

CHAPTER 6

Nutritional Requirements of Swine Breeders

- Gestation and Lactation -

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INTRODUCTION

The high prolificacy of swine breeders has allowed for an increase in the number of animals sold, thereby enhancing the profitability of the production system. Nonetheless, higher physiological and metabolic demands have been observed in hyper-prolific sows, influencing their nutritional requirements, especially in terms of energy and amino acids.

The nutritional requirement tables present in this chapter were determined from research carried out with female swine breeders reared under national conditions, enriched by data from international literature regarding physiological and metabolic conditions.

The advancement in nutritional concepts concerning the amino acid requirements of hyper-prolific swine breeders has led to the understanding that some amino acids are essential for the production of metabolites important for specific physiological functions, in addition to being necessary for maintenance and tissue synthesis, as well as having regulatory roles within the animal's body.

The metabolic demands on current swine breeders frequently result in body weight losses during lactation and post-weaning, necessitating recuperation in the subsequent gestation. This highlights the importance of taking into account adjustments in nutritional requirements to ensure adequate reproductive performance in the future.

Swine breeders exhibit differences in nutritional requirements based on parity order, attributable to different physiological components, including body growth, the number of piglets born, and weight loss during lactation, among others. As a result, as gilts and sows advance in the number of parities, the deposition of maternal protein decreases, and the protein and amino acid requirements are focused on replenishing the reserves that were mobilized during the previous lactation.

In this chapter, metabolizable energy, crude and digestible protein, total and digestible essential amino acids, minerals, total calcium, available and digestible phosphorus, sodium, potassium, and chloride requirements are presented. The recommendations for trace minerals

and vitamins are assumed to be adequately met, provided the levels supplied are equivalent to those described in Chapter 7.

The macronutrient requirements of swine breeders were established as the amount of nutrients per day per animal for optimal performance. Equations to determine the daily metabolizable energy (ME) and standardized ileal digestible (SID) lysine requirements for gestating and lactating sows are presented. These equations take into account factors during the gestation phase such as body weight, weight gain, number of piglets, reproductive gain, mammary gland development, maternal growth, and recovery from weight loss from the previous lactation. For the lactation phase, factors considered include litter size, body weight, weight loss, litter weight gain, mammary gland involution, and weight loss during the weaning-to-estrus interval. This information is detailed in the Guidelines Tables (Tables 6.06 and 6.15).

The nutritional requirements of gestating swine breeders are estimated across four categories: nulliparous, primiparous, secundiparous, and multiparous. For lactating swine breeders, the requirements are estimated for three categories: primiparous, secundiparous, and multiparous. Additionally, the body mobilization of swine breeders was considered, taking into account their parity order. Daily feed intake was estimated using values obtained from the ME equation and the dietary energy content, enabling the calculation of the percentage of dietary nutrients.

As an example of the variation in ME and SID lysine requirements, data on the performance of gestating and lactating swine breeders are presented, in which the daily requirements for ME and SID lysine are calculated.

The nutritional requirements of the other essential amino acids were calculated by applying the ideal protein concept, i.e., by maintaining the ratio of each amino acid to lysine and expressed in standardized ileal digestibility (SID) and total content. The total lysine requirement was

calculated considering an average standardized ileal lysine digestibility of 88%.

To ensure that nonessential amino acids are not limiting when synthetic amino acids are included in commercial diets, the 35% essential nitrogen to total nitrogen (Ne:Total N) ratio was considered for the gestation phase, and the 39% Ne:Total N was considered for the lactation phase of swine breeders. The minimum levels of dietary crude and digestible protein for gestating and lactating swine breeders may be estimated through the proportions of SID lysine in crude and digestible protein, respectively.

The main nutrients are presented in g/day and as a % of the diet for swine breeders with different productivity levels.

Nutritional Requirements of Swine Breeders

- Gestation -

Table 6.01 - Equations to Estimate Maternal Weight Gain (MWG) and Reproductive Weight Gain (RWG) of Gestating Gilts and Sows¹

$$\text{MWG (kg/day)} = (0.01503 - 0.00011 \times \text{average days}) \times \text{total MWG (kg)}$$

$$\text{RWG}_{0-85 \text{ days}} \text{ (kg/day)} = (0.000246 \times \text{average days}) \times \text{N}^{\circ} \text{ piglets}$$

$$\text{RWG}_{86-115 \text{ days}} \text{ (kg/day)} = (-0.0307 + 0.000726 \times \text{average days}) \times \text{N}^{\circ} \text{ piglets}$$

MWG = Maternal Weight Gain (kg/day)

RWG = Reproductive Weight Gain (uterus + fetuses + fluids + placenta + mammary tissue = 2.33 kg/piglet)

Gestation = 115 days

Example:

Initial Sow Weight = 150 kg

Total MWG = 30 kg; No. piglets = 14

Average Days (period of gestation de 0 – 85 days) = 42.5 days

Average Days (period of gestation de 86 – 115 days) = 100.5 days

$$\text{MWG}_{0-85 \text{ days}} \text{ (kg/day)} = (0.01503 - 0.00011 \times 42.5) \times 30 = 0.311 \text{ kg/day}$$

$$\text{MWG}_{86-115 \text{ days}} \text{ (kg/day)} = (0.01503 - 0.00011 \times 100.5) \times 30 = 0.119 \text{ kg/day}$$

$$\text{RWG}_{0-85 \text{ days}} \text{ (kg/day)} = (0.000246 \times 42.5) \times 14 = 0.146 \text{ kg/day}$$

$$\text{RWG}_{86-115 \text{ days}} \text{ (kg/day)} = (-0.0307 + 0.000726 \times 100.5) \times 14 = 0.592 \text{ kg/day}$$

¹ Estimated values from Brazilian experimental data, NRC (1998, 2012), Close & Cole (2001), and Mejia et al. (2007).

Table 6.02 - Equation to Estimate Metabolizable Energy (ME, kcal/day) Requirements and Feed Intake of Gestating Gilts and Sows (g/day)¹

$$\text{ME Req.} = 106 W^{0.75} + 4915 \text{ MWG} + 1826 \text{ RWG}$$

W = Average Body Weight (kg)

MWG = Maternal Weight Gain (kg/day)

RWG = Reproductive Weight Gain (uterus+ fetuses + fluids + placenta + mammary tissue = 2.33 kg/piglet) kg/day; Gestation = 115 days

Example:

²AWP_{0-85 days} = 169 kg ($W^{0.75} = 46.872$); AWP_{86-115 days} = 200.9 kg ($W^{0.75} = 53.362$); No. piglets = 14

MWG_{0-85 days} (kg/day) = 0.311; MWG_{86-115 days} (kg/day) = 0.119 (Table 6.01)

RWG_{0-85 days} (kg/day) = 0.146; RWG_{86-115 days} (kg/day) = 0.592 (Table 6.01)

ME Req. 0-85 days = $(106 \times 46.872 + (4915 \times 0.311) + (1826 \times 0.146)$

ME Req. 0-85 days = 6764 kcal/day

ME Gestation Diet = 3100 kcal/kg

Recommended Feed Intake_{0-85 days} = $6764 / 3100 = 2182 \text{ g/day}$

ME Req. 86-115 days = $(106 \times 53.362) + (4915 \times 0.119) + (1826 \times 0.592)$

ME Req. 86-115 days = 7322 kcal/day

ME Gestation Diet = 3100 kcal/kg

Recommended Feed Intake_{86-115 days} = $7322 / 3100 = 2362 \text{ g/day}$

¹ Estimated values from Brazilian experimental data, NRC (1998, 2012), Close & Cole (2001), and Mejia et al. (2007).

² AWP = average weight in the phase.

Table 6.03 - Equation to Estimate Standardized Digestible Lysine (SID Lys) Requirements of Gestating Gilts and Sows (g/day)¹

$$\text{SID Lys (g/day)} = (0.036 W^{0.75})/0.7 + 22.6 \text{ MWG} + 22.6 \text{ RWG}$$

W = Average Body Weight (kg)

MWG=Maternal Weight Gain (kg/day)

RWG=Reproductive Weight Gain (uterus + fetuses + fluids + placenta + mammary tissue = 2.33 kg/piglet) kg/day; Gestation = 115 days

Example:

AWP₀₋₈₅ = 169 kg ($W^{0.75} = 46.872$); AWP₈₆₋₁₁₅ = 200.8 kg ($W^{0.75} = 53.362$); No. piglets = 14

MWG_{0-85 days} (kg/day) = 0.311; MWG_{86-115 days} (kg/day) = 0.119 (Table 6.02)

RWG_{0-85 days} (kg/day) = 0.146; RWG_{86-115 days} (kg/day) = 0.592 (Table 6.02)

AWP = average weight in the phase.

SID Lys Req. _{0-85 days} = $(0.036 \times 46.872) / 0.7 + (22.6 \times 0.311) + (22.6 \times 0.146)$

SID Lys Req. _{0-85 days} = 12.74 g/day

Recommended Feed Intake _{0-85 days} = 2182 g/day

Dietary % SID Lysine = 0.583 %

SID Lys Req. _{86-115 days} = $(0.036 \times 53.362) / 0.7 + (22.6 \times 0.119) + (22.6 \times 0.592)$

SID Lys Req. _{86-115 days} = 18.81 g/day

Recommended Feed Intake _{86-115 days} = 2362 g/day

Dietary % SID Lys = 0.796 %

¹ Estimated values from Brazilian experimental data, NRC (1998, 2012), Close & Cole (2001), and Mejia et al. (2007).

Table 6.04 - Amino Acid to Lysine Ratio Used to Estimate Amino Acid Requirements of Swine Breeders: Gestation

Phase		Gestation			
		0 – 85 days		86 – 115 days	
Amino Acids		SID	Total	SID	Total
Lysine	%	100	100	100	100
Methionine	%	34	33	35	34
Methionine + Cysteine	%	68	67	70	69
Threonine	%	77	80	80	83
Tryptophan	%	20	20	20	20
Arginine	%	100	97	113	110
Valine	%	73	73	77	77
Isoleucine	%	60	60	60	60
Leucine	%	100	89	100	94
Histidine	%	35	34	35	34
Phenylalanine	%	55	54	56	55
Phenylalanine + Tyrosine	%	110	108	112	110

Table 6.05 - Example of Calculation of Digestible Essential Nitrogen (Dig. Ne), Total Essential Nitrogen (Net), and Digestible and Total Crude Protein Requirements of Swine Breeders: Gestation¹

Amino Acids	N (%)	SID AA Req. (%)	Dig. Ne (%)	Total AA Req. (%)	Net (%)
Lysine	19.16	0.742	0.142	0,843	0,163
Methionine	9.39	0.260	0.024	0,287	0,027
Threonine	11.76	0.593	0.070	0,700	0,083
Tryptophan	13.72	0.148	0.020	0,169	0,023
Arginine	32.16	0.838	0.270	0,927	0,299
Valine	11.96	0.571	0.068	0,649	0,078
Isoleucine	10.68	0.445	0.048	0,506	0,054
Leucine	10.68	0.742	0.079	0,792	0,085
Histidine	27.08	0.260	0.070	0,287	0,078
Phenylalanine	8.48	0.415	0.035	0,463	0,040
Dig. Ne Req.		0.827		0.925	
Net Req. ²		2.362		2.644	
Protein Req. ³		14.76		16.53	

¹ Example for second parity sows (period of gestation from 86 to 115 days).

² Dig. Ne: Nt ratio of 35%.

³ Conversion factor of N to protein: 6.25.

86 to 115 days – SID Lys: Digestible Protein ratio of 5.0.

86 to 115 days – SID Lys: Crude Protein ratio of 4.5.

- Total lysine requirement was calculated considering 88.0% the ileal digestibility of lysine in the diet. Total amino acid to total lysine ratios were used to estimate total amino acid requirements (Table 6.04).

Example. Simplified calculation of protein level from 86 to 115 days:

% Digestible Protein = (% SID Lys x 100) / 5 = (0.742 x 100) / 5 = 14.8%

% Crude Protein = (% SID Lys x 100) / 4.5 = (0.742 x 100) / 4.5 = 16.5%

Example. Simplified calculation of protein level from 0 to 85 days:

% Digestible Protein = (% SID Lys x 100) / 5.3 = (0.453 x 100) / 5.3 = 8.6%

% Crude Protein = (% SID Lys x 100) / 4.7 = (0.453 x 100) / 4.7 = 9.6%

Table 6.06 - Guidelines for Swine Breeders: Gestation

Phase / Variable	Parity Order ¹			
	Nulliparous	PO1	PO2	≥PO3
At Insemination				
Average Body Weight, kg	150	172	188	219
BT P2 ² , mm ²	14	15	15	15
At Gestation				
Body Weight Gain, kg	63	68	72	78
Number of Piglets	14	15	15	15
Reproductive Gain, kg	28	30	30	30
Mammary Gland Development	5.0	5.0	5.0	5.0
Maternal Development, kg	30	20	15	13
Weight Lost/ Recovery, kg	0	13	22.2	30
At Farrowing				
Average Body Weight, kg ³	213	240	260	298
BT P2, mm	18	19	19	19

¹PO1 = parity 1 (Primiparous); PO2= parity 2 (Secundiparous); ≥PO3= Multiparous with 3 or more parities. Calculations of parity 4 sows were used for this category.

²Backfat thickness at point P2 (6 cm away from dorsal midline at the last rib).

³Sow weight before farrowing.

Table 6.07 - Daily Nutritional Requirements of Gestating Swine Breeders (kcal/day and g/day)

Item		Nulliparous		PO1	
		0 – 85	86 – 115	0 – 85	86 – 115
Average Body Weight	kg	150	189	172	203
Maternal Weight Gain	kg/day	0,311	0,119	0,207	0,080
Reproductive Weight Gain	kg/day	0,146	0,592	0,157	0,634
Metabolizable Energy (ME)	kcal/day	6772	7323	6676	7634
Diet ME (DME)	kcal/kg	3100	3100	3100	3100
Diet Net Energy	kcal/kg	2400	2400	2400	2400
Intake (ME/DME)	g/day	2184	2362	2153	2461
Nutrient					
Calcium	g/day	17.0	18.5	17.5	19.0
Available Phosphorus	g/day	8.9	9.7	9.2	10.0
Digestible Phosphorus	g/day	8.0	8.7	8.3	9.0
Potassium	g/day	7.4	8.0	8.5	9.1
Sodium	g/day	3.7	3.9	4.2	4.4
Chlorine	g/day	2.9	3.0	3.2	3.4
Digestible Protein and Amino Acids					
Digestible Protein	g/day	241.8	374.4	205.6	379.7
Lysine	g/day	12.73	18.80	10.83	19.07
Methionine	g/day	4.32	6.59	3.68	6.67
Methionine + Cysteine	g/day	8.67	13.18	7.36	13.36
Threonine	g/day	9.81	15.05	8.33	15.26
Tryptophan	g/day	2.56	3.76	2.17	3.81
Arginine	g/day	12.73	21.26	10.83	21.56
Valine	g/day	9.30	14.48	7.90	14.69
Isoleucine	g/day	7.64	11.29	6.50	11.44
Leucine	g/day	12.73	18.80	10.83	19.07
Histidine	g/day	4.46	6.59	3.79	6.67
Phenylalanine	g/day	7.01	10.53	5.96	10.68
Phenylalanine + Tyrosine	g/day	14.00	21.07	11.91	21.36
Digestible Essential Nitrogen	g/day	13.54	20.97	11.52	21.26
Total Protein and Amino Acids					
Crude Protein	g/day	268.4	412.9	228.4	429.0
Lysine	g/day	14.46	21.35	12.29	21.68
Methionine	g/day	4.76	7.25	4.05	7.38
Methionine + Cysteine	g/day	9.70	14.74	8.25	14.96
Threonine	g/day	11.58	17.72	9.84	17.99
Tryptophan	g/day	2.88	4.28	2.45	4.33
Arginine	g/day	14.02	23.48	11.93	23.85
Valine	g/day	10.55	16.44	8.98	16.69
Isoleucine	g/day	8.67	12.80	7.38	13.02
Leucine	g/day	12.86	20.08	10.94	20.38
Histidine	g/day	4.91	7.25	4.18	7.38
Phenylalanine	g/day	7.80	11.74	6.63	11.94
Phenylalanine + Tyrosine	g/day	15.62	23.48	13.28	23.85
Total Essential Nitrogen	g/day	14.59	23.12	12.79	22.64

Table 6.07 - Daily Nutritional Requirements of Gestating Swine Breeders (kcal/day and g/day) continuation...

Item		PO2		≥PO3	
		0 – 85	86 – 115	0 – 85	86 – 115
Average Body Weight	kg	188	214	219	244
Maternal Weight Gain	kg/day	0,155	0,060	0,135	0,052
Reproductive Weight Gain	kg/day	0,157	0,634	0,157	0,634
Metabolizable Energy (ME)	kcal/day	6710	7857	7237	8480
Diet ME (DME)	kcal/kg	3100	3100	3100	3100
Diet Net Energy	kcal/kg	2400	2400	2400	2400
Intake (ME/DME)	g/day	2164	2534	2334	2735
Nutrient					
Calcium	g/day	18.0	19.5	18.0	19.5
Available Phosphorus	g/day	9.5	10.3	9.5	10.3
Digestible Phosphorus	g/day	8.5	9.2	8.5	9.2
Potassium	g/day	8.7	9.3	8.7	9.3
Sodium	g/day	4.5	4.7	4.5	4.7
Chlorine	g/day	3.3	3.5	3.3	3.5
Digestible Protein and Amino Acids					
Digestible Protein	g/day	186.0	373.7	182.5	376.3
Lysine	g/day	9.80	18.79	9.62	18.93
Methionine	g/day	3.33	6.58	3.27	6.62
Methionine + Cysteine	g/day	6.66	13.15	6.54	13.24
Threonine	g/day	7.55	15.01	7.42	15.12
Tryptophan	g/day	1.97	3.75	1.91	3.77
Arginine	g/day	9.80	21.22	9.62	21.36
Valine	g/day	7.16	14.46	7.03	14.55
Isoleucine	g/day	5.88	11.27	5.76	11.35
Leucine	g/day	9.80	18.79	9.62	18.93
Histidine	g/day	3.44	6.58	3.36	6.62
Phenylalanine	g/day	5.39	10.51	5.30	10.58
Phenylalanine + Tyrosine	g/day	10.77	21.04	10.57	19.28
Digestible Essential Nitrogen	g/day	10.43	20.94	10.22	21.09
Total Protein and Amino Acids					
Crude Protein	g/day	207.0	418.5	203.04	401.0
Lysine	g/day	11.14	21.34	10.94	21.51
Methionine	g/day	3.68	7.27	3.60	7.31
Methionine + Cysteine	g/day	7.46	14.74	7.34	14.83
Threonine	g/day	8.91	17.72	8.74	17.85
Tryptophan	g/day	2.23	4.28	2.20	4.30
Arginine	g/day	10.82	23.47	10.61	23.68
Valine	g/day	8.13	16.43	8.00	16.56
Isoleucine	g/day	6.68	12.81	6.57	12.92
Leucine	g/day	9.91	20.05	9.75	20.23
Histidine	g/day	3.79	7.27	3.72	7.31
Phenylalanine	g/day	6.01	11.75	5.92	11.82
Phenylalanine + Tyrosine	g/day	12.03	23.47	11.81	23.68
Total Essential Nitrogen	g/day	11.59	23.42	11.39	22.47

Table 6.08 - Nutritional Requirements of Gestating Swine Breeders (kcal/day and %)

Item		Nulliparous		PO1	
		0 – 85	86 – 115	0 – 85	86 – 115
Average Body Weight	kg	150	189	172	203
Maternal Weight Gain	kg/day	0.311	0.119	0.207	0.080
Reproductive Weight Gain	kg/day	0.146	0.592	0.157	0.634
Metabolizable Energy (ME)	kcal/day	6772	7323	6676	7634
Diet ME (DME)	kcal/kg	3100	3100	3100	3100
Diet Net Energy	kcal/kg	2400	2400	2400	2400
Intake (ME/DME)	g/day	2184	2362	2153	2461
Nutrient					
Calcium	%	0.778	0.783	0.813	0.772
Available Phosphorus	%	0.408	0.411	0.428	0.406
Digestible Phosphorus	%	0.366	0.368	0.386	0.366
Potassium	%	0.339	0.339	0.395	0.370
Sodium	%	0.169	0.165	0.195	0.179
Chlorine	%	0.133	0.127	0.149	0.138
Digestible Protein and Amino Acids					
Digestible Protein	%	11.07	15.85	9.55	15.43
Lysine	%	0.583	0.796	0.503	0.775
Methionine	%	0.198	0.279	0.171	0.271
Methionine + Cysteine	%	0.396	0.557	0.342	0.543
Threonine	%	0.449	0.637	0.387	0.620
Tryptophan	%	0.117	0.159	0.101	0.155
Arginine	%	0.583	0.899	0.503	0.876
Valine	%	0.426	0.613	0.367	0.597
Isoleucine	%	0.350	0.478	0.302	0.465
Leucine	%	0.583	0.796	0.503	0.775
Histidine	%	0.204	0.279	0.176	0.271
Phenylalanine	%	0.321	0.446	0.277	0.434
Phenylalanine + Tyrosine	%	0.641	0.892	0.553	0.868
Digestible Essential Nitrogen		0.620	0.888	0.535	0.864
Total Protein and Amino Acids					
Crude Protein	%	12.29	17.48	10.61	16.43
Lysine	%	0.662	0.904	0.571	0.881
Methionine	%	0.218	0.307	0.188	0.300
Methionine + Cysteine	%	0.444	0.624	0.383	0.608
Threonine	%	0.530	0.750	0.457	0.731
Tryptophan	%	0.132	0.181	0.114	0.176
Arginine	%	0.642	0.994	0.554	0.969
Valine	%	0.483	0.696	0.417	0.678
Isoleucine	%	0.397	0.542	0.343	0.529
Leucine	%	0.589	0.850	0.508	0.828
Histidine	%	0.225	0.307	0.194	0.300
Phenylalanine	%	0.357	0.497	0.308	0.485
Phenylalanine + Tyrosine	%	0.715	0.994	0.617	0.969
Total Essential Nitrogen	%	0.668	0.979	0.594	0.920

Table 6.08 - Nutritional Requirements of Gestating Swine Breeders (kcal/day and %) continuation...

Item		PO2		≥PO3	
		0 – 85	86 – 115	0 – 85	86 – 115
Average Body Weight	kg	188	214	219	242
Maternal Weight Gain	kg/day	0.155	0.060	0.104	0.040
Reproductive Weight Gain	kg/day	0.157	0.634	0.157	0.634
Metabolizable Energy (ME)	kcal/day	6706	7849	7247	8484
Diet ME	kcal/kg	3100	3100	3100	3100
Diet Net Energy	kcal/kg	2400	2400	2400	2400
Intake (ME/DME)	g/day	2163	2532	2338	2737
Nutrient					
Calcium	%	0.832	0.770	0.770	0.712
Available Phosphorus	%	0.439	0.407	0.406	0.376
Digestible Phosphorus	%	0.393	0.363	0.364	0.336
Potassium	%	0.402	0.367	0.372	0.340
Sodium	%	0.208	0.186	0.192	0.172
Chlorine	%	0.153	0.138	0.141	0.128
Digestible Protein and Amino Acids					
Digestible Protein	%	8.60	14.76	7.82	13.76
Lysine	%	0.453	0.742	0.412	0.692
Methionine	%	0.154	0.260	0.140	0.242
Methionine + Cysteine	%	0.308	0.519	0.280	0.484
Threonine	%	0.349	0.594	0.317	0.554
Tryptophan	%	0.091	0.148	0.082	0.138
Arginine	%	0.453	0.838	0.412	0.782
Valine	%	0.331	0.571	0.301	0.533
Isoleucine	%	0.272	0.445	0.247	0.415
Leucine	%	0.453	0.742	0.412	0.692
Histidine	%	0.159	0.260	0.144	0.242
Phenylalanine	%	0.249	0.416	0.227	0.388
Phenylalanine + Tyrosine	%	0.498	0.831	0.453	0.775
Digestible Essential Nitrogen		0.482	0.827	0.438	0.771
Total Protein and Amino Acids					
Crude Protein	%	9.57	16.53	8.70	14.65
Lysine	%	0.515	0.843	0.468	0.786
Methionine	%	0.170	0.287	0.154	0.267
Methionine + Cysteine	%	0.345	0.582	0.314	0.542
Threonine	%	0.412	0.700	0.374	0.652
Tryptophan	%	0.103	0.169	0.094	0.157
Arginine	%	0.500	0.927	0.454	0.865
Valine	%	0.376	0.649	0.342	0.605
Isoleucine	%	0.309	0.506	0.281	0.472
Leucine	%	0.458	0.792	0.417	0.739
Histidine	%	0.175	0.287	0.159	0.267
Phenylalanine	%	0.278	0.464	0.253	0.432
Phenylalanine + Tyrosine	%	0.556	0.927	0.505	0.865
Total Essential Nitrogen	%	0.536	0.925	0.487	0.821

Nutritional Requirements of Swine Breeders

- Lactation -

Table 6.09 - Equation to Estimate Metabolizable Energy Requirements (ME, kcal/day) and Feed Intake of Lactating Gilts and Sows (g/day)¹

$$\text{ME Req. (kcal/day)} = 106 W^{0.75} + 6230 \text{ LWG} - 4600 \text{ FWL}$$

$$\text{Correction for temperature} = 2.4 \times W^{0.75} (\text{TN} - \text{T})$$

W = Average Body Weight (kg)

LWG = Litter Weight Gain (kg/day)

FWL = Female Weight Loss Postpartum (kg/day)

TN = Thermoneutral Temperature (°C) = 20 °C

T = Average Temperature (°C)

Suggested average temperatures for ME requirement correction: between 14 and 26°C. Higher range temperature values may negatively influence performance and overestimate corrections for feed intake and nutritional levels.

Example:

W = 240 kg; $W^{0.75} = 60.976$

Litter = 14.1; Piglet birth weight = 1.3 kg; Piglet weaning weight = 5.90;

Lactation days = 23 days

$$\text{LWG} = ((5.90 - 1.3) \times 14.1) / 23 = 2.82 \text{ kg/day}$$

Weight at the Start of Lactation = 240 kg; Weight at the End of Lactation = 218.4 kg

$$\text{FWL} = (240 - 218.4) / 23 = 0.939 \text{ kg/day}$$

$$\text{ME Req.} = (106 \times 60.976) + (6230 \times 2.82) - (4600 \times 0.939)$$

$$\text{ME Req.} = (6463) + (17568) - (4319.4) = 19712 \text{ kcal/day}$$

ME Lactation Diet = 3400 kcal/kg

$$\text{Estimated Feed Intake} = 19712 / 3.40 = 5798 \text{ g/day}$$

Correction for Average Temperature of 25°C (TN = 20°C)

$$\text{Correction for T}^\circ = 2.4 \times 60.976 (20 - 25) = -731.7 \text{ kcal/day}$$

$$\text{ME Req. for } 25^\circ\text{C} = 19712 - 731.7 = 18980 \text{ kcal/day}$$

$$\text{Estimated Feed Intake} = 5582 \text{ g/day}$$

¹ Estimated values from Brazilian experimental data, NRC (1998, 2012), Close & Cole (2001), and e Mejia et al. (2007).

Table 6.10 - Equation to Estimate Standardized Digestible Lysine (SID Lys) Requirements of Lactating Gilts and Sows (g/day)¹

$$\text{SID Lys (g/day)} = 0.036 W^{0.75} + 23.6 \text{ LWG} - 7.0 \text{ FWL}$$

W = Average Body Weight (kg)

LWG = Litter Weight Gain (kg/day)

FWL = Female Weight Loss (kg/day)

Example:

W = 240 kg; $W^{0.75} = 60.976$

²Litter = 14.1; Piglet birth weight = 1.3 kg; Piglet weaning weight = 5.90; Lactation days = 23 days

$$\text{LWG} = ((5.90 - 1.3) \times 14.1) / 23 = 2.82 \text{ kg/day}$$

Weight at the Start of Lactation=240 kg; Weight at the End of Lactation=218.4 kg

$$\text{FWL} = (240 - 218.4) / 23 = 0.939 \text{ kg/day}$$

$$\text{SID Lys Req.} = (0.036 \times 60.976) + (23.6 \times 2.82) - (7.0 \times 0.939)$$

$$\text{SID Lys Req.} = (2.195) + (66.552) - (6.573) = 62.17 \text{ g/day}$$

Estimated Feed Intake = 5798 g/day (Table 6.09)

% Dietary SID Lys = 1.072 %

Correction for Average Temperature of 25°C (TN = 20°C)

SID Lys Req. = 62.17 g/day

Estimated Feed Intake = 5582 g/day (Table 6.09)

% Dietary SID Lys = 1.114 %

¹ Estimated values from Brazilian experimental data, NRC (1998, 2012), Close & Cole (2001), and e Mejia et al. (2007).

² Considering suckling piglets' mortality rate of 6%.

Table 6.11 - Amino Acid to Lysine Ratio Used to Estimate Amino Acid Requirements of Swine Breeders: Lactation

Amino Acids	Lactation		
		SID	Total
Lysine	%	100	100
Methionine	%	28	27
Methionine + Cysteine	%	56	55
Threonine	%	65	68
Tryptophan	%	22	22
Arginine	%	100	98
Valine	%	83	83
Isoleucine	%	60	60
Leucine	%	115	115
Histidine	%	40	39
Phenylalanine	%	58	57
Phenylalanine + Tyrosine	%	116	114

Table 6.12 - Example of Calculation Digestible Essential Nitrogen (Dig. Ne), Total Essential Nitrogen (Net), and Digestible and Total Crude Protein Requirements of Swine Breeders: Lactation¹

Amino Acids	N (%)	SID AA Req. (%)	Dig. Ne (%)	Total AA Req. (%)	Net (%)
Lysine	19.16	1.081	0.207	1.228	0.235
Methionine	9.39	0.303	0.028	0.335	0.031
Threonine	11.76	0.703	0.083	0.835	0.098
Tryptophan	13.72	0.238	0.033	0.270	0.037
Arginine	32.16	1.082	0.348	1.203	0.387
Valine	11.96	0.897	0.107	1.019	0.122
Isoleucine	10.68	0.649	0.069	0.737	0.079
Leucine	10.68	1.243	0.133	1.412	0.151
Histidine	27.08	0.432	0.117	0.479	0.130
Phenylalanine	8.48	0.627	0.053	0.700	0.059
Dig. Ne Req.		1.178		1.329	
Net Req. ²		3.023		3.408	
Protein Req. ³		18.88		21.30	

¹ Example for second parity order sows, litter weight gain of 3.10 kg/day, weight loss of 0.639 kg/day.

² Ne: Nt ratio of 39%.

³ Conversion factor of N to protein of 6.25.

SID Lys: Digestible Protein ratio of 5.7.

SID Lys: Crude Protein ratio of 5.1.

- Total lysine requirement was calculated considering 88.0% the ileal digestibility of lysine in the diet. Total amino acid to total lysine ratios were used to estimate total amino acid requirements (Table 6.11).

Example. Simplified calculation of protein level:

% Digestible Protein = (% SID Lys x 100) / 5.7 = (1.081 x 100) / 5.7 = 18.9 %

% Crude Protein = (% SID Lys x 100) / 5.1 = (1.081 x 100) / 5.1 = 21.2 %

Table 6.13 - Guidelines for Swine Breeders: Lactation

Phase/Variable	Parity Order ¹		
	PO1	PO2	≥PO3
Body Weight of Pre-Partum Sow, kg	213	240	280
BT P2 ² , mm	18	20	20
No. Piglets	13.2	14.1	14.1
Body Weight of Postpartum Sow, kg	185	210	240
Female Weight Loss During Lactation, kg	13	14.7	21.6

¹ PO1 = parity 1 (Primiparous); PO2= parity 2 (Secundiparous); >PO3= Multiparous with 3 or more parities. Calculations of parity 4 sows were used for this category.

² Backfat thickness at point P2 (6 cm away from dorsal midline at the last rib).

Table 6.14 - Nutritional Requirements of Lactating Gilts and Sows (kcal/day and g/day)

Parity Order		P01	
Female Weight Postpartum	kg	185	
Litter Weight Gain	kg/day	2.63	2.89
Weight Loss	kg/day	0.563	0.563
Metabolizable Energy	kcal/day	19125	20764
Diet Metabolizable Energy	kcal/kg	3400	3400
Diet Net Energy	kcal/kg	2540	2540
Intake	g/day	5625	6107
Nutrient			
Calcium	g/day	47.0	47.0
Available Phosphorus	g/day	26.0	28
Digestible Phosphorus	g/day	23.0	23.0
Potassium	g/day	17.5	17.5
Sodium	g/day	12.0	12.0
Chlorine	g/day	11.0	11.0
Digestible Protein and Amino Acids			
Digestible Protein	g/day	1047	1156
Lysine	g/day	59.96	66.20
Methionine	g/day	16.76	18.57
Methionine + Cysteine	g/day	33.58	37.07
Threonine	g/day	38.98	43.05
Tryptophan	g/day	13.22	14.53
Arginine	g/day	59.96	66.20
Valine	g/day	49.78	54.96
Isoleucine	g/day	36.00	39.70
Leucine	g/day	68.96	76.15
Histidine	g/day	23.96	26.50
Phenylalanine	g/day	34.76	38.41
Phenylalanine + Tyrosine	g/day	69.58	76.76
Digestible Essential Nitrogen	g/day	65.36	72.18
Total Protein and Amino Acids			
Crude Protein	g/day	1181	1305
Lysine	g/day	68.12	75.24
Methionine	g/day	18.39	20.34
Methionine + Cysteine	g/day	37.46	41.41
Threonine	g/day	46.29	51.18
Tryptophan	g/day	14.96	16.55
Arginine	g/day	66.77	73.71
Valine	g/day	56.53	62.47
Isoleucine	g/day	40.89	45.13
Leucine	g/day	78.36	86.54
Histidine	g/day	26.55	29.31
Phenylalanine	g/day	38.81	42.87
Phenylalanine + Tyrosine	g/day	77.68	85.74
Total Essential Nitrogen	g/day	73.74	81.41

Table 6.14 - Nutritional Requirements of Lactating Gilts and Sows (kcal/day and g/day) continuation...

Parity Order		PO2		≥ PO3	
Female Weight Postpartum	kg	210		240	
Litter Weight Gain	kg/day	2.82	3.10	2.82	3.10
Weight Loss	kg/day	0.639	0.639	0.939	0.939
Metabolizable Energy	kcal/day	20476	22233	19712	21469
Diet Metabolizable Energy	kcal/kg	3400	3400	3400	3400
Diet Net Energy	kcal/kg	2540	2540	2540	2540
Intake	g/day	6022	6539	5798	6314
Nutrient					
Calcium	g/day	52	52	50.0	50.0
Available Phosphorus	g/day	28.0	28.0	27.0	27.0
Digestible Phosphorus	g/day	25.0	25.0	25.0	25.0
Potassium	g/day	20.0	20.0	19.0	19.0
Sodium	g/day	13.0	13.0	13.0	13.0
Chlorine	g/day	12.0	12.0	12.0	12.0
Digestible Protein and Amino Acids					
Digestible Protein	g/day	1119	1235	1085	1202
Lysine	g/day	64.07	70.69	62.15	68.82
Methionine	g/day	17.95	19.81	17.39	19.26
Methionine + Cysteine	g/day	35.89	39.56	34.79	38.52
Threonine	g/day	41.67	45.97	40.41	44.77
Tryptophan	g/day	14.09	15.56	13.68	15.15
Arginine	g/day	64.07	70.69	62.15	68.82
Valine	g/day	53.17	58.65	51.60	57.14
Isoleucine	g/day	38.42	42.44	37.28	41.29
Leucine	g/day	73.71	81.28	71.49	79.18
Histidine	g/day	25.65	28.25	24.87	27.53
Phenylalanine	g/day	37.16	41.00	36.06	39.90
Phenylalanine + Tyrosine	g/day	74.31	82.00	72.13	79.81
Digestible Essential Nitrogen	g/day	69.86	77.03	67.72	75.01
Total Protein and Amino Acids					
Crude Protein	g/day	1263	1393	1225	1356
Lysine	g/day	72.81	80.30	70.62	78.17
Methionine	g/day	19.63	21.71	19.08	21.09
Methionine + Cysteine	g/day	40.05	44.14	38.85	43.00
Threonine	g/day	49.50	54.60	48.01	53.16
Tryptophan	g/day	16.02	17.66	15.54	17.17
Arginine	g/day	71.36	78.66	69.23	76.65
Valine	g/day	60.40	66.63	58.62	64.91
Isoleucine	g/day	43.66	48.19	42.38	46.91
Leucine	g/day	83.71	92.33	81.23	89.91
Histidine	g/day	28.42	31.32	27.54	30.50
Phenylalanine	g/day	41.49	45.77	40.24	44.58
Phenylalanine + Tyrosine	g/day	82.98	91.55	80.53	89.15
Total Essential Nitrogen	g/day	78.83	86.84	76.42	84.61

Table 6.15 - Daily Nutritional Requirements of Lactating Gilts and Sows (kcal/day and %)

Parity Order		PO1	
Female Weight Postpartum	kg	185	
Litter Weight Gain	kg/day	2.63	2.90
Weight Loss	kg/day	0.563	0.563
Metabolizable Energy	kcal/day	19125	20764
Diet Metabolizable Energy	kcal/kg	3400	3400
Diet Net Energy	kcal/kg	2540	2540
Intake	g/day	5625	6107
Nutrient			
Calcium	%	0.836	0.770
Available Phosphorus	%	0.462	0.458
Digestible Phosphorus	%	0.409	0.377
Potassium	%	0.311	0.287
Sodium	%	0.213	0.196
Chlorine	%	0.196	0.180
Digestible Protein and Amino Acids			
Digestible Protein	%	18.62	18.93
Lysine	%	1.066	1.084
Methionine	%	0.298	0.304
Methionine + Cysteine	%	0.597	0.607
Threonine	%	0.693	0.705
Tryptophan	%	0.235	0.238
Arginine	%	1.066	1.084
Valine	%	0.885	0.900
Isoleucine	%	0.640	0.650
Leucine	%	1.226	1.247
Histidine	%	0.426	0.434
Phenylalanine	%	0.618	0.629
Phenylalanine + Tyrosine	%	1.237	1.257
Digestible Essential Nitrogen	%	1.162	1.182
Total Protein and Amino Acids			
Crude Protein	%	21.00	21.37
Lysine	%	1.211	1.232
Methionine	%	0.327	0.333
Methionine + Cysteine	%	0.666	0.678
Threonine	%	0.823	0.838
Tryptophan	%	0.266	0.271
Arginine	%	1.187	1.207
Valine	%	1.005	1.023
Isoleucine	%	0.727	0.739
Leucine	%	1.393	1.417
Histidine	%	0.472	0.480
Phenylalanine	%	0.690	0.702
Phenylalanine + Tyrosine	%	1.381	1.404
Total Essential Nitrogen	%	1.311	1.333

Table 6.15 - Daily Nutritional Requirements of Lactating Gilts and Sows (kcal/day and %) continuation...

Parity Order		PO2		≥ PO3	
Female Weight Postpartum		210		240	
Litter Weight Gain	kg/day	2.82	3.10	2.82	3.10
Weight Loss	kg/day	0.639	0.639	0.939	0.939
Metabolizable Energy	kcal/day	20476	22233	19712	21469
Diet Metabolizable Energy	kcal/kg	3400	3400	3400	3400
Diet Net Energy	kcal/kg	2540	2540	2540	2540
Intake	g/day	6022	6539	5798	6314
Nutrient					
Calcium	%	0.864	0.795	0.862	0.792
Available Phosphorus	%	0.465	0.428	0.466	0.428
Digestible Phosphorus	%	0.415	0.382	0.431	0.396
Potassium	%	0.332	0.306	0.328	0.301
Sodium	%	0.216	0.199	0.224	0.206
Chlorine	%	0.199	0.184	0.207	0.190
Digestible Protein and Amino Acids					
Digestible Protein	%	18.58	18.88	18.72	19.04
Lysine	%	1.064	1.081	1.072	1.090
Methionine	%	0.298	0.303	0.300	0.305
Methionine + Cysteine	%	0.596	0.605	0.600	0.610
Threonine	%	0.692	0.703	0.697	0.709
Tryptophan	%	0.234	0.238	0.236	0.240
Arginine	%	1.064	1.081	1.072	1.090
Valine	%	0.883	0.897	0.890	0.905
Isoleucine	%	0.638	0.649	0.643	0.654
Leucine	%	1.224	1.243	1.233	1.254
Histidine	%	0.426	0.432	0.429	0.436
Phenylalanine	%	0.617	0.627	0.622	0.632
Phenylalanine + Tyrosine	%	1.234	1.254	1.244	1.264
Digestible Essential Nitrogen	%	1.160	1.178	1.168	1.188
Total Protein and Amino Acids					
Crude Protein	%	20.97	21.30	21.13	21.48
Lysine	%	1.209	1.228	1.218	1.238
Methionine	%	0.326	0.332	0.329	0.334
Methionine + Cysteine	%	0.665	0.675	0.670	0.681
Threonine	%	0.822	0.835	0.828	0.842
Tryptophan	%	0.266	0.270	0.268	0.272
Arginine	%	1.185	1.203	1.194	1.214
Valine	%	1.003	1.019	1.011	1.028
Isoleucine	%	0.725	0.737	0.731	0.743
Leucine	%	1.390	1.412	1.401	1.424
Histidine	%	0.472	0.479	0.475	0.483
Phenylalanine	%	0.689	0.700	0.694	0.706
Phenylalanine + Tyrosine	%	1.378	1.400	1.389	1.412
Total Essential Nitrogen	%	1.309	1.329	1.318	1.340

Table 6.16 - Daily Nutritional Requirements of Lactating Gilts and Sows (Average Temperature of 25 °C) (kcal/day and %)

Parity Order		PO1	
Female Weight Postpartum	kg	185	
Litter Weight Gain	kg/day	2.63	2.90
Weight Loss	kg/day	0.565	0.565
Metabolizable Energy	kcal/day	18523	20162
Diet Metabolizable Energy	kcal/kg	3400	3400
Diet Net Energy	kcal/kg	2540	2540
Intake	g/day	5448	5930
Nutrient			
Calcium	%	0.862	0.792
Available Phosphorus	%	0.477	0.472
Digestible Phosphorus	%	0.422	0.388
Potassium	%	0.321	0.295
Sodium	%	0.220	0.202
Chlorine	%	0.202	0.185
Digestible Protein and Amino Acids			
Digestible Protein	%	19.23	19.49
Lysine	%	1.101	1.116
Methionine	%	0.308	0.312
Methionine + Cysteine	%	0.617	0.625
Threonine	%	0.716	0.725
Tryptophan	%	0.242	0.246
Arginine	%	1.101	1.116
Valine	%	0.914	0.926
Isoleucine	%	0.661	0.670
Leucine	%	1.266	1.284
Histidine	%	0.440	0.447
Phenylalanine	%	0.639	0.647
Phenylalanine + Tyrosine	%	1.277	1.295
Digestible Essential Nitrogen	%	1.200	1.216
Total Protein and Amino Acids			
Crude Protein	%	21.70	22.00
Lysine	%	1.251	1.268
Methionine	%	0.338	0.342
Methionine + Cysteine	%	0.688	0.697
Threonine	%	0.851	0.862
Tryptophan	%	0.275	0.279
Arginine	%	1.226	1.243
Valine	%	1.038	1.052
Isoleucine	%	0.751	0.761
Leucine	%	1.439	1.458
Histidine	%	0.488	0.495
Phenylalanine	%	0.713	0.723
Phenylalanine + Tyrosine	%	1.426	1.446
Total Essential Nitrogen	%	1.354	1.373

Table 6.16 - Daily Nutritional Requirements of Lactating Gilts and Sows (Average Temperature of 25 °C) (kcal/day and %) continuation...

Parity Order		PO2		≥ PO3	
Female Weight Postpartum	kg	210		240	
Litter Weight Gain	kg/day	2.82	3.10	2.82	3.10
Weight Loss	kg/day	0.652	0.652	0.939	0.939
Metabolizable Energy	kcal/day	19814	21571	18890	20737
Diet Metabolizable Energy	kcal/kg	3400	3400	3400	3400
Diet Net Energy	kcal/kg	2540	2540	2540	2540
Intake	g/day	5828	6344	5582	6099
Nutrient					
Calcium	%	0.892	0.820	0.896	0.820
Available Phosphorus	%	0.480	0.442	0.484	0.443
Digestible Phosphorus	%	0.429	0.394	0.448	0.410
Potassium	%	0.343	0.315	0.340	0.311
Sodium	%	0.223	0.205	0.233	0.213
Chlorine	%	0.189	0.173	0.197	0.180
Digestible Protein and Amino Acids					
Digestible Protein	%	19.20	19.47	19.54	19.70
Lysine	%	1.099	1.115	1.119	1.128
Methionine	%	0.308	0.312	0.313	0.316
Methionine + Cysteine	%	0.615	0.624	0.627	0.632
Threonine	%	0.714	0.725	0.727	0.733
Tryptophan	%	0.242	0.245	0.246	0.248
Arginine	%	1.099	1.115	1.119	1.128
Valine	%	0.912	0.925	0.929	0.936
Isoleucine	%	0.659	0.669	0.671	0.677
Leucine	%	1.264	1.282	1.287	1.297
Histidine	%	0.440	0.446	0.448	0.451
Phenylalanine	%	0.637	0.647	0.649	0.654
Phenylalanine + Tyrosine	%	1.275	1.293	1.298	1.308
Digestible Essential Nitrogen	%	1.198	1.215	1.219	1.229
Total Protein and Amino Acids					
Crude Protein	%	21.66	21.98	22.05	22.24
Lysine	%	1.249	1.267	1.271	1.282
Methionine	%	0.337	0.342	0.343	0.346
Methionine + Cysteine	%	0.687	0.697	0.699	0.705
Threonine	%	0.849	0.862	0.864	0.872
Tryptophan	%	0.275	0.279	0.280	0.282
Arginine	%	1.224	1.242	1.246	1.256
Valine	%	1.037	1.052	1.055	1.064
Isoleucine	%	0.749	0.760	0.763	0.769
Leucine	%	1.436	1.457	1.462	1.474
Histidine	%	0.487	0.494	0.496	0.500
Phenylalanine	%	0.712	0.722	0.724	0.731
Phenylalanine + Tyrosine	%	1.424	1.444	1.449	1.461
Total Essential Nitrogen	%	1.352	1.372	1.376	1.387

