PIC Nutrient Specifications – 2008

Introduction

This publication provides a summary of nutrient recommendations for PIC pigs. Recommendations are based primarily on published and internal research, research from the University of Missouri and Ajinimoto Heartland with commercial PIC products. The nutrient specifications have been validated in commercial environments. The NRC publication (1998) serves as the basis for certain information. Concepts and the basis for recommendations are discussed in greater detail in other Technical Memos.

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Dietary Energy

Energy levels are expressed as Metabolizable energy (ME) in this guide because it is the system most commonly used in North and South America. The ME (and DE) system is adequate for describing available energy for simple diets (Corn-Soy) or for diets of young pigs. However, the Net energy (NE) system is a more accurate method of measuring the available energy when a more diverse set of ingredients are used. NE is in routine use by several feed companies for this reason. Other groups have 'modified' ME values for certain ingredients (eg., soybean meal, wheat midds) to reflect NE relationships. This guide specifies energy as NRC ME, based on a simple diet type that is defined for each phase. Nutrition specialists can then adapt the specified Lysine:ME relationships to their own system. Adjustments in ME for hot environmental temperature or for profit related fat use will require adjusting Lysine levels to keep Lysine:ME constant.

Tables 1, 2 and 3 below are tables that demonstrate the response of PIC pigs to added energy. The first table is the overall means and the second and third show the means of gilts and barrows for ADG and F/G.

Table 1. Effects of added fat to a corn - soybean meal diet[a]

	Added fat, %			
	1.0	2.5	4.0	5.5
NRC ME, kcal/kg	3236.2	3306.6	3374.8	3443
ADG, kg	.95	.95	.97	.98
ADFI, kg	2.48	2.44	2.41	2.4
F/G	2.59	2.55	2.49	2.42
HCW, kg	97.5	98.6	93.4	99.1
FOM lean, %	53.1	53.1	53.3	53.3

[a] A total of 4,900 pigs (PIC 337 x Camborough; initial weight 34 kg) with 50 replications per treatment. There were 100 pens each of barrows and gilts with 24 to 25 pigs per pen.

Table 2. Effects of ADG to added fat to a corn - soybean meal diet

		Added fat, %			
Weight Range, kg	Gender	1.0	2.5	4.0	5.5
35 to 54	Barrows	923	936.5	950	945.6
	Gilts	918.3	918.3	936.5	932
54 to 75	Barrows	1022.9	1054.7	1068.3	1104.7
	Gilts	918.3	932	941	959.2
75 to 95	Barrows	1118.3	1127.4	1136.5	1109.2
	Gilts	986.5	995.6	1004.7	995.6
95 to 113	Barrows	913.7	968.3	950.1	991.0
	Gilts	909.2	891	900.1	900.1

Table 3. Effects of F/G to added fat to a corn - soybean meal diet

		Added fat, %			
Weight Range, kg	Gender	1.0	2.5	4.0	5.5
35 to 54	Barrows	1.99	1.94	1.91	1.90
	Gilts	2.05	2.02	1.93	1.94
54 to 75	Barrows	2.46	2.31	2.27	2.18
	Gilts	2.39	2.29	2.17	2.09
75 to 95	Barrows	2.92	2.83	2.76	2.74
	Gilts	2.81	2.74	2.75	2.69
95 to 113	Barrows	3.29	3.04	3.00	2.77
	Gilts	2.99	3.10	2.99	2.97

The results from this trial demonstrate that barrows respond to added fat better than gilts. In this trial for every 1% added fat barrows improved ADG by 0.8% and F/G by 2.0%. For gilts, every 1% added fat, ADG improved by 0.3% and F/G by 1.2%.

Pig flow can influence the value of added fat in a production system. A producer with a fixed time in finishing or who is short of finishing space can pay a higher price for added fat. Whereas a producer that is on a variable time system or has adequate finisher space can hold the pigs for 5 to 7 days longer and the value of additional fat in the diet is not as great.

Formulating to an Ideal Amino Acid Pattern

To obtain optimum performance, all amino acids must meet or exceed the requirement.
The NRC (1998) has defined the ideal balance of amino acids for each physiological phase. NRC (1998) served as the basis for PIC recommendations for sows but recent research based modifications have been made for lactation sows and growing pigs based on the collaboration work of PIC, Ajinimoto Heartland and the University of Missouri. They are normally expressed in relation to the level of lysine since it is most likely to be first limiting in the diet. Since ingredient

amino acids differ in their digestibility, standardized ileal digestible (SID) amino acid values are preferred when formulating diets that are more complex than corn-soybean meal diets.

This guide specifies the SID lysine requirement, which is satisfactory for corn-soy formulations. The suggested ratio of dietary amino acids for each phase is as follows.

Table 4. Ideal Pattern for breeding herd based on SID Amino Acid Formulations[a,b]

	Gestation[c]		Lactation[d]		
Amino Acid	**Gilt**	**Herd**	**Gilt**	**Herd**	**Boar Stud**
Lysine	100	100	100	100	100
Methionine + Cystine	70	70	50	50	70
Threonine	76	76	64	64	74
Tryptophan	18	18	18	18	20
Valine	68	68	75	75	67
Isoleucine	58	58	56	56	58

[a] Lysine set equal to 100% and other amino acids expressed as a percent of Lysine.

[b] Ratio's are appropriate IF applied to Standardized Ileal Digestible (SID) amino acids (Corn-Soy based) or which is suggested for more complex diets.

[c] Assumption: Gilt – 136 kg body weight (bw) at breeding and 34.0 kg net maternal gain
Sow – 181.8 kg bw at breeding and 9.0 kg net maternal gain

[d] Assumption: 175 kg bw post-farrowing, 10 kg weight loss & 2200-2500 g/d Litter growth.

Table 5. Ideal Pattern for nursery and finishing pigs based on SID Amino Acid Formulations

	Nursery	Finish					Paylean®
Amino Acid	**3.6 to 22.7 kg**	**22.7 to 40.8 kg**	**40.8 to 59.0 kg**	**59.0 to 81.6 kg**	**81.6 to 104 kg**	**104 to 127 kg**	**104 to 127 kg**
Lysine	100	100	100	100	100	100	100
M + C	58	55	55	55	55	55	55
Threonine	60	61	62	63	64	66	68
Tryptophan	16	16	16	16	16	16	16
Valine	65	68	68	68	68	68	68
Isoleucine	55	56	56	56	56	56	56

Camborough® Gilt Product Development Specifications.

Gilt nutrition during development has a significant impact on early and lifetime performance of females.

Gilt development and management begins in the early stages of a gilts life and ends when the gilt completes her first lactation. This topic has been discussed by Boyd and Williams at the 2008 Banff conference.

Recommended Developing Gilt Growth and Body Composition Targets are set out below.

- Birth to first service daily gains of .64 to .68 kg/day
- Achieve a body weight of 136 kg at first service (210 days of age)
- Target P2 back fat of 14-16 mm at 1st service (12 mm minimum)

Nutrient requirements for development are found in Table 6.

- The requirements are designed to meet nutrient demands for adequate protein growth and not designed to maximize ADG (as would be the goal of a commercial feeding program.(see Grow finish specifications, "Nutrient levels for optimum lean deposition" for commercial feeding)
- Gilt development energy recommendations are 5-6% lower than typical commercial diets after the nursery phase.

Vitamin and trace mineral requirements are higher than commercial recommendations in order to prepare the gilt for reproductive function (See Vitamin and trace mineral for Genetic nucleus and multiplication table)

For further information relating the Nutrition management of the developing gilt please refer to the Camborough user guide and product manual published by PIC.

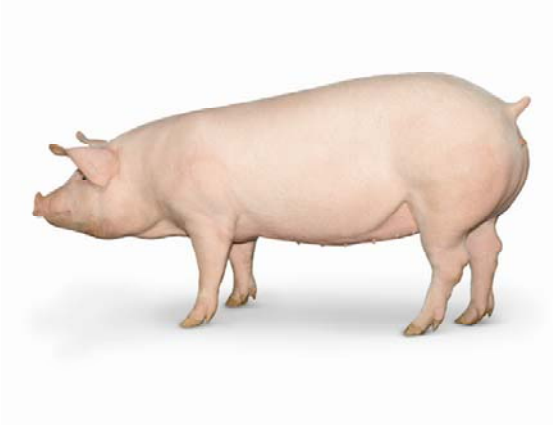
Table 6. PIC Nutrient Specifications for Gilt Development[a]

		Weigh range, kg				
Nutrient	**Unit**	**11.3-22.7**	**22.7-40.8**	**40.8-68**	**68-95**	**95-136**
NRC ME	**Mcal/kg**	3322	3278	3278	3278	3278
SID lysine[b]	**%**	1.32	1.15	0.95	0.80	0.65
Calcium	**%**	0.80	0.75	0.70	0.70	0.70
aPhosphorus	**%**	0.42	0.36	0.35	0.35	0.35

[a] Amounts are expressed as the concentration per pound of complete diet.
[b] Lysine levels are provided as the bases for normal lean:fat ratios (SID = standard ileal digestible and a = available).
Other nutrients are the nutrients most related to proper bone development.
See Vitamin and Trace mineral addition rates for Multiplication.

Note: Goal for first service is 210 days, 136 kg and one heat no service recorded. All targets need to be accomplished for proper gilt development (See 2007 PIC gilt and sow manual). Depending on the environment, square footage, etc, nutrition (especially energy and amino acids) will need to be adjusted.
Adjustments will vary from producer to producer depending on gilt growth.

Camborough® Sow Product Specifications



The sow feeding program is a phase feeding system. Feeding involves a gestation diet and 1 or preferably 2 lactation diets. Pregnant sow feeding requires (1) feeding the proper amount of diet to meet energy needs and, (2) then matching nutrient level to the amount fed so that daily nutrient need is met (in g/day). The minimum amount of energy and nutrients is provided in Table 8. These amounts are driven by the amount of growth that we want to achieve as shown in Table 9. Lactation is especially demanding and requires full-feeding beginning day 4. The recommended feeding program of lactating sows is to feed 1.8 kg on day 1 and 2.7 kg on day 2 and 2.7 kg on day 3. On day 4 the sows need to be on full feed by always keeping fresh feed in front of the sow at all times. PIC research has proved that prolific PIC gilts and sows produce more milk which requires improved diets (Boyd et al., 2000). Further, the typical lactation diet is inadequate for gilts so a second diet is advised when feasible especially for start up farms with all gilts and parity segregation farms (Table 3). The main difference between gilt or P1 lactation diet and older sows is the amount of digestible lysine. There is also a cost savings involved with parity segregation feeding with approximate savings of $3.40 per sow per year.

Table 7. Sow Feeding Milestones (Concepts applied from T. Update on Feeding Prolific Sows).

Milestone	Amount, kg[a]	Feed Type
Pre-breeding Gilt	Full-feed (pre-breed flush)	Gestation
Gestation to 5 d Post-breed		
Gilts	2.0	Gestation
Sows	2.0	Gestation
Very Thin Sows	2.9	Gestation
Gestation: 5 d to 90[b]	Per body condition score	Gestation
Gestation: 90 d to 116[c]	2.7-2.9	Gestation
Pre-farrow 2-4 d	1.8 -2.3	Lactation
Lactation: 1 d Post - farrow	1.8	Lactation
Lactation: 2 and 3 d Post - farrow	2.7, 2.7	Lactation
Lactation: 4 d to weaning	Full-feed	Lactation
Weaning through breeding	Full-feed	Gestation*

[a] Assumes 3223 Kcal NRC ME/kg for Gestation and 3300 Kcal NRC ME/kg for Lactation diets.

[b] Minimum feed levels to reclaim body fat reserves are shown in Table 4. Objective is to reclaim body reserves (fat, protein, bone minerals) by 60 d pregnant.

[c] Average gestation length, 116 d.

- Where possible the weaned sow should be fed 3 to 4 times per day; the pregnant sow should be fed twice daily, where feasible.

Daily Nutrient Needs and Diet Specifications for Gestation

Nutrient specifications for pregnancy are presented in Table 8. Energy and Lysine needs are based on suggested levels of growth in Table 9. Gilt specifications can be used when stocking units. Specifications for herds are a compromise between needs for gilts vs. older sows. Gilts are challenged to a greater extent during lactation than sows. Feed gilts 2.0-2.3 kg/day until day 90 of pregnancy, this will allow for significant growth to prepare for the rigor of first lactation.

Table 8. Recommendations for Gestating PIC Gilts and Sows

Nutrient	Unit	Gilt	Herd
Net wt gain[a]	Kg	34	Table 2
P2 fat endpoint	mm	14-16	14-16
NRC ME[b]	Kcal/kg	3223	1465
NRC ME[b]	Kcal/d	6886	7179
Calcium	grams/day	19.4	20.0
aPhosphorus[c]	grams/day	8.8	8.9
Crude Fiber	%	4 to 6	4 to 6
Calcium	%	0.95	0.90
aPhosphorus[c]	%	0.43	0.40
Added salt	%	0.45	0.45
Max L – lysine	%	0.15	0.15
Feed intake[d]	Kg	> 1.8	> 1.8
SID lysine[c]	%	0.62	0.62
SID lysine			
d 0 to 90	grams/day	14	14
d 90 to 116	grams/day	18	18
d 90 to farrow			
NRC ME[b]	Kcal/d	9156	9156

[a] Net tissue growth by the sow declines with each parity. See Table 9 for suggested gain and feed level.
[b] NRC ME is based on a Corn-Soy diet with 15% wheat midds.
[c] SID = standard ileal digestible. Formulate to SID lysine levels.
The 0.62% SID lysine level is based on 2.0 kg per day intake.
[d] Do not feed less than 1.8 kg per day at any given time period. This will go below maintenance requirement.

Energy and Lysine Needs for Pregnancy Weight Gain[a]

Daily energy and lysine levels in Table 8 are minimums and assume proper body condition. Estimates are driven by the amount needed for suggested growth by parity. Larger females require more energy for maintenance, but this increase is off-set by declining maternal gain. This is for gilts and sows from breeding to day 90 of gestation only after 90 days an increase of feed by .45 to .9 kg is recommended.

Table 9. Energy and lysine needs for gestation weight gain

Body Weight at Mating, kg	LITTER NO.	Suggested Net Gain, kg	Feed Intake, kg/d	NRC ME Kcal/d	SID Lysine g/d
127	1st	34	2.1	6886	12.3
150	2nd	34	2.3	7325	12.5
174	3rd	25	2.2	7275	12.3
191	4th	21	2.2	7205	11.9
200	5th	16	2.1	7070	11.5
204	6th	14	2.2	6930	11.4
209	7th	9	2.1	7035	11.1

[a] Computed using the 1998 NRC Gestation Model. Assumed 3223 Kcal NRC ME/kg diet and 12 fetuses and also assumes sows needed 2 mm of back fat. SID lysine estimated by 86% of total lysine.

Improve satiety in gestation sows with fiber

Since feed intake is restricted during gestation, to prevent excess body weight gain, sows can often appear restless. For this reason, ingredients that have high levels of insoluble non-starch components are often used (hulls from soybeans and oats; alfalfa) at the rate of 15 to 20% of the diet. This tends to increase satiety and shifts some of the digestion to the cecum from which volatile fatty acids arise.

Below is an example of a gestation diet formulated to a SID lysine 0.62%. The use of fiber is recommended and in this example DDGS and wheat midds are used, other fibrous ingredients that will work is soy hulls, wheat shorts, and oat hulls.

Table 10. PIC Gestation Example Diet

Ingredient	Kilograms
Corn	527.3
SBM	77.3
DDGS	136.4
Wheat Midds	134.1
Dicalcium Phosphate	8.6
Limestone	15
Salt	4.1
L-lysine	1.4
L-threonine	.23
VTM + Choline + Phytase	4.8

Daily Nutrient Needs and Diet Specifications for Lactation

Nutrient specifications are presented in Table 11. Daily ME intake is the multiple of (1) expected daily feed intake (based on intakes achieved in commercial sow systems) and (2) the ME content of a Corn-Soy diet. The level of Lysine for gilts is based on PIC research to optimize second litter-size (20 d lactation). Two lactation diets are recommended when stocking units and should be a consideration when designing new units. A single herd diet will increase loss of body protein in gilts, which may result in a second litter-size 'dip or plateau'.
The goal for lactation is to wean 165 kilograms of pigs/sow/year. By following the nutrition specs and working with the PIC Technical Service group, this will be achieved. For more information on achieving these and other reproductive targets, please refer to the 2007 PIC gilt and sow technical manual.

6.1 kg x 11 pigs weaned x 2.46 litters/sow/year = 165 kgs

Table 11. Recommendations for Lactating PIC Gilts and Sows[a]

Nutrient	Unit	Gilt	Sow	Herd
Net weight body loss	%	< 10	< 10	< 10
Fat Loss, max.	mm	0 - 2	0 - 2	0 - 2
Litter growth	grams/day	2250	2400	2325
NRC ME	Kcal/kg	3410	3322	3355
Ave feed intake[b]	kg/day	5.0	5.7	5.5
NRC ME	Kcal/day	17050	18875	18300
Calcium	grams/day	47	51	47
aPhosphorus	grams/day	21	23	21
SID lysine	grams/day	63	49	55
SID lysine	**%**	1.22	0.87	0.95
Calcium	%	0.95	0.90	0.95
aPhosphorus	%	0.43	0.40	0.43
Added salt	%	0.45	0.45	0.45
Max L – lysine	%	0.30	0.30	0.30

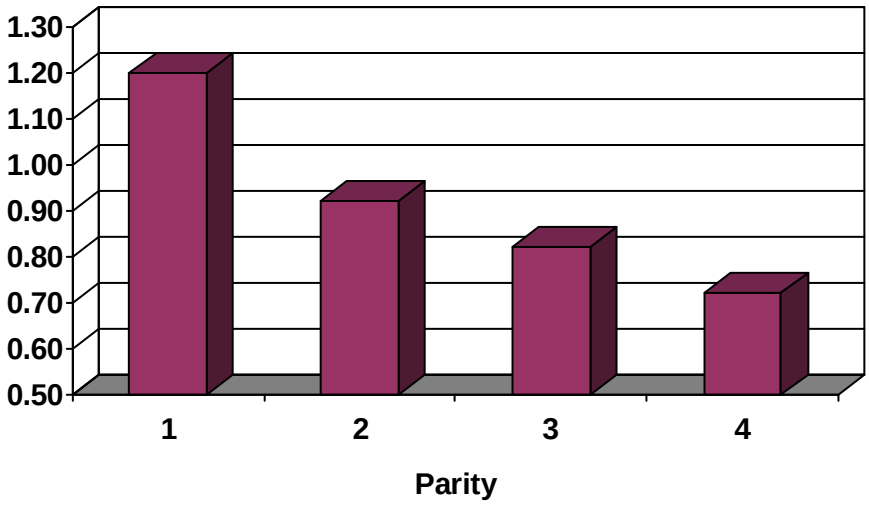
[a] About 85-90% energy balance with litter growth rates shown and 20 d lactation (1998 NRC model).
[b] Average feed intake over suckling period not maximum intake achieved within the period.

How does the SID lysine requirement differ with each parity?

Srichana et al., 2006 demonstrated with PIC Camborough sows the SID lysine in lactation decreases as the sow matures (see figure 1 below).

P1: 1.20% SID lysine
P2: 0.92% SID lysine
P3: 0.82% SID lysine
P4: 0.72% SID lysine

SID Lysine Requirement of PIC Lactating Sows



Below is an example of a diet for PIC sows formulated to a SID lysine level of 0.95%

Table 12. PIC Lactation Example Diet

Ingredient	Kilograms
Corn	607.9
SBM	210.9
DDGS	45.5
CWG	9.1
Dicalcium Phosphate	12.9
Limestone	12
Salt	4.1
L-lysine	1.8
L-threonine	.36
VTM + Choline + Phytase	4.5

Estimating Farm-specific Lactation Lysine Needs

The farm-specific lysine level for lactation depends on the actual litter growth rate and average lactation feed intake by sows. The daily lysine requirement is driven strictly by rate of litter growth and this can vary with health and thermal stress. This needs to be matched with the level of feed consumed. Table 11 could be used to derive farm-specific lysine needs. It is appropriate for sows but not for gilts since a higher lysine level is needed for gilts to maximize second litter size than is required to support milk production (see Current Concepts for Feeding Prolific Sows).

Where possible the provision of a gilt lactation diet should be used; where this is not possible top- dressing with soybean meal is recommended.

Table 13. Lactation Lysine Level Varies with Litter Growth Rate and Sow Feed Intake (for sow only)

Litter [a] Growth, kg/day	Litter[b] Wean Wt, kg	Average Feed Intake, kg/day[d] (SID lysine, %)						SID Lysine[c,d] g/day
		9	10	11	12	13	14	
1.65	49.9	.39	.34	.31	.29	.27	--	34
1.88	54.4	.43	.39	.35	.33	.31	.27	40
2.08	58.9	.49	.43	.39	.37	.33	.31	44
2.3	63.5	--	.49	.45	.41	.37	.35	49
2.5	68.0	--	--	.49	.45	.41	.39	54
2.7	72.6	--	--	.53	.49	.45	.42	58

[a] Assumes 11 pigs with an average birth weight of 1.5 kg/pig. LGR is calculated as follows: ((Litter-Wean Weight – (No. nursed x 1.5 kg/pig)) ÷ Lactation length, days.

[b] Litter wean weight applicable to a 21d lactation. Adjustment factors for different wean ages were suggested by NSIF, 1987.

[c] Calculated from updated Pettigrew equation (Boyd, et al., 2000a) and assumes that Lysine need is not strictly related to ME intake. The equation is based on a linear relationship between LGR and Lysine need (g/d) to support milk production.

[d] Feed Intake assumes 681.8 Kcal NRC ME/kg. SID lysine is based on 86% of total lysine.

Boar Stud Specifications

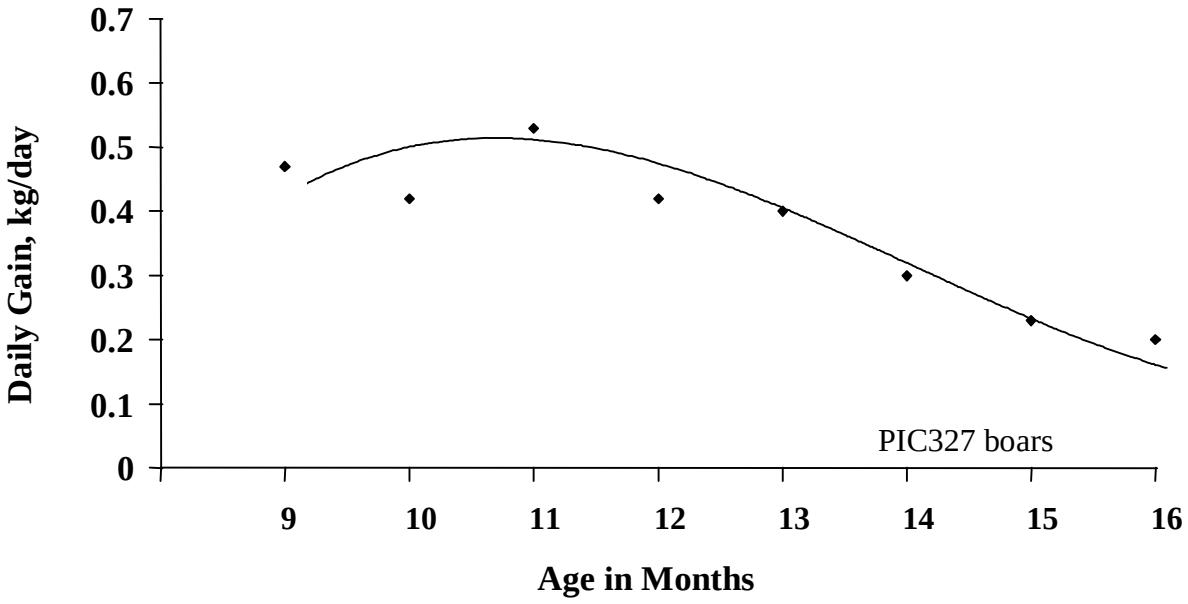
Energy needs to support target weight gains (Table 14/ Figure 2) without compromising sperm output have been calculated and validated in AI studs (Technical memo 142.) Higher levels may result in maximum sperm output. Very little information exists on which to base Nutrient specifications. Those in Table 15 are used by PIC and given for reference only. Energy and amino acid levels are based on limited University research.

Table 14. Minimum Feed Level in Relation to Body Weight[a]

Body Weight kg	Total Kcal ME/day [b]	Feed kg/day
< 159	7200	2.3
159	7920	2.5
205	8640	2.7
250	9505	3.0
295	10370	3.3
341	11230	3.5

[a] Adapted from PIC Technical Memo 142. Assumes ambient temperature of 62-65°F.
[b] Based on a dietary energy density of 3168 Kcal ME/kg.

Figure 2. Growth Rate of Working Boars[a]



[a]Adapted from PIC Technical Memo 142. 1 kg of Gain = 2.2 lbs.

Table 15. Boar Minimum Diet Specifications[a]

Nutrient	Unit	
NRC ME	Kcal/kg	3080
Protein	%	16
Fiber	%	4.5 to 6.0
SID lysine[b]	%	0.62
Calcium	%	0.85
T Phosphorus[b]	%	0.75
aPhosphorus[b]	%	0.40
Added salt	%	0.45
Linoleic acid	%	1.90

[a] Amount / kg of complete diet assuming feed level in Table 1. See Vitamin & Trace mineral section for specifications.
[b] T = total, a = available, SID = Standardized ileal digestible. Formulate to either Total or SID levels but not both.

Diet specifications are based on the minimum feed levels shown in Table 14 above. Vitamin and trace mineral levels are presented in the final section for all phases of production including the boar stud. Organic mineral sources are recommended especially for selenium, copper, zinc and manganese.

Nursery Diet Specifications

Nutrient specifications are shown in Table 16. A feeding program and budget is illustrated in Table 17. They are based on extensive research information from production companies and published literature. A soybean maximum is suggested for each phase as a starting point for commercial conditions. Higher levels may result in 'looseness' but should be tested so that a farm-specific maximum can be set.

Diets must be matched to body weight and the correct amount fed within each phase. Feeding 2 diets simultaneously within a weaned group is advised through phase 2 for optimum growth and livability. Typical weight variation at weaning means that feeding to the average pig weight will result in feeding the diet that matches requirements for only 65-70% of the pigs (Table 17, footnote b). This will result in increased variation in nursery end weight.

Table 16. Diet Specifications for a 3 to 4 Phase Nursery Program.

Nutrient	Unit	Early Wean 3.6-5.5 kg	Phase 2 5.5-7.3 kg	Phase 3 7.3-11.4 kg	Phase 4 11.4-22.7 kg
Growth rate	Kg/d	.15	.23	.41	.66
Feed Intake[a]	Kg/d	.16	.26	.54	1
Feed:Gain	Ratio	1.03	1.16	1.31	1.52
NRC ME	Kcal/kg	3417	3417	3373	3362
Lactose[b]	%	20.0	15.0	7.5	0.0
Total Fat	%	3 to 6	3 to 6	2 to 4	2 to 4
SID lysine[c]	%	1.46	1.46	1.42	1.30
SID Meth + Cystine:lysine	Ratio	0.58	0.58	0.58	0.58
SID Threonine:lysine	Ratio	0.60	0.60	0.60	0.60
SID Tryptophan:lysine	Ratio	0.16	0.16	0.16	0.16
SID Valine:lysine	Ratio	0.65	0.65	0.65	0.65
SID Isoleucine:lysine[e]	Ratio	0.55	0.55	0.55	0.55
Calcium	%	0.85-0.95	0.85-0.95	0.80-0.90	0.80-0.90
aPhosphrous	%	0.55	0.52	0.40	0.40
aPhos:ME	g/Mcal	1.58	1.50	1.16	1.16
Sodium	%	0.35-0.85	0.35-0.60	0.25-0.40	0.25-0.40
Chloride	%	0.40	0.40	0.36	0.36
Added salt	%	0.20	0.25	0.40	0.40
Potassium	%	0.70	0.70	0.65	0.65
Soybean meal[d]	%	15	18	28	28-32

[a] Average Intake shown for 11.3-22.7 kg pig assumes pelleted. Add 5% for grind and mix.
[b] Lactose or equivalent sugars. Sucrose can replace 50% Lactose after 5-7 d of feeding to induce digestive enzyme.
[c] T = Total and SID = standard ileal digestible.
[d] Suggested levels for commercial production and good to high health. High health pigs can tolerate higher levels of SBM (7.3-11.4 kg,30% ; 11.3-22.7 kg,32%)
[e] Diet with < 1% blood cells.

Feed Budgeting. Providing the proper amount of each diet and avoiding excesses is important to economics. Feed budgets allow a producer to predict and control feed cost. The budgeted amount should be verified at the outset by weighing a representative sample of pigs at each diet switch. The actual amount fed of each diet should be within 5% of target.

An example feed budget is shown in Table 17 for three weaning scenarios. The budgeted amount of feed per phase is driven by feed conversion (FCR) data in Table 16. The percentage of pigs that are expected to be smaller than the average is also considered (Table 17, footnote b). A change in FCR will result if diet energy density is different than shown in Table 16 (especially for 11.4-22.7 kg phase) so the budgeted amount must be changed to reflect the difference.

Table 17. Example Feeding Program and Feed Budget[a,b]

Ave Wean Age	**days**	**14**	**17**	**20**
Ave Wean Weight	**Kg**	**4.77**	**5.45**	**6.13**
Diet Phase	**Weight**	**Feed Budget per pig**		
Phase 1	3.6-5.5	0.9	0.45	0.45
Phase 2	5.5-7.3	1.8	1.8	1.8
Phase 3	7.3-11.4	5.5	5.5	5.5
Phase 4	11.4-22.7	18.2	18.2	18.0
Total Feed	Kg	26.40	25.95	25.75
Total Gain	Kg	17.9	17.3	16.6
Feed:Gain	Ratio	1.47	1.50	1.55

[a] Budget assumes 22.7 kg end weight for Nursery and FCR shown in Table 1.

[b] Early Wean diet allocated assuming FCR = 1.05 and a Population percent by wean weight as follows:

Population %, Avg 5.5 kg wean weight:	4 kg	4.5 kg	5 kg	5.5 kg	5.9 kg	6.4 kg	6.8 kg
	5%	10%	20%	30%	20%	10%	5%

Grow-Finish Specifications: Nutrient Levels for Optimum Lean Deposition

Nutrient specifications in Tables 18 and 19 are for lean growth optimization. Performance was determined under conditions of high health, thermoneutral environment and with corn-soy diets.

Lysine specifications are presented as grams per Mcal of NRC ME. Formulating diets of growing pigs to grams of Lysine/day can be misleading (discussed in Grow-Finish Technical Update). The dietary energy level used in the recommendations is 3300 or 3520 Kcal NRC ME/kg since it approximates the corn-soy diet. Actual dietary energy levels require a number of considerations that are specific to market and environment (see Usry et al., 1997). The available phosphorus curve (g P/Mcal NRC ME) is higher than the NRC for Nursery and especially for Grow-Finish phases because levels have not proven adequate to withstand the force imposed on bones during stunning in commercial plants (as compared to University Labs).

Table 18. PIC Gilt Specifications[a]

Gilts		**Phase of growth, kg**									
Item	**Unit**	**22.7-40.9**		**40.9-59.1**		**59.1-81.8**		**81.8-104.5**		**104.5-127.3**	
Growth rate	Kg/d	.81		.87		.97		.95		.9	
Feed intake	Kg/d	1.3		1.9		2.5		2.6		2.7	
Feed:Gain	Ratio	1.69		2.24		2.60		2.75		3.02	
NRC ME	Kcal/kg	3300	3520	3300	3520	3300	3520	3300	3520	3300	3520
Added fat	%	0	5	0	5	0	5	0	5	0	5
SID lysine/Mcal ME[b]	g/Mcal	3.17	3.17	2.76	2.76	2.39	2.39	2.11	2.11	1.96	1.96
SID lysine[c]	%	1.05	1.12	0.91	0.97	0.79	0.84	0.70	0.74	0.65	0.69
SID Meth + Cystine:lysine[d]	Ratio	0.55		0.55		0.55		0.55		0.55	
SID Threonine:lysine	Ratio	0.61		0.62		0.63		0.64		0.66	
SID Tryptophan:lysine	Ratio	0.16		0.16		0.16		0.16		0.16	
SID Valine:lysine	Ratio	0.68		0.68		0.68		0.68		0.68	
SID Isoleucine:lysine	Ratio	0.56		0.56		0.56		0.56		0.56	
Calcium	%	0.75		0.63		0.61		0.58		0.56	
aPhosphorus	%	0.36		0.30		0.28		0.26		0.22	
Added salt	%	0.40		0.40		0.40		0.35		0.30	
L-lysine max	%	0.45		0.40		0.375		0.325		0.225	

[a] Expected growth and suggested nutrient levels for high health and thermal neutral conditions. Lysine specifications are based on a series of trials leading to curve validation studies: Technical Memos 160 and 183 and PIC Experiment 9611.
[b] Equation used: 0.000027*weight^2-0.015318*weight+4.114302
[c] Equation used: (SID lysine per NRC ME*NRC ME per lb*2.2)/10000
[d] SID = Standardize ileal digestible value.
[e] Diet without Paylean®.

Table 19. PIC Barrow Specifications[a]

Barrows		Phase of growth, kg									
Item	**Unit**	**22.7-40.9**		**40.9-59.1**		**59.1-81.8**		**81.8-104.5**		**104.5-127.3**	
Growth rate	Kg/d	.82		.9		1.0		.97		.90	
Feed intake	Kg/d	1.4		2.1		2.6		2.67		2.7	
Feed:Gain	Ratio	1.73		2.30		2.58		2.73		3.05	
NRC ME	Kcal/kg	3300	3520	3300	3520	3300	3520	3300	3520	3300	3520
Added fat	%	0	5	0	5	0	5	0	5	0	5
SID lysine/Mcal ME[b]	g/Mcal	3.17	3.17	2.66	2.66	2.24	2.24	1.97	1.97	1.89	1.89
SID lysine[c]	%	1.05	1.12	0.88	0.94	0.74	0.79	0.65	0.69	0.62	0.67
SID Meth + Cystine:lysine[d]	Ratio	0.55		0.55		0.55		0.55		0.55	
SID Threonine:lysine	Ratio	0.61		0.62		0.63		0.64		0.66	
SID Tryptophan:lysine	Ratio	0.16		0.16		0.16		0.16		0.16	
SID Valine:lysine	Ratio	0.68		0.68		0.68		0.68		0.68	
SID Isoleucine:lysine	Ratio	0.56		0.56		0.56		0.56		0.56	
Calcium	%	0.75		0.63		0.61		0.58		0.56	
aPhosphorus	%	0.36		0.30		0.28		0.26		0.22	
Added salt	%	0.40		0.40		0.40		0.35		0.30	
L-lysine max	%	0.45		0.40		0.375		0.325		0.225	

[a] Lysine specifications are based on a series of trials leading to curve validation studies: Technical Memos 160 and 183 and PIC Exp. 9611.
[b] Equation used: 0.00004*weight^2-0.019913*weight+4.369743
[c] Equation used: (SID lysine per NRC ME*NRC ME per lb*2.2)/10000
[d] SID = Standardize ileal digestible value.
[e] Diet without Paylean®.

Vitamin and Trace Mineral Addition Rates: Commercial[a,b]

PIC recommendations were established after extensive comparison with Universities and major Nutrition groups. A systematic allowance was made in relation to the NRC recognizing that this information is based on studies under nearly ideal conditions Commercial Nutritionists prior to publication reviewed micronutrient recommendations.

Table 20. Suggested specifications: Amount per kg. of complete diet.

		Nursery		Grow-Finish		Sow	Boar
Nutrient	**Unit**	**< 5.5 kg**	**5.5-27.3 kg**	**27.3-68.2 kg**	**68.2-Mkt**	**Gest - Lact**	**Stud**
Vitamin A	IU/kg	11000	9900	6600	4840	9900	11000
Vitamin D	IU/kg	1760	1650	1210	990	1760	1760
Vitamin E	IU/kg	83.6	77	33	22	66	110
Vitamin K	mg/kg	5.5	4.4	3.3	2.2	4.4	4.4
Choline	mg/kg	440	330	110	0	660	660
Niacin	mg/kg	70.4	44	26.4	22	44	44
Riboflavin	mg/kg	13.2	9.9	5.72	4.4	9.9	9.9
d-Pantothenate	mg/kg	39.6	33	19.8	14.3	33	33
Vitamin B12	mcg/kg	55	44	26.4	22	37.4	37.4
Folic Acid	mcg/kg	1045	770	0	0	1320	1650
d-Biotin	mcg/kg	275	154	0	0	220	550
Thiamine	mg/kg	3.52	3.3	0	0	2.2	2.2
Pyridoxine	mg/kg	7.04	4.4	0	0	3.3	3.3
Vitamin C (stable)	mg/kg	132	0	0	0	0	132
Zinc	PPM	150[c]	130[c]	120	70	125	125
Iron	PPM	200[d]	175[d]	80	65	100	100
Manganese	PPM	50	45	30	25	50	50
Copper	PPM	18[c]	15[c]	12	10	15	15
Iodine	PPM	0.65	0.55	0.40	0.35	0.35	0.65
Selenium	PPM	0.30	0.30	0.30	0.30	0.30	0.30

[a] B-Vitamins supplemented at approximately 3.5 x NRC (1998) for < 5.5 kg pigs. Multiples for other groups approx. as follows: 5.4-27.3 kg, 3 x NRC.
27.3-68.2 kg, 2.5 x NRC.
68.2 kg-Mkt, 1.5 x NRC.
Sows tend to be 2.5 x NRC for Vitamins in general.
Boars are similar to sows with extra margins set for several micro-nutrients.
Add 2.3 IU of Vitamin E/lb of complete diet for each 1% fat above 3% total dietary fat.

[b] Pelleting and(or) expanding decreases Vitamin stability by 10-12% and 15-20% respectively. Consult Vitamin manufacturer to verify the extent by vitamin so additional fortification can be made as required.

[c] Nutritional levels are shown for Zinc and Copper. Chemotherapeutic levels of Zinc as follows: < 5.4 kg 2600 PPM; 5.4-27.3 kg., 2200 PPM; 27.3-68.2 kg, 1600 PPM. Chemotherapeutic levels of Copper is 220 PPM for each phase. Inorganic forms assumed.

[d] Supplemental iron are near to NRC levels because of the substantial iron content of di-calcium phosphate and because high iron intake encourages E.Coli proliferation in the young pig.

Vitamin and Trace Mineral Addition Rates: PIC Multiplication[a, b]

PIC recommendations were established after extensive comparison with University and major Nutrition groups. A systematic allowance was made relative to the NRC
Micronutrient recommendations for Vitamins D and Biotin are contractual for Multiplication. Other micronutrients are recommended minimums. Levels shown assume micronutrient additions and give no credit for ingredient content.

Table 21. Suggested specifications: Amount per kg. of complete diet.

		Nursery		Grow-Finish		Sow	Boar
Nutrient	**Unit**	**< 5.5 kg**	**5.5-27.3 kg**	**27.3-68.2 kg**	**68.2-Mkt**	**Gest - Lact**	**Stud**
Vitamin A	IU/kg	11000	9900	7700	5720	9900	9900
Vitamin D	IU/kg	1870	1760	1540	1320	1760	1760
Vitamin E	IU/kg	83.6	77	33	22	66	110
Vitamin K	mg/kg	5.5	4.4	3.3	2.2	4.4	4.4
Choline	mg/kg	440	330	110	0	660	660
Niacin	mg/kg	70.4	44	26.4	22	44	44
Riboflavin	mg/kg	13.2	9.9	5.72	4.	9.9	9.9
d-Pantothenate	mg/kg	39.6	33	19.8	14.3	33	33
Vitamin B12	mcg/kg	55	44	26.4	22	37.4	37.4
Folic Acid	mcg/kg	1045	770	748	451	1320	1650
d-Biotin	mcg/kg	330	275	275	198	220	550
Thiamine	mg/kg	3.6	3.3	2.42	1.54	2.2	2.2
Pyridoxine	mg/kg	7.04	4.4	2.42	1.54	3.3	3.3
Vitamin C (stable)	mg/kg	132	0	0	0	0	132
Zinc	PPM	135[c]	125[c]	100	70	125	125
Iron	PPM	110[d]	100[d]	80	65	100	100
Manganese	PPM	40	35	20	16	35	35
Copper	PPM	18[c]	15[c]	12	10	15	15
Iodine	PPM	0.65	0.55	0.40	0.35	0.35	0.65
Selenium	PPM	0.30	0.30	0.30	0.30	0.30	0.30

[a] Multiplication VTM requires the addition of greater amounts of Vitamins D and Biotin in Nursery and Grow-Finish diets as compared to commercial specifications. The addition of Folic Acid, Thiamine and Pyridoxine during the Grow-Finish phase is suggested as an extra precaution. Addition rates assume an ME level typical for Corn-Soy diets.
B-Vitamins are supplemented at about 3.5 x NRC (1998) for < 5.45 kg pigs. Multiples for other groups approx. as follows: 5.45-27.3 kg, 3 x NRC.
27.3-68.2 kg, 2.5 x NRC.
68.2-Mkt, 1.5 x NRC.
Sows tend to be 2.5 x NRC for Vitamins in general.
Boars are similar to sows with extra margins set for several micronutrients.
Add 2.3 IU of Vitamin E / lb of complete diet for each 1% fat above 3% total dietary fat.

[b] Pelleting and(or) expanding decreases Vitamin stability by 10-12% and 15-20% respectively. Consult Vitamin manufacturer to verify the extent by vitamin so additional fortification can be made as required.

[c] Nutritional levels are shown for Zinc and Copper. Chemotherapeutic levels of Zinc as follows: < 5.4 kg 2600 PPM; 5.4-7.3 kg., 2200 PPM; 7.3-10 kg, 1600 PPM. Chemotherapeutic level for Copper is 225 PPM for each phase. Inorganic forms assumed. Sulfate forms of Zn, Fe, Mn and Cu are preferred.

[d] Supplemental iron are near to NRC levels because of the substantial iron content of di-calcium phosphate and because high iron intake encourages E.Coli proliferation in the young pig.

Alternative ingredients

With the price increase in corn and soybean meal many producers are looking at using alterative ingredients like corn dried distiller's grains, bakery by-products, glycerin and fractioned corn. Please remember that these products are by-products and users must be careful when using them. Some alternative ingredients are not well studied and should be used with extreme caution. Glycerin is still being studied for an energy source and therefore the use should be limited with a max of 6% because of knowledge and feed flowability. These products tend to be very variable in nutrients and may contain mycotoxins. Ingredient samples must be taken and analyzed to determine their nutrient levels. Consistency is very important so try and work with one plant when receiving alternative ingredients to get a consistent product. When dealing with alternative ingredients producers must keep in mind feed mill space, feed flowability, and carcass traits.

There are two feeding strategies for DDGS they are 1) Step up program, 2) High inclusion. The idea of a step up program is to slowly let the pigs get used to the taste and smell of DDGS and not adding a lot of DDGS suddenly. The second idea is to have a high level of DDGS in the starter diets so the pigs will have to get used to DDGS early and use more DDGS faster. New research from Gaines et al. (2007), indicates decreased carcass yield with high levels of DDGS due to increased intestine weight. Other ingredients that may decrease yield if used at a too high of level are soybean meal, wheat midds and soy hulls.
Some packers are now testing for iodine value (IV) which is a measure of the level of unsaturation or softness of a fat. Benz et al. (2007a,c) has proven that IV will increase with inclusion of oils with high levels of unsaturated fatty acids like corn oil from DDGS. Other ingredients that will increase IV are extruded expelled soybean meal (Benz et al., 2007b) and high oil corn. Below is an example of the amount (%) of DDGS that can be added to nursery and finishing diets that will minimize the yield decline and keep the IV low (Table 22). This guide also shows when new ingredients are used that only 5% increases should be done. Stepping up faster with DDGS or other by-products can result in lower feed intakes. Other ingredients in the diet can also affect IV so consultant with your nutritionist and packer on IV specs. Breeding herd inclusions are shown in Table 23.

Research also has proved that when dietary linoleic acid is increased this will cause IV to increase.

Producers must work closely with their nutritionists to implement these ingredients in their diets.

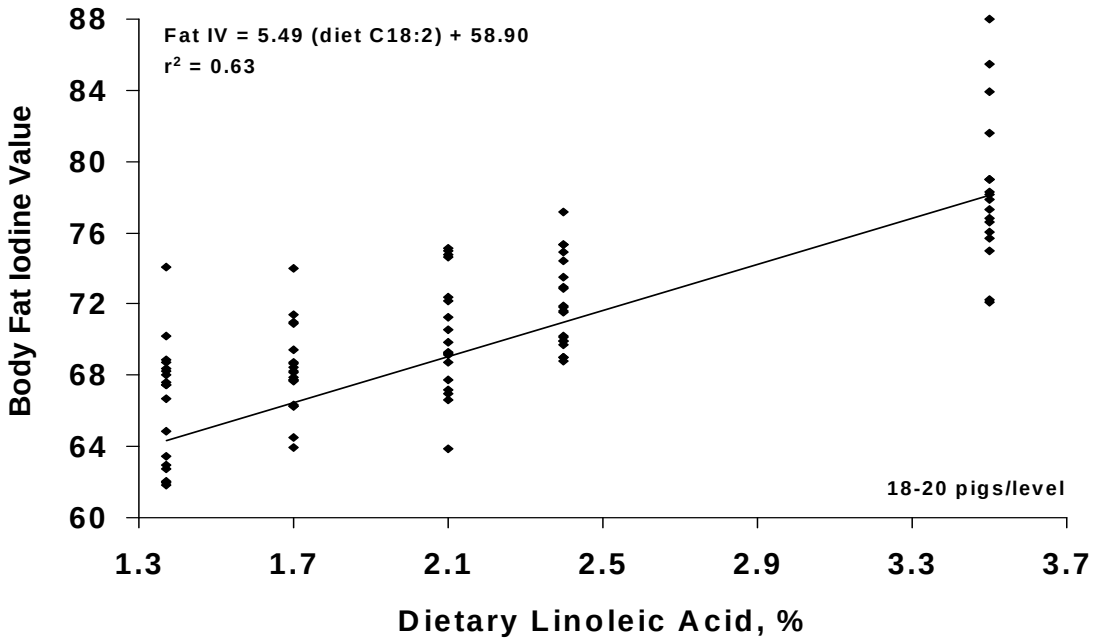
Table 22. Amount of DDGS in diets for market pigs or replacement gilts.

DDGS	Unit	5.4-6.8	6.8-11.3	11.3-22.7	22.7-40.9	40.9-68.1	68.1-95.0	100.4-127.3	Paylean
Market	%	0.0	5.0	10.0	15.0	15.0	10.0	0.0	0.0
Multiplication	%	0.0	5.0	10.0	15.0	15.0	15.0	15.0	--

Table 23. Amount of DDGS in the breeding herd.

Diet	Unit	DDGS
Gestation	%	0 to 30
Lactation	%	0 to 20
Boar	%	0 to 15

Potential issues with feeding DDGS



Pork Quality

Below are pictures courtesy of Purdue University from bellies from pigs that were fed either 0%, 10%, 20%, or 30% DDGS. The pictures show the flop test and as higher levels of DDGS was fed the fat on the bellies got softer.

0% DDGS

10% DDGS

20% DDGS

30% DDGS

Paylean®[a]

Paylean® is a great product with proven results when diets are formulated correctly. With the new labeling in 2006 with Paylean®, market pigs can be fed to heavier weights. Please keep in mind that Paylean® should not be fed to replacement gilts or boars. Below is a guideline when feeding Paylean® for less than 21 days or greater than 21. With the SID lysine in the Paylean diet being high there is a risk of adding too much soybean meal and causing a yield reduction (Gaines et al., 2004 and 2007).

Table 24. Diet specifications for diets with Paylean®

Paylean®	Unit	< 21 days	> 21 days
Growth rate	kg/day	1.02	.97
Feed intake	Kg/day	2.7	2.8
Feed:Gain ratio	F/G	2.71	2.88
NRC ME	kcal/kg	3410	3410
SID Lysine	%	0.95	0.85
Added Fat	%	2 to 3	2 to 3
SID Meth + Cystine:lysine	Ratio	0.55	
SID Threonine:lysine	Ratio	0.68	
SID Tryptophan:lysine	Ratio	0.16	
SID Valine:lysine	Ratio	0.68	
SID Isoleucine:lysine	Ratio	0.56	
Calcium	%	0.56	
T Phosphorus	%	0.51	
aPhosphorus	%	0.24	
Added salt	%	0.30	
Min L-lysine	%	0.30	
Max L-lysine	%	0.40	

[a] Paylean® is Elanco's trade mark for ractopamine HCl.

Effects of nutrition on yield

Recent research has demonstrated that ingredient type can affect the yield of PIC finishing pigs. As mentioned in the alternative ingredient section, high fiber ingredients have shown to decrease yield. Also in the Paylean® section references low soybean meal and high synthetic amino acid diets can increase yield. High levels of soybean meal throughout the finishing period can also cause low yield. Below is a trial conducted with high levels of soybean meal and low levels of synthetic amino acids (Tables 25 and 26).

Table 25. Effects of soybean meal on carcass yield[a]

	SBM levels			*P* - value
Diets	Low	Medium	High	Linear
Corn, %	69.8	64.5	59.2	--
SBM, %	22.5	27.6	32.7	--
L-Lysine, %	0.225	0.225	0.225	--
Results				
Carcass weight, kg	101.0	99.2	98.1	0.05
Carcass yield, %	76.5	76.2	74.4	0.09

[a] Pigs were PIC 337 x Camborough with 8 replications per treatment.

Table 26. Effect of low versus high synthetic amino acid diets for PIC gilts fed Paylean® (6.5 g/ton) for 21 days[a]

	L-Lysine, kg/ton			
Item	.68 kg (252.7 kg/ton SBM)	2.7 kg (180.9 kg/ton SBM)	SEM	*P*-Value
Growth				
Day 0 BW, kg	104.4	104.9	1.30	0.57
Day 21 BW,kg	126.3	126.4	1.50	0.96
ADG, kg/d	1.04	1.02	0.03	0.33
ADFI, kg/d	2.81	2.76	0.08	0.32
Feed/Gain	2.70	2.70	0.04	0.96
Carcass				
Carcass wt., kg	94.1	96.1	1.07	0.03
Backfat, mm	16.3	16.7	0.02	0.63
Yield, %	76.4	77.6	0.38	0.05
Lean, %	56.0	55.8	0.29	0.69

[a]Data represents the means of 8 replicate pens (21 pigs/pen). Diets were formulated to a 0.95% SID lysine (2.78 g SID lysine/Mcal ME) and fed for 21 days. Trial was conducted at PorkTech, LLC (Moberly, MO).

Feed Manufacturing

Guidelines for feed manufacturing for PIC pigs.

Meal feed:
Roller mill
700 microns with a standard deviation of < 2.3
Mixing CV of less than 10%

- < 30 % over 1 mm
- < 20 % under 300 microns
- < 2.5 % under 150 microns

Pellets:
Hammer mill
500 microns with a standard deviation of < 2.5
PDI > 90

Feed Form:
With increased feed prices feed efficiency has become increasingly important. PIC has done a number of large scale trials comparing feed form of meal and pellets on feed efficiency. Below are a few trials comparing sire lines and meal versus pellets on growth performance (Table 27, 28 and 29). The trial results demonstrate that feeding pellets will improve (6% to 10%) feed efficiency in all sire lines however full value pigs may be higher (1% to 3%) in meal diets for some lines. All pigs were not vaccinated for PCV2 and not fed Paylean®.

Table 27. Impact of feed form on PIC 280 sired pigs[a]

	Sire line x Feed form		
Item	**PIC 280 Meal**	**PIC 280 Pellet**	***P* <**
On test weight, kg	28.6	29.2	0.53
Off test weight, kg	115.9	120.3	0.016
ADG, kg	.92	.96	0.0011
F/G	2.74	2.48	0.0001
Age at 125 kg, d	174.4	172.1	0.0001
Survival rate, %	97.2	98.2	0.27
Yield, %	74.5	74.6	0.19
Lean, %	54.7	54.5	0.23

[a] A total of 1,044 pigs (PIC 280 x Camborough) were used with 41 replications for meal and 43 replications for pellets.

Table 28. Impact of feed form on PIC 337 sired pigs[a]

	Sire line x Feed form		
Item	**PIC 337 Meal**	**PIC 337 Pellet**	***P <***
On test weight, kg	24.2	24.1	0.97
Off test weight, kg	120.6	122.4	0.01
ADG, kg	.95	.96	0.01
F/G	2.52	2.36	0.0001
Age at 125 kg, d	171.0	168.9	0.0003
Deads, %	2.1	3.1	0.18
Culls, %	3.5	4.1	0.52
Lean, %	56.1	55.6	0.0004

[a] A total of 1,730 pigs (PIC 337 x Camborough) were used with 75 replications for meal and 73 replications for pellets.

Table 29. Impact of feed form on PIC 380 sired pigs[a]

	Feed form		
Item	**Meal**	**Pellet**	***P <***
On test weight, kg	25.3	24.7	0.30
Off test weight, kg	121.9	122.8	0.22
ADG, kg	.95	.97	0.003
F/G	2.49	2.36	0.0001
Age at 125 kg, d	168.8	166.8	0.0001
Deads, %	1.5	3.4	0.01
Culls, %	1.5	2.9	0.06
Backfat, mm	17.3	18.0	0.0001
Loin depth, mm	58.6	59.9	0.0001
Lean, %	55.4	55.1	0.009

[a] A total of 1,699 pigs (PIC 380 x Camborough) were used with 76 replications for meal and 74 replications for pellets.

Feeder Space

Guidelines for feeder space for PIC pigs depending on feeder type.
Feeder Requirements:

Wet or Dry Feeders:
- Maximum of 12 pigs per feeder space
- Minimum of 35.5 centimeters per head space

Tube Feeders:
- Maximum of 10 pigs per tube
- Minimum of 5.0 centimeters trough space per pig

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DISCLAIMER. Performance data shown in Nutrient specification tables were obtained in Commercial settings and under conditions of high health, thermo-neutral temperature and good management. They are not guaranteed levels of performance. A competent Nutritionist should adapt suggested Nutrient levels to specific conditions. These concepts are discussed in greater detail in Nutrition Technical Updates for Sows, Nursery pigs and Grow-Finish pigs.

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