19.3
	Fresh shoulder roasts cooking loss, %	33.9	-	-	31.9
	Fresh loin chops cooking loss, %	20.6	-	-	19.8
Uttaro et al., 1993	Loin drip loss, %	6.45	-	-	4.31
	Loin cooking loss, %	25.73	-	-	24.36*

P < .05

Table 15. Report Summary of Paylean's Effect on Muscle pH

		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Aalhus et al., 1990	Initial pH of longissimus dorsi, 40 min	6.23[a]	-	6.10[b]	6.15[ab]
	Ultimate pH of longissimus dorsi, 24 h	5.49	-	5.52	5.51
Dunshea et al., 1993	Ultimate pH of longissimus dorsi - boar	5.39	-	-	5.40
	Ultimate pH of longissimus dorsi - gilt	5.43	-	-	5.38
	Ultimate pH of longissimus dorsi - barrow	5.41	-	-	5.44
Stites et al., 1994	Ultimate pH of loin chop	5.41	5.44	5.44	5.48

[a,b] Means in the same row with different letters are significantly different
Note: Significant differences ($P < .05$) were not observed in the Dunshea or Stites studies.

Table 16. Report Summary of Paylean's Effect on Cooked Fresh Loin Juiciness.

		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Stites et al., 1994	Juiciness[1,2]	4.82	4.93	5.03	5.13
Elanco 1992-1993	Juiciness[3]	9.45	9.34	9.40	9.23

[1]Control vs. average Paylean effect was not significant (P > 0.05) nor was the linear effect significant (P > 0.05).
[2](1=extremely dry, 8=extremely juicy.
[3]Trained sensory panelists used a 15 cm semi-structured line scale in the evaluation of the parameter (1=least desirable, 15=most desirable)

Table 17. Report Summary of Paylean's Effect on Pork Tenderness.

		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Aalhus et al., 1990	Shear of loin chop (kg)	5.56[a]	-	6.32[b]	6.41[b]
Stites et al., 1994	Fresh loin sensory tenderness[1]	5.72	5.44	5.61	5.69
	Fresh loin Warner-Bratzler shear force, kg	2.94	3.15	3.76	2.78
Uttaro et al., 1993	Warner-Bratzler shear force, kg (cured and cooked ham)	3.88	-	-	3.79
	Warner-Bratzler shear force, kg (fresh loin)	4.23	-	-	4.72*
Elanco 1992-1993	Fresh loin tenderness - Sensory[2]	10.20	9.86	10.13	9.72
	Fresh loin tenderness - Warner-Bratzler shear, kg	2.99	3.25	3.33	3.49

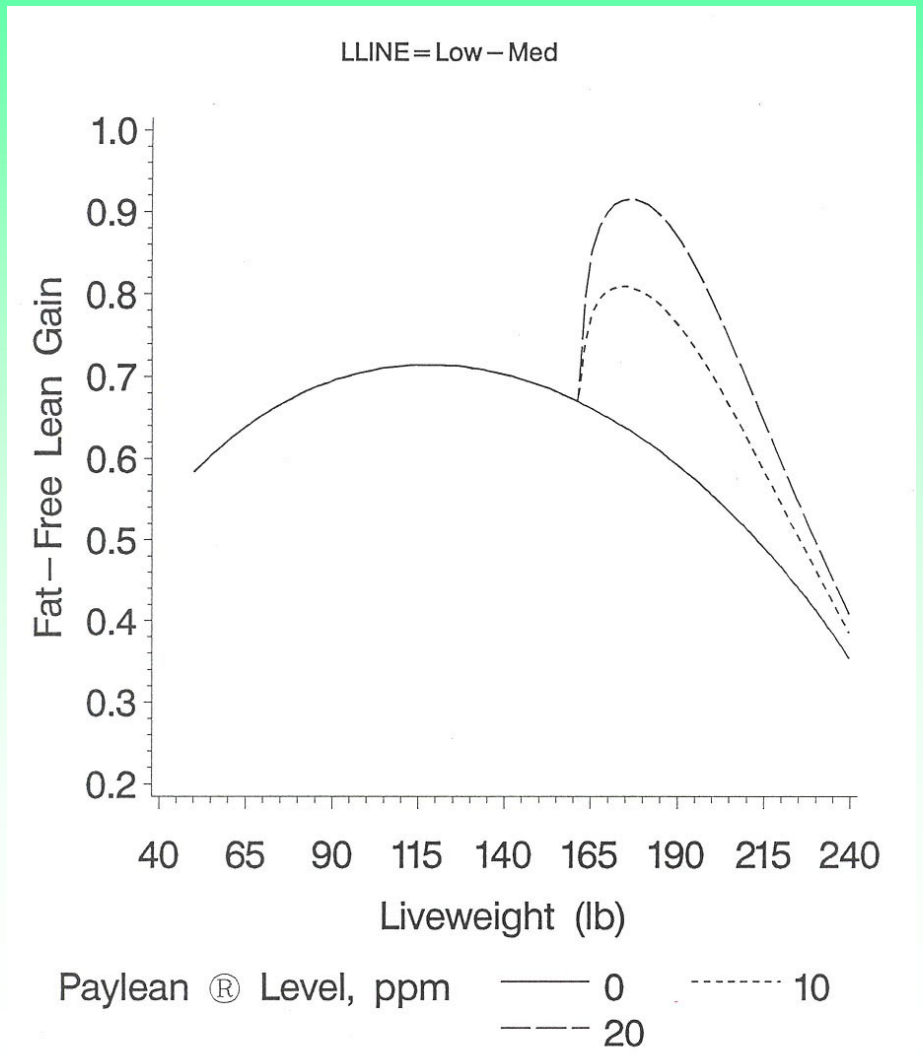
[1](1=extremely tough, 8= extremely tender)
[2]Trained sensory panelists used a 15 cm semi-structured line scale in the evaluation of the parameter (1=least desirable, 15=most desirable)
*P < .05
[a,b] Means in the same row with different letters are significantly different.

Table 18. Report Summary of Paylean's Effect on Pork Flavor

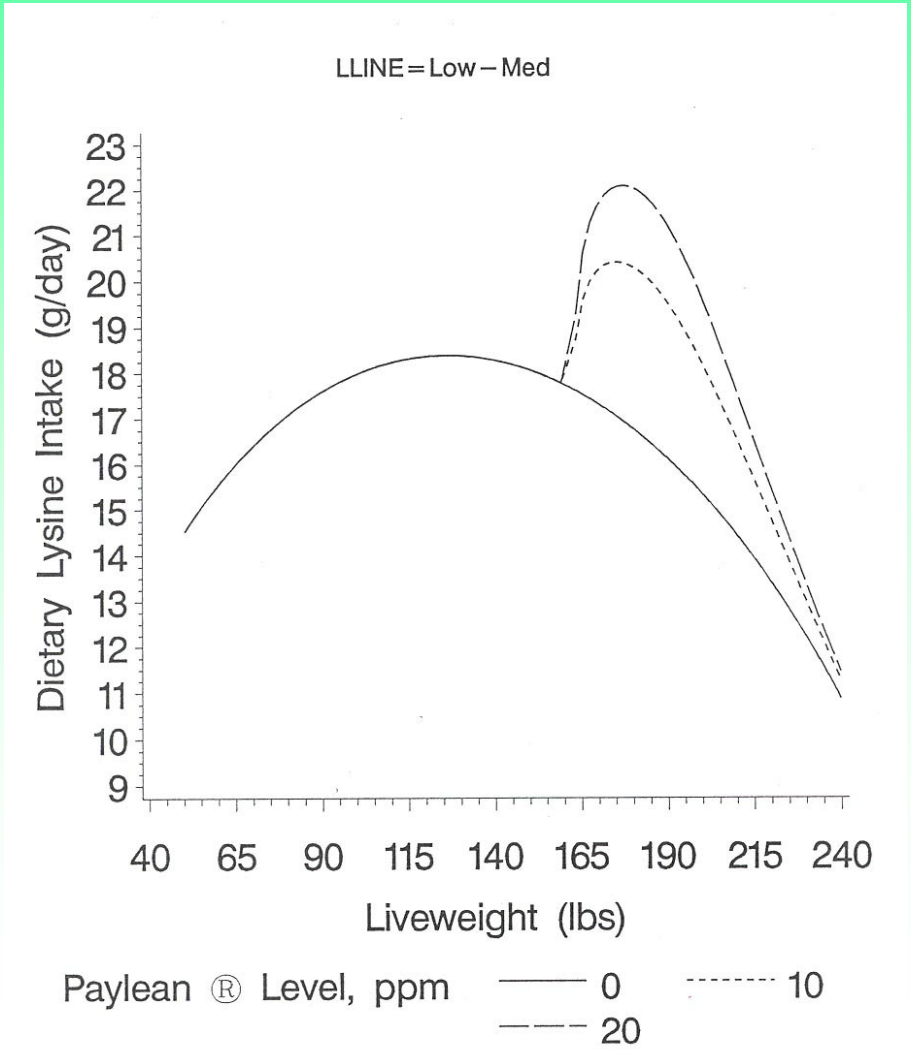
		Paylean g/ton			
Study	**Parameter**	**0**	**4.5**	**9**	**18**
Stites et al., 1994	Flavor intensity[1] - fresh loin	6.42	6.26	6.34	6.18
	Off Flavor intensity[2] - fresh loin	7.30	7.30	7.04	7.16
	Off Flavor intensity[2] - cured ham slices	7.46	6.98	6.86	6.97
Elanco 1992-19933	Flavor - fresh loin	9.96	9.75	9.74	9.93
	Off Flavor - fresh loin	14.97	14.98	14.99	14.99
	Flavor - cured ham	10.14	10.33	10.37	10.33
	Off Flavor - cured ham	14.99	14.97	14.88	15.01

[1]1=extremely bland, 8=extremely intense, Control vs. average Paylean effect was not significant (P > 0.05) nor was the linear effect (P > .05)
[2]1=extremely strong off flavor, 8=extremely weak/no-off flavor. Control vs. average Paylean effect was not significant (P > 0.05) nor was the linear effect (P > .05)
[3]Trained sensory panelists used a 15 cm semi-structured line scale in the evaluation of the parameter (1=least desirable, 15=most desirable)

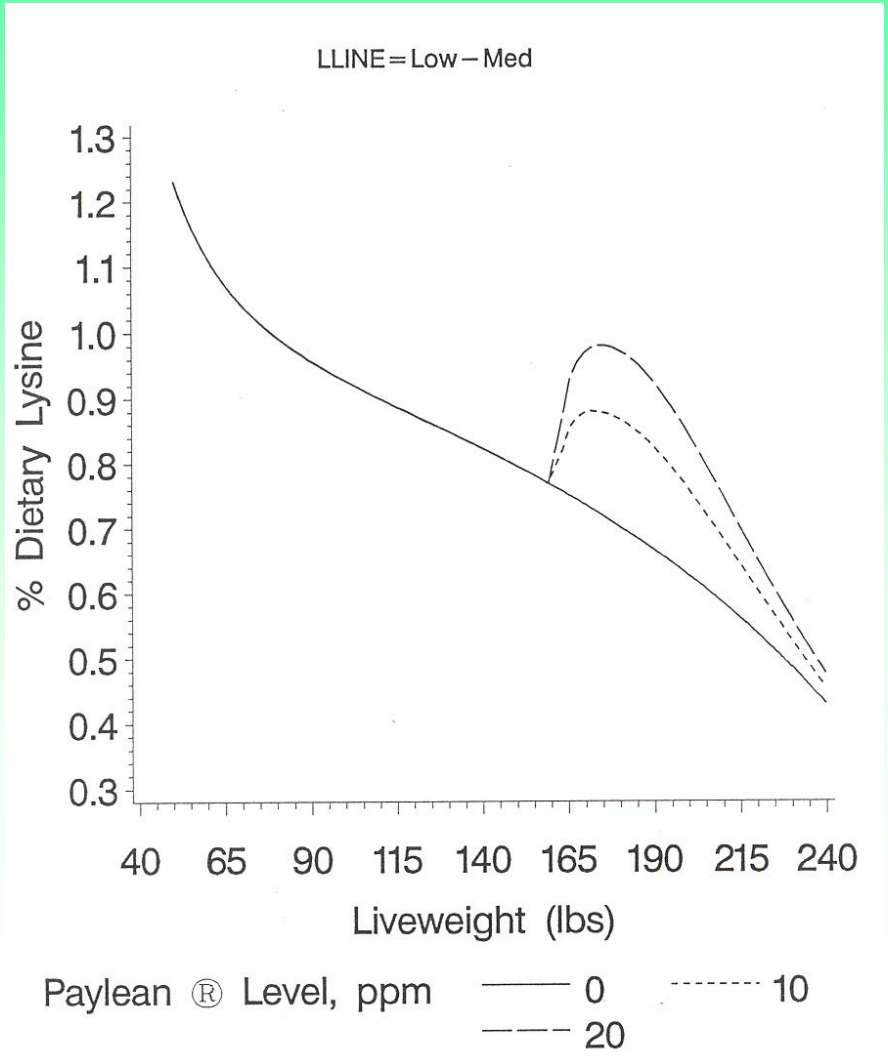
Fat-free lean gain of pigs receiving Paylean®



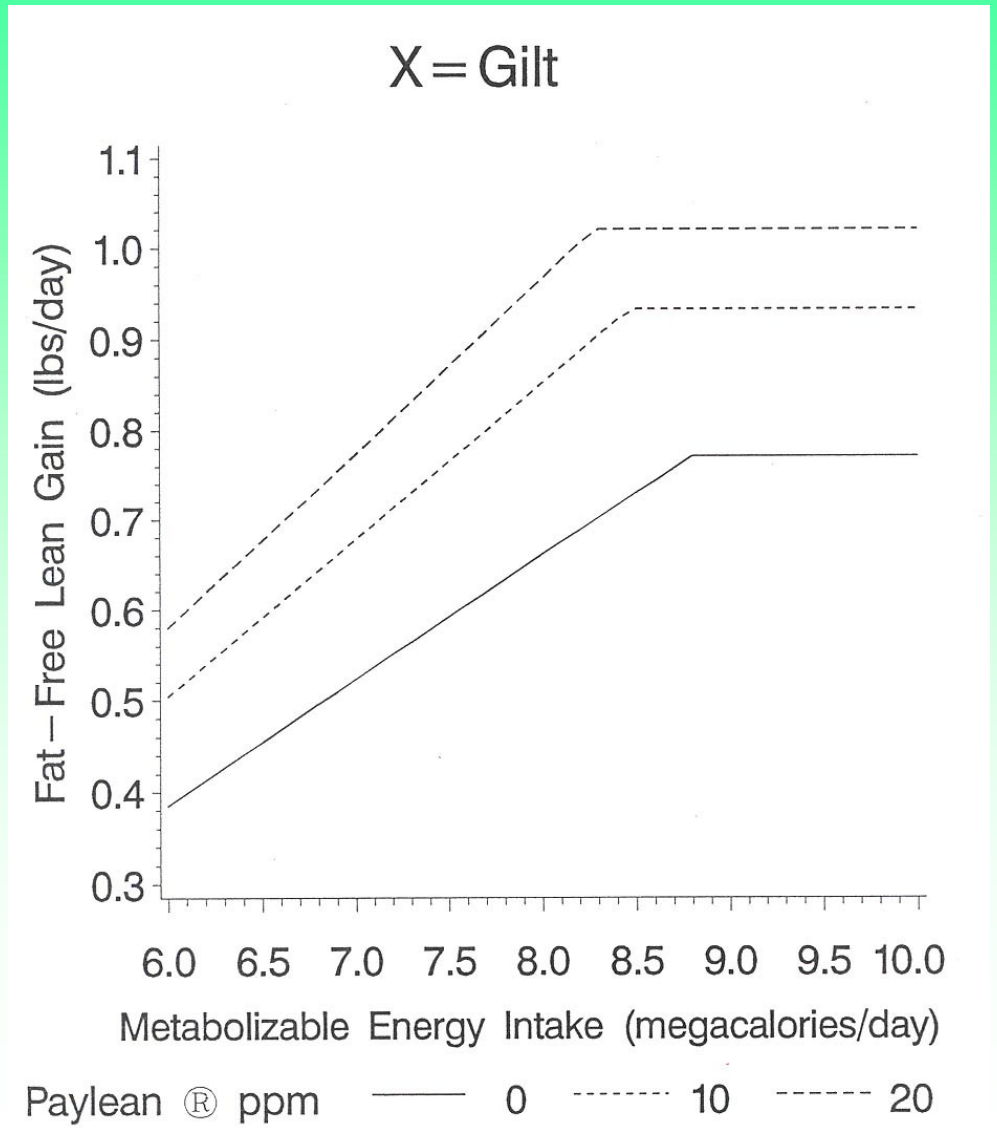
Dietary lysine requirements for pigs receiving Paylean®



Dietary lysine concentration for pigs receiving Paylean®



Energy requirements for pigs receiving Paylean®



Energy requirements for pigs receiving Paylean®

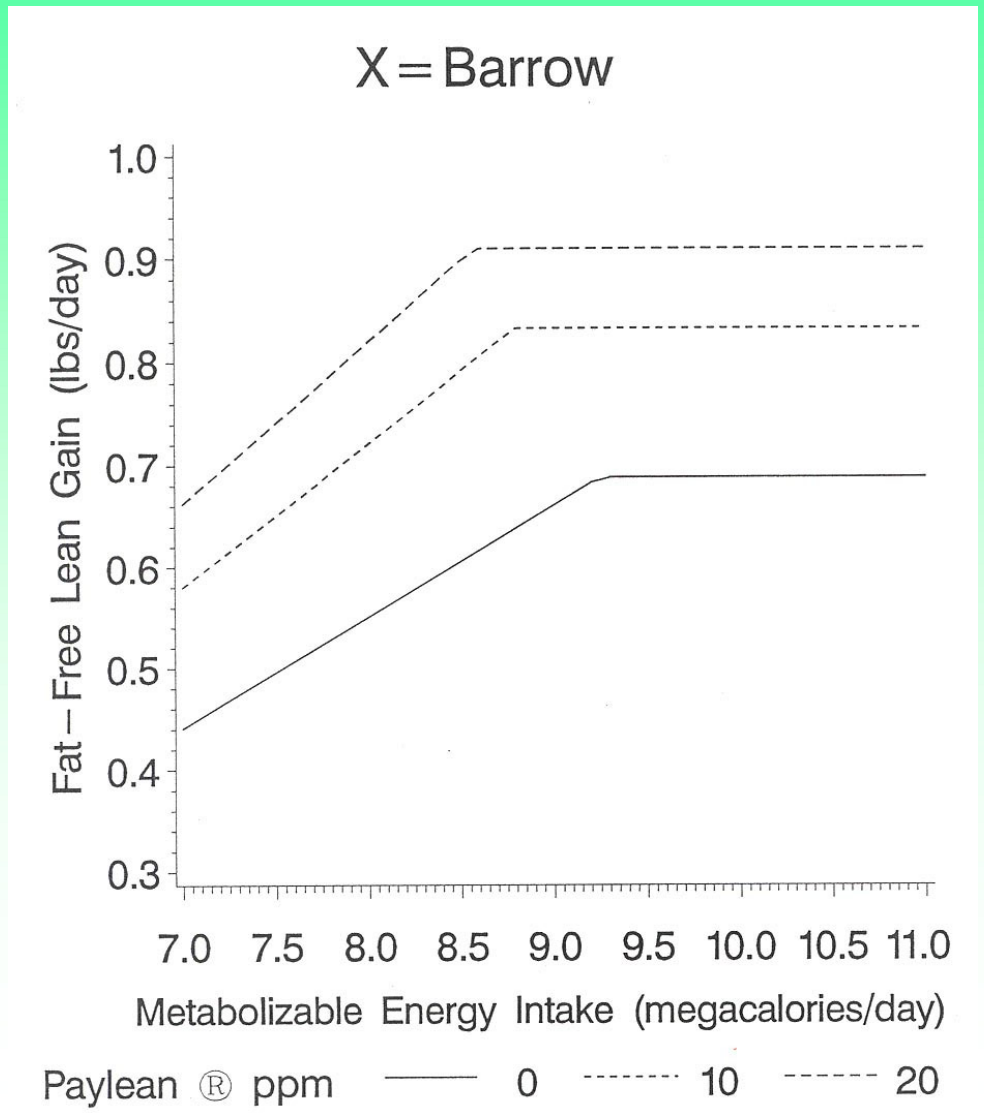


Table 1. Effect of Paylean Dosage on Finisher Pig Growth Performance -- A Twenty Trial Summary

Paylean Dosage, g/ton	Total No. of Pigs	Average Initial Wt, lbs	Least Squares Means			
			Final Wt, lbs	ADG, lbs/hd/day[c/]	ADFI, lbs/hd/day[c/]	Feed Efficiency[c/]
0	479	147.1	229.3	1.84	6.6	3.62
4.5	488	147.0	231.1	1.97**	6.50*	3.33**
				(7.1)	(-1.5)	(-8.0)
9	486	147.1	232.0**	1.99**	6.42**	3.25**
				(8.1)	(-2.7)	(-10.2)
18	469	146.9	231.5*	2.02**	6.34**	3.16**
				(9.8)	(-3.9)	(-12.7)
Std. Error of Mean			**0.7**	**0.11**	**0.04**	**0.02**

*Different from control (P < .05); **Different from control (P < .01).
[c/]Figures in parentheses indicate percent change from control.

3/1/2000

Table 2. Effect of Paylean Dosage on Finisher Pig Carcass Measurements - A Thirteen Trial Summary

Paylean Dosage, g/ton	Total No. of Pigs[b/]	Least Squares Means: Dressing Percent	Least Squares Means: 10th Rib Fat Depth, in.	Least Squares Means: 10th Rib Loin Eye, sq. in.
0	199	73.3	1.08	5.08
4.5	201	73.7*	1.06	5.51**
9	203	74.1**	.99**	5.68**
18	199	74.4**	.95**	5.80**

[b/]Number of pigs at completion of the respective trials; *Different from control (P < .05); **Different from control (P < .01).

3/1/2000

Table 2. Effect of Paylean Dosage on Finisher Pig Carcass Measurements - A Thirteen Trial Summary

Paylean Dosage, g/ton	Total No. of Pigs[b/]	10th Rib Loin Eye		
		Color[d/]	Marbling[d/]	Firmness[d/]
0	199	2.8	2.0	3.0
4.5	201	2.8	2.0	2.9
9	203	2.8	2.1	3.0
18	199	2.7	2.2	3.0

Table 9. Paylean Dose Response for Average Improvement in Swine Growth Performance and Carcass Parameters

	Paylean (g/ton)		
Item	4.5	9.0	18.0
Average Daily Gain[1/]	7.1	8.1	9.8
Feed Efficiency[1/]	8.0	10.2	12.7
Dressing Percentage	0.4	0.8	1.1
Percentage Dissected Lean	2.1	3.8	5.7

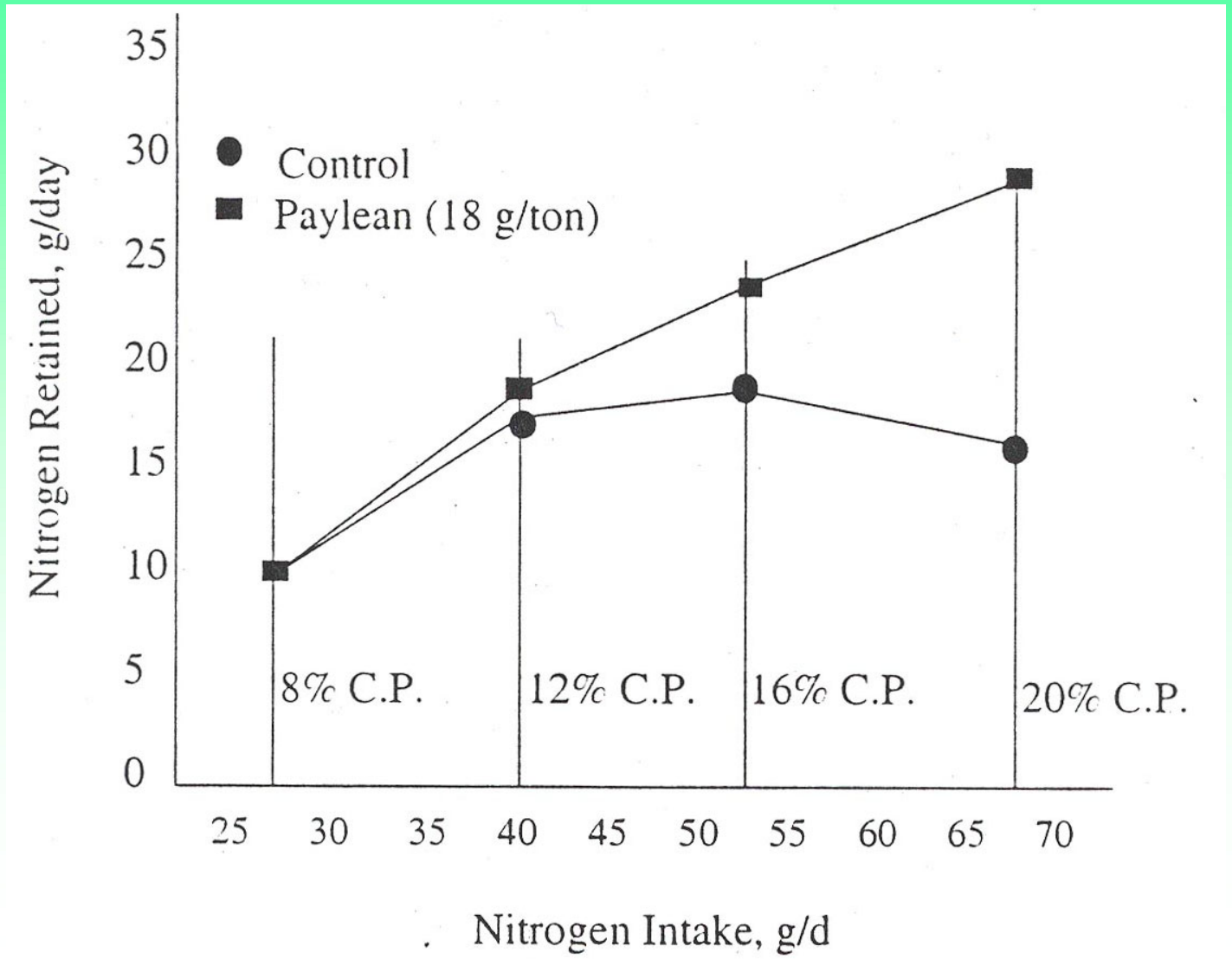
[1/]Numerical values pertain to percent improvement over control.

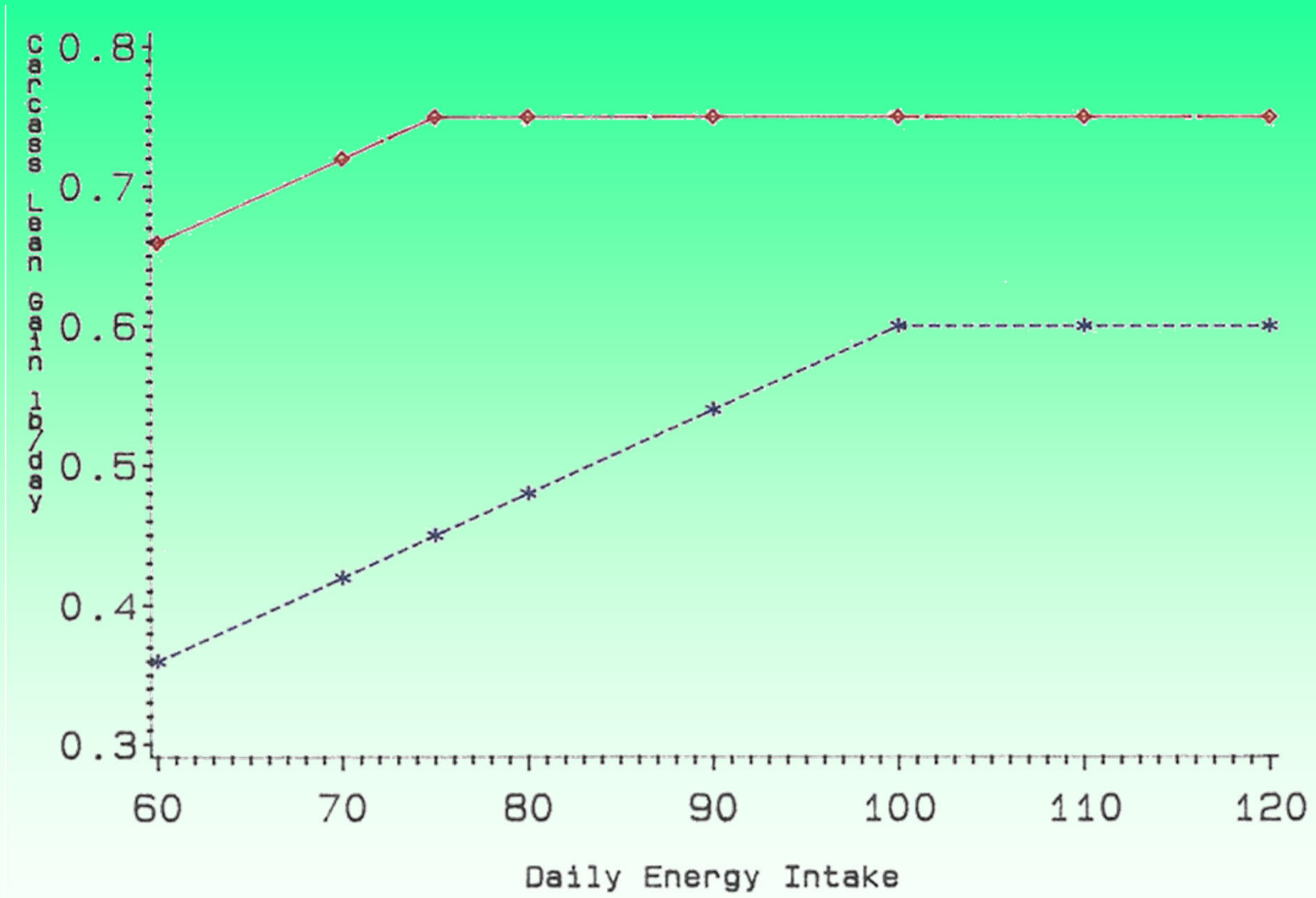
3/1/2000

%CP-Paylean, g/ton

Item	16-0	16-9	16-18	13-0	13-18
ADFI, lb./d	6.30	6.02	6.02	6.17	5.95
ADG, lb./d	1.79	1.82	1.89	1.75	1.72
F/G	3.55	3.34	3.20	3.53	3.49

Figure 5. Effect of Paylean on Nitrogen Retention in Finishing Barrows Fed Rations of Different Protein Levels - AF7678701

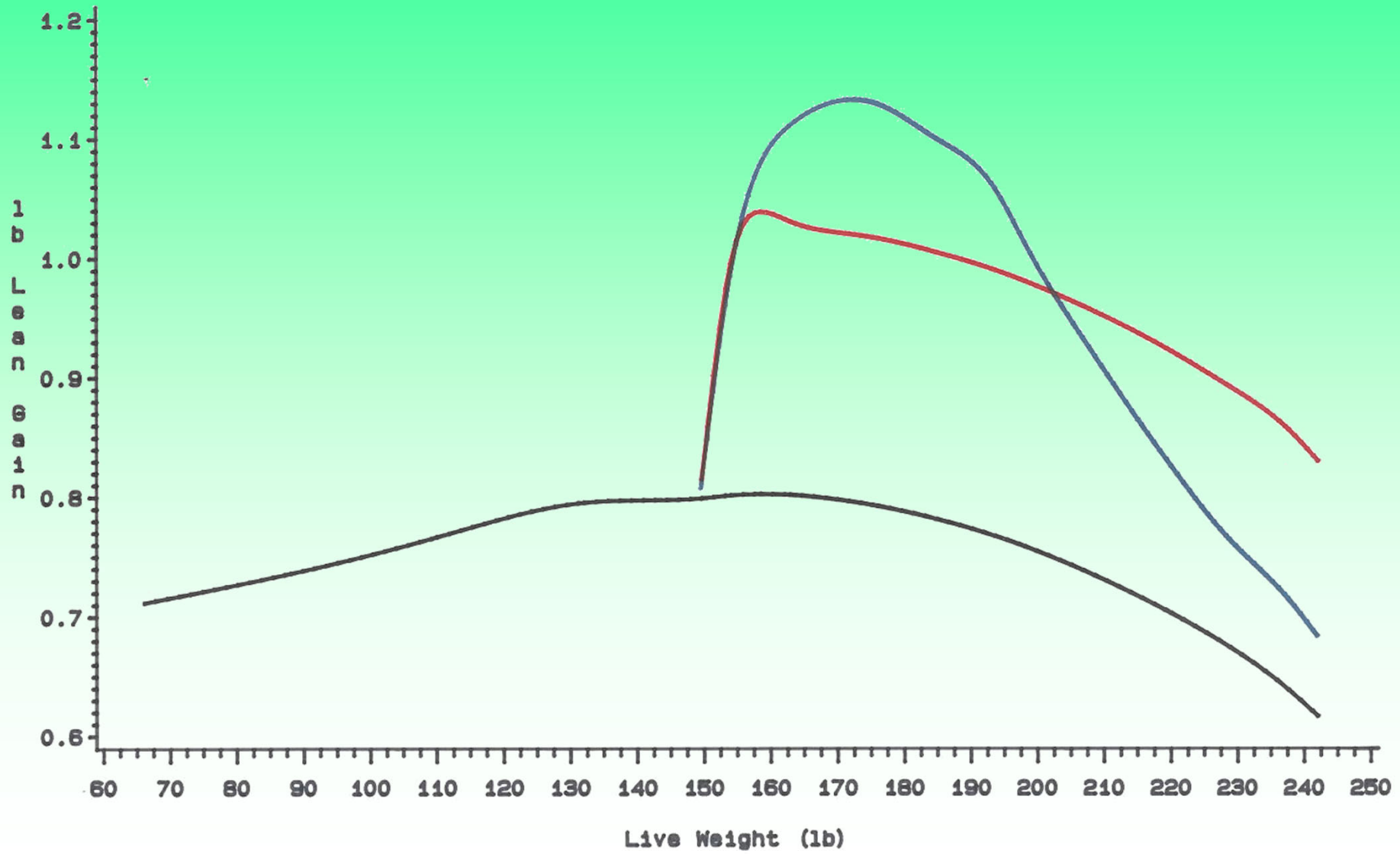




* Energy intake as a percent above maintenance required for maximum lean gain

Alternative Lean Gain Rate – lb.

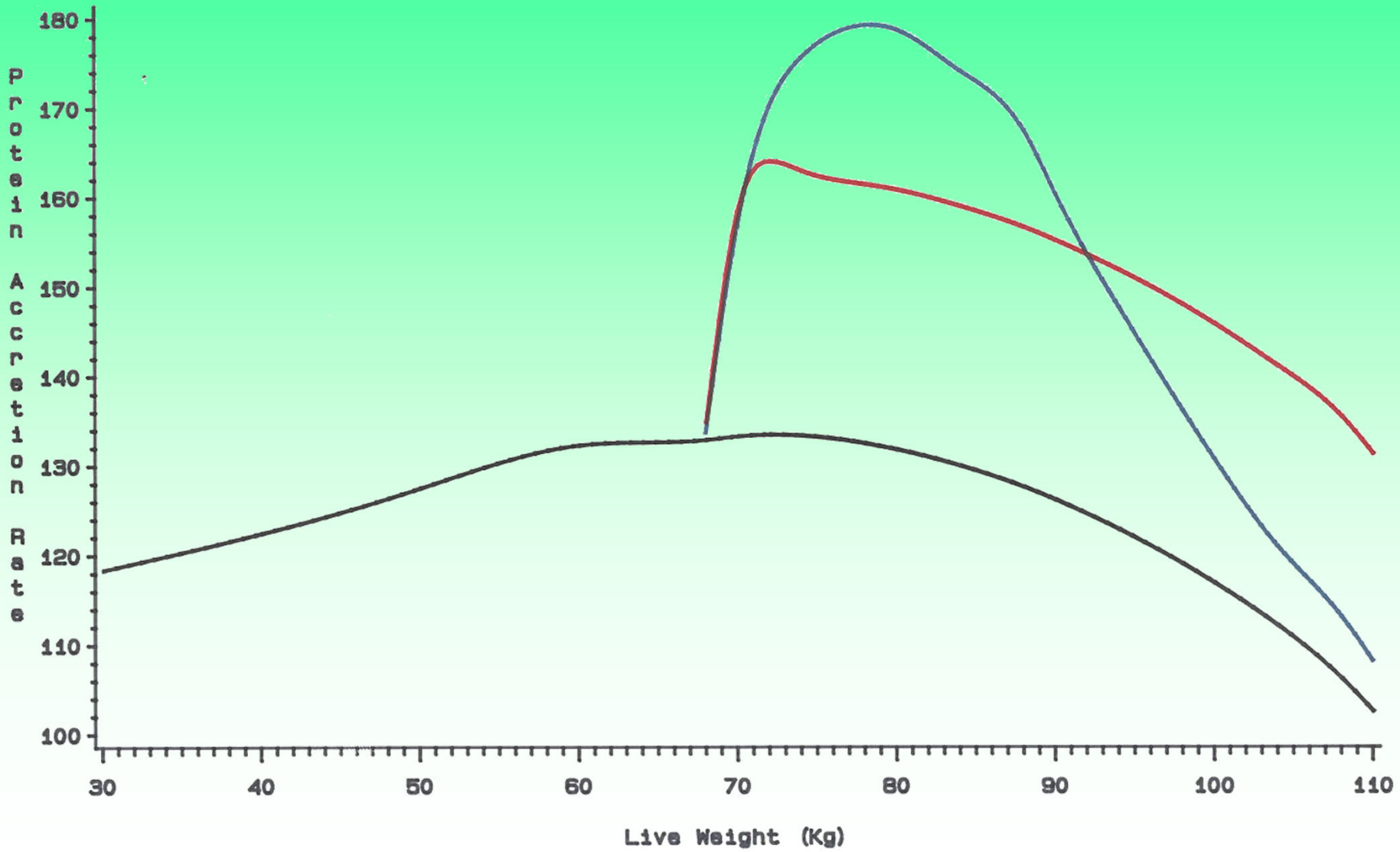
Control Uniform Rac. Proposed Rac.



3/1/2000

ALTERNATIVE PROTEIN ACCRETION RATE CURVES

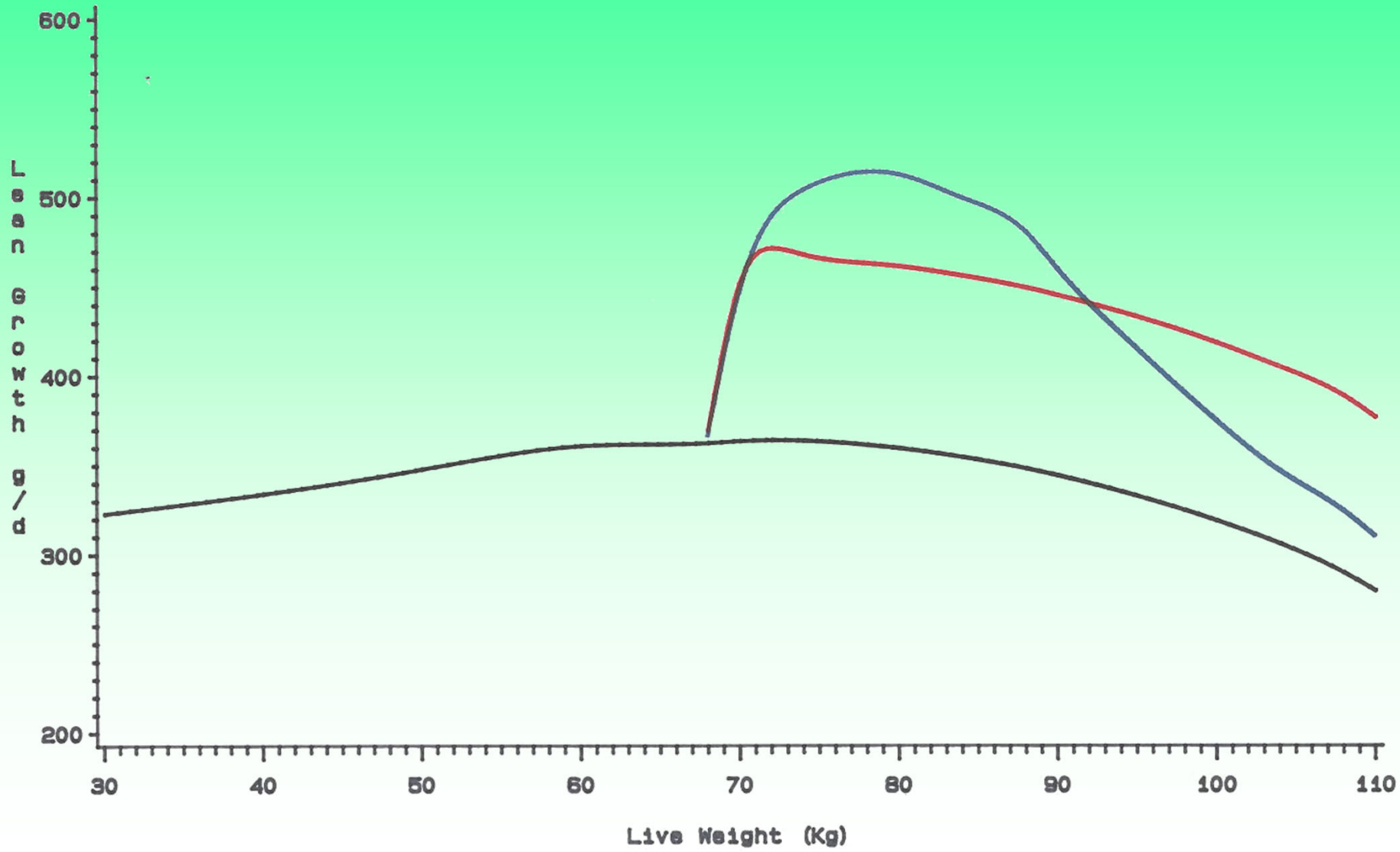
Control Uniform Rac. Proposed Rac.



3/1/2000

Alternative Lean Growth Rate

Control Uniform Rac. Proposed Rac.



3/1/2000