

CHAPTER 3

Nutritional Requirement of Replacement Pullets, Layers, and Broiler Breeders

Nilva Kazue Sakomura¹, Matheus de Paula Reis², Marie-Pierre
Létourneau Montminy³ and Horacio Santiago Rostagno⁴

¹ Department of Animal Science, FCAV- UNESP- Jaboticabal, Brazil

² Trow Nutrition, Community of Madrid, Spain.

³ Laval University, Quebec, Canadá.

⁴ Department of Animal Science, Federal University of Viçosa, Viçosa, Brazil

INTRODUCTION

The main objective of nutritionists is to formulate balanced diets to meet animals' energy and nutrient requirements as accurately as possible. Considering the advances in animal performance promoted by recent genetic improvements, such requirements must be regularly updated to allow animals to express their full genetic potential.

The nutritional requirements of replacement pullets presented in this 5th edition were calculated considering the genetic growth potential estimated in studies developed at UNESP-Jaboticabal (Alves et al., 2019). Live weight was estimated using the Gompertz equation, and weight gain was obtained from the first derivative of this equation. For layers and breeders, the production potential recommended in the manuals of the main genetic strains published in 2022 was considered.

Feed intake is influenced by several factors, particularly by providing an adequate dietary energy level to supply the bird's energy requirements. Daily feed intake was calculated as the ratio between daily metabolizable energy (ME) requirement and dietary ME content.

Metabolizable energy (ME) requirements were calculated by applying the factorial model proposed by Sakomura et al. (2005) and net energy (NE) requirements based on a thesis carried out at UNESP-Jaboticabal. In the current edition, maintenance requirement values of 113 kcal/kg^{0.75} ME and 92.3 kcal NE were applied, independently of the bird category. Energy requirements for weight gain are corrected as a function of body weight using a quadratic equation. However, different coefficients were applied for each bird category to minimize body composition differences, as mentioned for standardized digestible lysine. Energy requirements for egg production were 2.4 kcal/g egg mass for white and brown layers and 1.54 kcal/g egg mass for broiler breeders.

Digestible amino acid requirements in standardized ileal digestibility (SID) and lysine requirements of growing pullets and laying hens were determined in studies conducted at UNESP-Jaboticabal. Lysine

requirements were used as a reference to estimate the requirements for the other amino acids, as the ideal protein concept. The ideal essential amino acid profile of pullets and layers was defined in studies carried out at UNESP-Jaboticabal.

The factorial model to determine SID Lys requirements of white and brown replacement pullets and broiler breeders was adjusted as a function of live weight and weight gain. The SID Lys requirement of growing pullets was divided into requirements for maintenance and weight gain (growth), in addition to the requirement for egg mass during the pre-laying phase, considering a 5 to 15% laying rate. The same factors were considered for layers and broiler breeders. The SID Lys requirement for maintenance of replacement pullets and layers was estimated as 45.1 mg per kg of metabolic weight ($\text{kg}^{0.75}$). The SID Lys requirement for growth was estimated per g of weight gain using a quadratic equation as a function of body weight. The parameters of that equation vary according to bird category to account for the body composition differences between growing pullets, white or brown layers and laying broiler breeders. The SID Lys requirements for egg production were calculated as 11.5 mg/g of egg mass for white or brown layers and 14.5 mg for broiler breeders.

Due to the increasing availability and inclusion of crystalline amino acids in poultry diets, to reduce dietary crude protein content, the essential nitrogen (Ne) to total nitrogen (Total N) ratio must be considered in feed formulation. When dietary crude protein levels are reduced, non-essential nitrogen (Nne) may become limiting. Therefore, the ideal Ne:Total N or Ne:Nne ratios in reduced-protein diets should be determined to maximize bird performance and nitrogen utilization efficiency. Digestible essential nitrogen (dig. Ne) to total essential nitrogen (Net) ratios were calculated as a function of the requirements and the N content of essential amino acids for each bird category. The ratios of the essential amino acids methionine, threonine, tryptophan arginine, glycine + serine, valine, isoleucine, leucine, histidine, and phenylalanine to lysine were calculated. Next, the obtained dig. Ne:Total N and Net:Total N ratios were used to calculate total

digestible nitrogen (total dig. N) and total N values. The recommended ratios are 50% for growing pullets and 44% for white and brown layers. The value of 44% reported in the 4th edition of the Brazilian Tables was applied for broiler breeders during the growing and laying phases. Based on the dig. N and total N values obtained, for each phase and bird category, the total and digestible protein requirements were estimated by multiplying the dig. N and total N by 6.25, considering a 16% N content in the dietary protein.

In the current edition, factorial models to estimate calcium (Ca) and phosphorus (P) requirements were developed, considering the requirements for maintenance, growth (replacement layer and broiler breeder pullets), and egg production (layers and broiler breeders). The coefficients of the factorial models were estimated based on data produced at the University of Laval (Canada) and published in the literature. The Ca and P requirements for maintenance were calculated as $70 \text{ mg/kg}^{0.75}$ metabolic weight (WPSA, 1984; Gopi et al., 2021). The Ca and P requirements for growth were adjusted for their deposition as a function of weight gain, using coefficients of 8.29 mg of Ca and 6.64 mg of P per gram of weight gain. Egg production requirement was calculated as a function of Ca and P deposition per gram of egg mass, using coefficients of 40 mg of Ca and 1.8 mg of P per gram of egg mass.

The proposed equations estimate Ca and P requirements (mg/bird/day) on a digestible basis. However, as feed formulation software programs use total Ca and available P values, Ca digestibility must be considered to estimate total Ca values. A 0.37 digestibility coefficient was applied for growing birds to calculate total Ca based on digestible Ca values. Ca digestibility was corrected as a function of age to contemplate the physiological changes experienced as birds age. The ratios presented in the 2017 edition were used to convert digestible P into available P, i.e., 1.18 for growing pullets, 1.11 for layers, and 1.05 for broiler breeders.

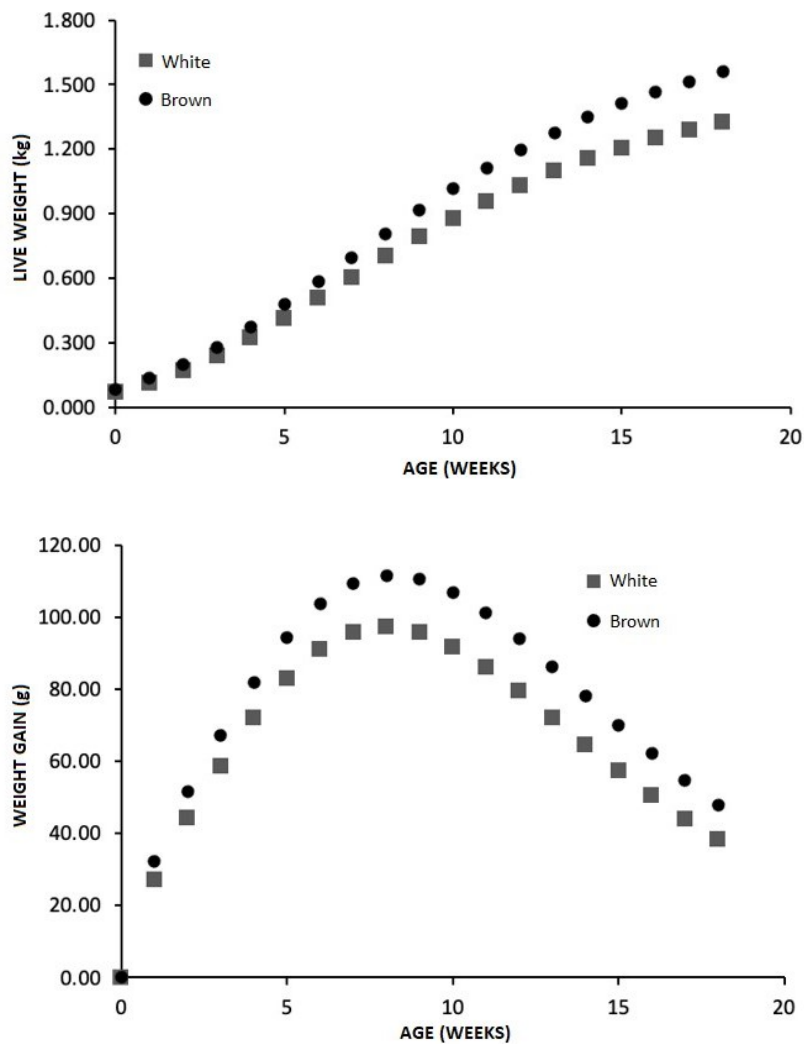
In this 5th edition, the sodium, potassium, chlorine, and linoleic acid requirements published in the 4th edition were updated based on the estimated feed intake of each bird category and production phase.

Factorial models allow for the adjustment of nutritional requirements as a function of the evolution of genetic potential for growth and production, as well as management and climate conditions, enabling the development of dynamic nutritional programs. To illustrate the application of factorial models for developing nutritional programs, Figure 1 shows an example of calculating the average lysine requirement for this production phase based on daily lysine requirements.

The nutritional programs for replacement pullets, layers, and broiler breeders during growing and laying phases were based on factorial models as a function of age and egg production. Nutritional programs were based on the genetic potential reported in the genetic strain manuals for high performance layers. Nutritional programs for standard performance layers assumed 5% lower performance than their genetic potential.

Nutritional Requirements of White and Brown Replacement Pullets

Table 3.01 - Live Weight and Daily Weight Gain Curves According to Gompertz Equation and the Derivative for White and Brown Replacement Pullets



Equation parameters for white replacement pullets: $W_m = 1.511$; $b = 0.025$; $t^* = 52.5$; Brown replacement pullets: $W_m = 1.808$; $b = 0.024$; $t^* = 54.0$; where, W = weight (kg); G = weight gain (g/day); t = age (days); W_m = mature body weight (kg), b = maturity rate (g/day), t^* = age at maximum growth rate (weeks). The parameters were obtained from Alves et al. (2019) for Lohmann LsL and Dekalb Brown lineages.

Table 3.02 - Equations Used to Estimate Apparent Metabolizable Energy (ME) Requirements of White and Brown Replacement Pullets (kcal/bird/day)¹

1 to 15 weeks:

$$\text{ME (kcal/day)} = 113 \times W^{0.75} + (3.77 + 1.65 \times W - 0.923 \times W^2) \times G$$

16 to 18 weeks:

$$\text{ME (kcal/day)} = 113 \times W^{0.75} + (3.77 + 1.65 \times W - 0.923 \times W^2) \times G + (2.4 \times \text{Egg})$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day); Egg = Egg Mass (g/bird/day)

Temperature: Thermoneutral temperature (TN) and temperature range (TR) were considered according to the bird's age: 8 to 14 days, TN = 29°C, TR = 26 – 32°C; 15 to 21 days, TN = 26°C, TR = 23 – 29°C; 22 to 28 days, TN = 23°C, TR = 18 – 28°C; 29 to 126 days, TN = 20°C, TR = 16 – 27°C.

Example: White Replacement Pullets

Age: 13 weeks (91 days); W = 1.025 kg, $W^{0.75} = 1.019$; G = 9.78 g/day

ME Req. = $113 \times 1.019 + (3.77 + 1.65 \times 1.025 - 0.923 \times 1.025^2) \times 9.78$.

ME Req. = $115 + 4.49 \times 9.78 = 159$ kcal/bird/day

Dietary ME² = 2.900 kcal/g

Estimated Feed Intake = $159/2.9 = 54.9$ g/day

Effect of temperature (T°C) of 26°C on maintenance ME requirement (ME_m):

T°C > TN

$$\text{ME}_m = 113 + 0.88 \times (T^\circ \text{C} - \text{TN})$$

$$\text{ME}_m = 113 + 0.88 \times (26 - 23) = 113 + 0.88 \times 3 = 115.64 \text{ kcal/bird/day}$$

Effect of temperature (T°C) of 17°C on maintenance ME requirement (ME_m):

T°C < TN

$$\text{ME}_m = 113 + 6.73 \times (\text{TN} - T^\circ \text{C})$$

$$\text{ME}_m = 113 + 6.73 \times (23 - 17)$$

$$\text{ME}_m = 113 + 6.73 \times 6 = 153.88 \text{ kcal/bird/day}$$

¹ Equations were adapted from Sakomura & Rostagno (2016), Neme et al. (2005), and Sakomura et al. (2004).

² Considering dietary ME in the whole growing period: White Pullet = 2.9 kcal/g and Brown Pullet = 2.85 kcal/g.

Table 3.03 - Equations Used to Estimate Net Energy (NE) Requirements of White and Brown Replacement Pullets (kcal/bird/day)¹

1 to 15 weeks:

$$\text{NE (kcal/bird/day)} = 92.3 \times W^{0.75} + (2.40 + 1.36 \times W - 0.706 \times W^2) \times G$$

16 to 18 weeks:

$$(\text{NE kcal/bird/day}) = 92.3 \times W^{0.75} + (2.40 + 1.36 \times W - 0.706 \times W^2) \times G + (1.54 \times \text{Egg})$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day)

Example: White Replacement Pullets

Age: 13 weeks (91 days); W = 1.025 kg, $W^{0.75} = 1.019$,

G = 9.78 g/bird/day

$$\text{NE Req.} = 92.3 \times 1.019 + (2.40 + 1.36 \times 1.025 - 0.7058 \times 1.025^2) \times 9.78.$$

$$\text{NE Req.} = 94.05 + 3.07 \times 9.78 = 124 \text{ kcal/bird/day}$$

Estimated Feed Intake = 54.9 g/day (Table 3.02)

Dietary NE² = 2.259 kcal/g

¹ Equations were adapted from Horna (2022) (Doctoral Thesis, UNESP – Jaboticabal).

² Considering feed intake determined according to the ME of 2.9 kcal/g, the dietary NE was calculated ($124/54.9 = 2.259 \text{ kcal/g}$).

Table 3.04 - Equations Used to Estimate Standardized Digestible Lysine (SID Lys) Requirements of White and Brown Replacement Pullets (g/bird/day and %)^{1,2}

$$\text{SID Lys (g/bird/day)} = \text{Maintenance Req.}^1 + \text{Weight Gain Req.}^2$$

1 to 15 weeks:

$$\text{SID Lys (g/bird/day)} = [45.1 \times W^{0.75} + (24.13 - 14.60 \times W + 17.44 \times W^2) \times G] / 1000$$

16 to 18 weeks:

$$\text{SID Lys (g/bird/day)} = [45.1 \times W^{0.75} + (24.13 - 14.60 \times W + 17.44 \times W^2) \times G + 9.46 \times \text{Egg}] / 1000$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day); Egg = Egg Mass (g/bird/day)

Example:

Parameters	Replacement Pullets	
	White	Brown
Age (weeks/days)	13(91)	18(126) ³
W (kg)	1.025	1.519
$W^{0.75}$	1.019	1.368
G (g/bird/day)	9.78	6.42
Feed Intake (g)	54.9	69
Egg Mass (g/bird/day)	-	6.6
SID Lys Maintenance (g/bird/day)	0.046	0.062
SID Lys Weight Gain (g/bird/day)	0.269	0.271
SID Lys Egg Mass (g/bird/day)	-	0.062
SID Lys Requirement (g/day)	0.315	0.595 ³
SID Lys Requirement (%)	0.57	0.86

¹ Daily requirements of digestible lysine for maintenance were estimated according to the values reported by Siqueira et al. (2011).

² Daily requirements of digestible lysine for growing White and Brown Pullets were estimated from research carried out at UNESP – Jaboticabal.

³ According to the reproductive organ development in the 18th week, 0.20 g/day of SID Lys was added.

Table 3.05 - Performance and Standardized Digestible Lysine (SID Lys), Metabolizable Energy (ME), and Net Energy (NE) Requirements of White¹ and Brown² Replacement Pullets Using the Equations in Tables 3.01, 3.02, 3.03 e 3.04

Age Week (Days)	Weight kg	Gain g/day	SID Lys g/day	ME kcal/day	NE kcal/day	Intake g/day	Cumulative Intake g	Lys/ME Ratio %/Mcal	SID Lys %
White Replacement Pullets ¹									
1 (7)	0.067	5.2	0.127	35	25	12	71	0.362	1.051
2 (14)	0.110	7.2	0.173	50	36	17	176	0.345	1.000
3 (21)	0.168	9.2	0.216	67	48	23	319	0.324	0.940
4 (28)	0.239	11.0	0.254	84	61	29	504	0.302	0.877
5 (35)	0.321	12.4	0.283	100	74	35	730	0.282	0.818
6 (42)	0.412	13.4	0.305	116	85	40	993	0.264	0.766
7 (49)	0.507	13.8	0.321	128	96	44	1291	0.250	0.724
8 (56)	0.604	13.8	0.331	139	104	48	1615	0.239	0.692
9 (63)	0.700	13.5	0.337	147	111	51	1962	0.230	0.666
10 (70)	0.792	12.8	0.339	152	116	53	2324	0.222	0.644
11 (77)	0.879	11.9	0.336	156	120	54	2698	0.215	0.623
12 (84)	0.959	10.9	0.329	159	123	55	3078	0.207	0.602
13 (91)	1.031	9.8	0.318	160	125	55	3463	0.199	0.577
14 (98)	1.097	8.8	0.304	160	126	55	3850	0.190	0.550
15 (105)	1.154	7.8	0.287	160	126	55	4237	0.179	0.519
16 (112)	1.205	6.8	0.400	168	132	58	4639	0.238	0.691
17 (119)	1.250	5.9	0.446	171	134	59	5049	0.260	0.755
18 (126)	1.289	5.1	0.493	175	137	60	5467	0.282	0.817
Brown Replacement Pullets ²									
1 (7)	0.082	6.1	0.148	41	29	14	86	0.358	1.022
2 (14)	0.133	8.3	0.197	58	42	20	210	0.340	0.970
3 (21)	0.199	10.5	0.244	76	55	27	378	0.320	0.911
4 (28)	0.280	12.5	0.285	96	70	34	592	0.299	0.851
5 (35)	0.373	14.1	0.320	114	84	40	853	0.280	0.799
6 (42)	0.476	15.2	0.348	131	97	46	1158	0.265	0.757
7 (49)	0.586	15.8	0.372	146	109	51	1501	0.255	0.727
8 (56)	0.697	15.9	0.392	158	118	55	1876	0.249	0.709
9 (63)	0.808	15.6	0.409	167	126	58	2276	0.245	0.699
10 (70)	0.915	15.0	0.421	173	132	61	2695	0.243	0.694
11 (77)	1.017	14.0	0.429	178	136	62	3126	0.242	0.689
12 (84)	1.111	13.0	0.431	180	139	63	3567	0.239	0.681
13 (91)	1.198	11.8	0.426	182	141	64	4012	0.235	0.668
14 (98)	1.277	10.7	0.416	182	143	64	4459	0.228	0.650
15 (105)	1.347	9.5	0.400	182	143	64	4907	0.219	0.625
16 (112)	1.410	8.4	0.511	190	149	67	5370	0.269	0.766
17 (119)	1.465	7.4	0.553	193	152	68	5841	0.286	0.816
18 (126)	1.514	6.5	0.595	197	154	69	6321	0.302	0.861

¹ Dietary ME 2.900; ²Dietary ME 2.850. White and Brown Pullets (16 to 18 weeks), extra requirements of + 0.10, 0.15 e 0.20 g SID Lys/ day, respectively, for reproductive tract development.

Table 3.06 - Amino Acid to Lysine Ratios Used to Estimate the Amino Acid Requirements of White and Brown Replacement Pullets¹

Phase	Starter		Grower		Pre Lay	
Age (Weeks)	1-4		5-15		16-18	
Amino Acid	SID	Total	SID	Total	SID	Total
Lysine	100	100	100	100	100	100
Methionine	41	41	44	44	46	46
Methionine + Cysteine	73	74	79	79	83	84
Threonine	68	71	67	70	70	73
Tryptophan	18	18	21	21	21	21
Arginine	108	106	109	109	109	109
Glycine + Serine	125	130	115	120	111	115
Valine	77	79	79	80	83	83
Isoleucine	70	71	74	75	76	78
Leucine	113	112	119	118	130	129
Histidine	37	37	37	37	39	39
Phenylalanine	67	66	69	69	71	71
Phenylalanine + Tyrosine	122	121	126	126	129	129

¹The amino acids to lysine ratios were obtained from information reported by Soares et al. (2021).

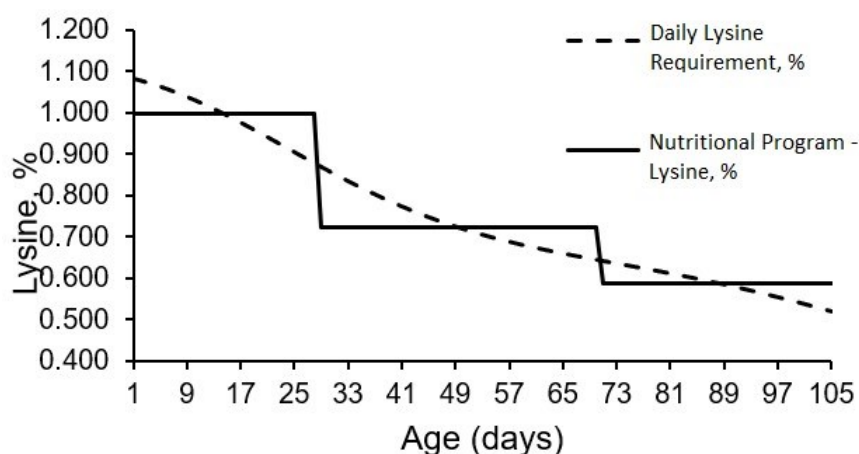


Figure 1 - Daily lysine requirements calculated using the factorial model (---) and a three-phase nutritional program (—) developed considering the midpoint requirement for each phase for white egg replacement pullets.

Table 3.07 - Example to Calculate Digestible Essential N (Dig. Ne), Total Essential N (Net), and Digestible and Total Crude Protein Requirements of White and Brown Replacement Pullets¹

Amino Acids	N (%)	SID AA Req. g/day)	Dig. Ne (g/day)	Total AA Req. (g/day)	Net (g/day)
Lysine	19.16	0.322	0.062	0.358	0.069
Methionine	9.39	0.141	0.013	0.147	0.014
Threonine	11.76	0.215	0.025	0.254	0.030
Tryptophan	13.72	0.068	0.009	0.064	0.009
Arginine	32.16	0.351	0.113	0.379	0.122
Glycine + Serine	15.99	0.370	0.059	0.465	0.074
Valine	11.96	0.254	0.030	0.283	0.034
Isoleucine	10.68	0.238	0.025	0.254	0.027
Leucine	10.68	0.383	0.041	0.401	0.043
Histidine	27.08	0.119	0.032	0.132	0.036
Phenylalanine	8.48	0.222	0.019	0.247	0.021
Ne Req.			0.425		0.475
Total N Req. ²			0.850		0.950
Protein Req., g/d ³			5.31		5.94

¹ Example for white replacement pullets (5 to 10 weeks of age and 0.515 kg of weight).

² Ne: Total N ratio of 50%.

³ Conversion factor of N to protein: 6.25.

The total lysine requirement was calculated considering 90.0% the ileal digestibility of lysine in the diet. Total amino acid to total lysine ratios was used (Table 3.06) to estimate total amino acid requirements.

- Dig. Lys(g/day) to Dig. Protein (g/day) ratio referring to the phases of 1 to 4, 5 to 10, 11 to 15, and 16 to 18 weeks are, respectively, 6.03, 6.00, 6.03, and 5.88%.

- Example: Dig. Protein (g/day) calculation considering Dig. Lys intake of 0.322: Dig. Protein = $(0.322 \times 100)/6.00 = 5.36$ g/day. Considering feed intake of 44.2 g/day: $5.36 \times 100/44.2 = 12.0$ % of Dig. Protein.

- Dig. Lys(g/day) to Total Protein (g/day) ratio referring to the phases of 1 to 4, 5 to 10, 11 to 15, and 16 to 18 weeks are, respectively, 5.42, 5.38, 5.38, and 5.30%.

- Example: Total Protein (g/day) calculation considering Dig. Lys intake of 0.322: Dig. Protein = $(0.322 \times 100)/5.40 = 5.96$ g/day. Considering feed intake of 44.2 g/day: $5.96 \times 100/44.2 = 13.5$ % of Total Protein.

Table 3.08 - Equations Used to Estimate Total Calcium, Standardized Digestible Phosphorus (Dig. P), and Available Phosphorus (Pav) of White and Brown Replacement Pullets¹

$$\text{Calcium (g/bird/day)} = \text{Maintenance Req.} + \text{Weight Gain Req.} + \text{Egg Req.}$$

1 to 15 weeks:

$$\text{Total Calcium (g/bird/day)} = [(70 \times W^{0.75} + 8.29 \times G)/0.37] / 1000$$

16 to 18 weeks:

$$\text{Total Calcium (g/bird/day)} = [(70 \times W^{0.75} + 8.29 \times G + 40 \times \text{Egg})/0.37] / 1000$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day); Egg = Egg Mass (g/bird/day)

Example for Calcium: White Replacement Pullets

Age: 13 weeks; W = 1.025 kg; $W^{0.75} = 1.019$; G = 9.78 g/bird/day

Estimated Feed Intake = 54.9 g/day

$$\text{Calcium Req.} = [(70 \times 1.019 + 8.29 \times 9.78)/0.37]/1000 = 0.412 \text{ g/bird/day}$$

$$\% \text{ Calcium} = (0.412 \times 100)/54.9 = 0.75 \%$$

$$\text{Dig. Phosphorus (g/bird/d)} = \text{Maintenance Req} + \text{Wt Gain Req} + \text{Egg Req}$$

1 to 15 weeks:

$$\text{Dig. P (g/bird/day)} = [70 \times W^{0.75} + 6.64 \times G] / 1000$$

15 to 18 weeks:

$$\text{Dig. P (g/bird/day)} = [70 \times W^{0.75} + 6.64 \times G + 1.8 \text{ Egg}] / 1000$$

Example for Phosphorus: White Replacement Pullets

Age: 13 weeks (91 days); W = 1.025 kg; G = 9.78 g/bird/day

Estimated Feed Intake = 54.9 g/day

$$\text{Dig. P (g/bird/day)} = 70 \times 1.019 + 6.64 \times 9.78 = 0.136 \text{ g/bird/day}$$

$$\text{Pav} = 0.136 \times 1.18 = 0.161 \text{ g/bird/day}$$

$$\text{Dig. P} = 0.136 \times 100/54.9 = 0.248 \%$$

$$\text{Pav (\%)} = 0.161 \times 100/54.9 = 0.293 \%$$

¹ The maintenance requirements for calcium and phosphorus of 70 mg/kg^{0.75} were adapted from WPSA (1984) and Gopi et al. (2021). Weight gain requirements for calcium and phosphorus (8.29 and 6.64 mg/g, respectively), and egg requirements for calcium and phosphorus (40 and 1.8 mg/g) were obtained from research carried out at Laval University. A calcium digestibility coefficient of 0.37 was obtained from the information reported by Mutucumarana et al. (2014). To convert Dig. P in Pav the value of 1.18 was used according to the Brazilian Tables (2017).

Table 3.09 - Total Calcium, Digestible Phosphorus, and Available Phosphorus Requirements of White and Brown Replacement Pullets, Using the Equations in Table 3.08

Age Week (Days)	Weight Kg	Gain g/day	Intake g/day	Calcium g/day	Dig. P g/day	Pav g/day	Calcium %	Dig. P %	Pav %
White Replacement Pullets									
1 (7)	0.071	5.3	12	0.142	0.044	0.052	1.17	0.363	0.428
2 (14)	0.115	7.3	17	0.198	0.061	0.072	1.15	0.356	0.420
3 (21)	0.172	9.2	23	0.256	0.080	0.094	1.11	0.347	0.409
4 (28)	0.243	10.9	29	0.311	0.097	0.115	1.08	0.336	0.397
5 (35)	0.325	12.3	35	0.359	0.113	0.133	1.04	0.325	0.384
6 (42)	0.414	13.2	40	0.397	0.125	0.148	1.00	0.314	0.371
7 (49)	0.508	13.6	44	0.424	0.134	0.159	0.96	0.304	0.358
8 (56)	0.604	13.6	48	0.440	0.140	0.166	0.92	0.293	0.346
9 (63)	0.698	13.3	51	0.446	0.144	0.169	0.88	0.284	0.335
10 (70)	0.789	12.6	53	0.445	0.144	0.170	0.85	0.275	0.324
11 (77)	0.874	11.8	54	0.439	0.143	0.169	0.81	0.266	0.314
12 (84)	0.953	10.8	55	0.428	0.141	0.166	0.78	0.258	0.304
13 (91)	1.025	9.8	55	0.412	0.136	0.161	0.75	0.248	0.293
14 (98)	1.090	8.8	55	0.400	0.134	0.159	0.72	0.243	0.287
15 (105)	1.148	7.8	55	0.385	0.131	0.154	0.70	0.236	0.279
16 (112)	1.199	6.8	58	0.727	0.133	0.157	1.25	0.229	0.270
17 (119)	1.243	6.0	59	0.886	0.132	0.156	1.50	0.223	0.264
18 (126)	1.282	5.2	60	1.057	0.132	0.155	1.75	0.218	0.258
Brown Replacement Pullets									
1 (7)	0.079	6.1	14	0.166	0.051	0.061	1.15	0.355	0.419
2 (14)	0.129	8.3	20	0.228	0.071	0.083	1.12	0.348	0.410
3 (21)	0.194	10.5	27	0.292	0.091	0.107	1.09	0.339	0.399
4 (28)	0.276	12.5	34	0.353	0.110	0.130	1.05	0.328	0.387
5 (35)	0.370	14.1	40	0.407	0.127	0.150	1.02	0.318	0.375
6 (42)	0.474	15.2	46	0.450	0.141	0.167	0.98	0.307	0.363
7 (49)	0.585	15.8	51	0.482	0.152	0.179	0.94	0.298	0.351
8 (56)	0.697	15.9	55	0.502	0.159	0.188	0.91	0.288	0.340
9 (63)	0.809	15.6	58	0.511	0.163	0.193	0.87	0.279	0.330
10 (70)	0.918	15.0	61	0.512	0.165	0.194	0.84	0.271	0.320
11 (77)	1.021	14.0	62	0.506	0.164	0.194	0.81	0.264	0.311
12 (84)	1.116	13.0	63	0.496	0.162	0.191	0.78	0.256	0.302
13 (91)	1.204	11.8	64	0.482	0.159	0.187	0.76	0.249	0.294
14 (98)	1.283	10.7	64	0.466	0.155	0.183	0.73	0.242	0.286
15 (105)	1.353	9.5	64	0.450	0.151	0.178	0.70	0.235	0.278
16 (112)	1.416	8.4	67	0.790	0.152	0.180	1.18	0.229	0.270
17 (119)	1.471	7.4	68	0.947	0.151	0.178	1.40	0.223	0.263
18 (126)	1.519	6.5	69	1.116	0.150	0.177	1.62	0.218	0.257

Table 3.10 - Nutritional Requirements of White Replacement Pullets, According to Growing Phase (g/day)

Phase		Starter		Grower/ Developer			Pre Lay			
Age (Week)		1-4		5-10		11-15		16-18		
Average Weight		kg	0.114	0.514		1.001		1.232		
Gain		g/day	7.4	13.4		10.3		6.3		
SID Lysine		g/day	0.176	0.322		0.323		0.448		
Metabolizable Energy		kcal/day	59	129		159		170		
Net Energy		kcal/day	43	96		124		133		
Diet Metab Energy		kcal/kg	2.900	2.900		2.900		2.900		
Diet Net Energy		kcal/kg	2086	2163		2253		2275		
Intake		g/day	20.3	44.6		55.0		58.6		
Nutrients										
Total Crude Protein		g/day	3.25	5.99		6.00		8.46		
Digestible Protein		g/day	2.91	5.36		5.36		7.61		
Calcium		g/day	0.202	0.425		0.420		0.816		
Available Phosphorus		g/day	0.074	0.159		0.164		0.156		
Digestible Phosphorus		g/day	0.063	0.135		0.139		0.132		
Potassium		g/day	0.107	0.232		0.281		0.299		
Sodium		g/day	0.037	0.075		0.088		0.094		
Chlorine		g/day	0.032	0.067		0.083		0.087		
Linoleic Acid		g/day	0.209	0.446		0.550		0.586		
Amino Acids			SID	Total	SID	Total	SID	Total	Total	
Lysine		g/day	0.176	0.196	0.322	0.358	0.323	0.359	0.448	0.498
Methionine		g/day	0.071	0.080	0.141	0.158	0.142	0.158	0.206	0.229
Met + Cys		g/day	0.128	0.145	0.254	0.283	0.255	0.284	0.372	0.418
Threonine		g/day	0.120	0.139	0.215	0.251	0.217	0.251	0.313	0.364
Tryptophan		g/day	0.032	0.035	0.068	0.075	0.068	0.075	0.094	0.105
Arginine		g/day	0.190	0.208	0.351	0.390	0.352	0.391	0.488	0.543
Gly + Ser		g/day	0.220	0.255	0.370	0.430	0.372	0.431	0.497	0.573
Valine		g/day	0.135	0.155	0.254	0.286	0.255	0.287	0.372	0.413
Isoleucine		g/day	0.123	0.139	0.238	0.269	0.239	0.269	0.340	0.388
Leucine		g/day	0.199	0.220	0.383	0.422	0.385	0.424	0.582	0.642
Histidine		g/day	0.065	0.073	0.119	0.132	0.120	0.133	0.175	0.194
Phenylalanine		g/day	0.118	0.129	0.222	0.247	0.223	0.248	0.318	0.354
Phe + Tyr		g/day	0.215	0.237	0.405	0.452	0.407	0.452	0.578	0.642
Essential Nitrogen		g/day	0.233	0.260	0.429	0.479	0.429	0.480	0.609	0.677

Table 3.11 - Nutritional Requirements of White Replacement Pullets, According to Growing Phase (%)

Phase		Starter		Grower/ Developer			Pre Lay		
Age (Weeks)		1-4		5-10		11-15		16-18	
Average Weight	kg	0.114		0.514		1.001		1.232	
Gain	g/day	7.4		13.4		10.3		6.3	
SID Lysine	g/day	0.176		0.322		0.323		0.448	
Metabolizable Energy	kcal/day	59		129		159		170	
Net Energy	kcal/day	43		96		124		133	
Diet Metab Energy	kcal/kg	2.900		2.900		2.900		2.900	
Diet Net Energy	kcal/kg	2.086		2.163		2.253		2.275	
Intake	g/day	20.3		44.6		55.0		58.6	
Nutrients									
Total Crude Protein	%	15.95		13.41		10.91		14.43	
Digestible Protein	%	14.36		12.04		9.76		12.99	
Calcium	%	1.144		0.954		0.764		1.393	
Available Phosphorus	%	0.419		0.357		0.299		0.266	
Digestible Phosphorus	%	0.355		0.303		0.253		0.226	
Potassium	%	0.528		0.521		0.511		0.510	
Sodium	%	0.182		0.169		0.160		0.161	
Chlorine	%	0.159		0.151		0.150		0.149	
Linoleic Acid	%	1.028		1.000		1.000		1.000	
Amino Acids		SID	Total	SID	Total	SID	Total	SID	Total
Lysine	%	0.866	0.962	0.722	0.802	0.588	0.653	0.764	0.849
Methionine	%	0.355	0.394	0.317	0.353	0.258	0.287	0.352	0.391
Met + Cys	%	0.641	0.712	0.570	0.634	0.465	0.516	0.634	0.713
Threonine	%	0.615	0.683	0.484	0.561	0.394	0.457	0.535	0.620
Tryptophan	%	0.156	0.173	0.152	0.168	0.123	0.137	0.160	0.178
Arginine	%	0.918	1.020	0.787	0.874	0.641	0.712	0.833	0.925
Gly + Ser	%	1.126	1.251	0.830	0.962	0.676	0.784	0.848	0.976
Valine	%	0.684	0.760	0.570	0.642	0.465	0.522	0.634	0.705
Isoleucine	%	0.615	0.684	0.534	0.602	0.435	0.490	0.581	0.662
Leucine	%	0.970	1.077	0.859	0.946	0.700	0.771	0.993	1.095
Histidine	%	0.320	0.356	0.267	0.297	0.218	0.242	0.298	0.331
Phenylalanine	%	0.580	0.635	0.498	0.553	0.406	0.451	0.542	0.603
Phe + Tyr	%	1.048	1.164	0.909	1.011	0.741	0.823	0.986	1.095
Essential Nitrogen	%	1.149	1.276	0.963	1.073	0.781	0.873	1.039	1.154

Table 3.12 - Nutritional Requirements of Brown Replacement Pullets, According to Growing Phase (g/day)

Phase		Starter		Grower/ Developer			Pre Lay		
Age (Weeks)		1-4		5-10		11-15		16-18	
Average Weight	kg	0.137		0.593		1.162		1.443	
Gain	g/day	8.5		15.5		12.3		7.8	
SID Lysine	g/day	0.201		0.373		0.426		0.557	
Metabolizable Energy	kcal/day	59		147		181		192	
Net Energy	kcal/day	43		109		141		151	
Diet Metab Energy	kcal/kg	2.850		2.850		2.850		2.850	
Diet Net Energy	kcal/kg	2052		2126		2211		2236	
Intake	g/day	20.8		51.4		63.6		67.3	
Nutrients									
Total Crude Protein	g/day	3.70		6.93		7.91		10.51	
Digestible Protein	g/day	3.32		6.38		7.28		9.47	
Calcium	g/day	0.233		0.483		0.488		0.878	
Available Phosphorus	g/day	0.085		0.180		0.189		0.179	
Digestible Phosphorus	g/day	0.072		0.153		0.160		0.152	
Potassium	g/day	0.110		0.267		0.324		0.343	
Sodium	g/day	0.037		0.087		0.102		0.108	
Chlorine	g/day	0.034		0.080		0.096		0.101	
Linoleic Acid	g/day	0.217		0.535		0.655		0.687	
Amino Acids		SID	Total	SID	Total	SID	Total	SID	Total
Lysine	g/day	0.201	0.223	0.373	0.414	0.426	0.473	0.557	0.619
Methionine	g/day	0.081	0.091	0.164	0.182	0.187	0.208	0.257	0.285
Met + Cys	g/day	0.146	0.165	0.295	0.327	0.337	0.374	0.462	0.520
Threonine	g/day	0.136	0.158	0.250	0.290	0.286	0.331	0.390	0.452
Tryptophan	g/day	0.036	0.040	0.078	0.087	0.090	0.099	0.117	0.130
Arginine	g/day	0.217	0.236	0.407	0.451	0.465	0.516	0.607	0.675
Gly + Ser	g/day	0.251	0.290	0.429	0.497	0.490	0.568	0.618	0.712
Valine	g/day	0.154	0.176	0.295	0.331	0.337	0.378	0.462	0.514
Isoleucine	g/day	0.140	0.158	0.276	0.311	0.316	0.355	0.423	0.483
Leucine	g/day	0.227	0.250	0.444	0.489	0.507	0.558	0.724	0.799
Histidine	g/day	0.074	0.083	0.138	0.153	0.158	0.175	0.217	0.241
Phenylalanine	g/day	0.135	0.147	0.257	0.286	0.294	0.326	0.395	0.439
Phe + Tyr	g/day	0.245	0.270	0.470	0.522	0.537	0.596	0.718	0.799
Essential Nitrogen	g/day	0.266	0.296	0.510	0.554	0.583	0.633	0.757	0.841

Table 3.13 - Nutritional Requirements of Brown Replacement Pullets, According to Growing Phase (%)

Phase		Starter		Grower/ Development			Pre Lay		
Age (Week)		1-4		5-10		11-15		16-18	
Average Weight	kg	0.137		0.593		1.162		1.443	
Gain	g/day	8.5		15.5		12.3		7.8	
SID Lysine	g/day	0.201		0.373		0.426		0.557	
Metabolizable Energy	kcal/day	59		147		181		192	
Net Energy	kcal/day	43		109		141		151	
Diet Metab Energy	kcal/kg	2.850		2.850		2.850		2.850	
Diet Net Energy	kcal/kg	2.052		2.126		2.211		2.236	
Intake	g/day	20.8		51.4		63.6		67.3	
Nutrients									
Total Crude Protein	%	17.79		13.49		12.44		15.61	
Digestible Protein	%	16.01		12.39		11.20		14.06	
Calcium	%	1.120		0.940		0.767		1.304	
Available Phosphorus	%	0.409		0.350		0.297		0.266	
Digestible Phosphorus	%	0.346		0.297		0.252		0.225	
Potassium	%	0.531		0.520		0.509		0.509	
Sodium	%	0.179		0.169		0.161		0.160	
Chlorine	%	0.163		0.155		0.151		0.150	
Linoleic Acid	%	1.046		1.040		1.030		1.020	
Amino Acids		SID	Total	SID	Total	SID	Total	SID	Total
Lysine	%	0.966	1.073	0.726	0.807	0.670	0.744	0.827	0.919
Methionine	%	0.392	0.440	0.319	0.355	0.295	0.327	0.381	0.423
Met + Cys	%	0.705	0.794	0.573	0.638	0.529	0.588	0.686	0.772
Threonine	%	0.657	0.762	0.486	0.565	0.469	0.521	0.579	0.671
Tryptophan	%	0.174	0.193	0.152	0.169	0.141	0.156	0.174	0.193
Arginine	%	1.043	1.137	0.791	0.880	0.730	0.811	0.901	1.002
Gly + Ser	%	1.208	1.395	0.835	0.968	0.804	0.893	0.918	1.057
Valine	%	0.744	0.848	0.573	0.646	0.536	0.595	0.686	0.763
Isoleucine	%	0.676	0.762	0.537	0.605	0.503	0.558	0.629	0.717
Leucine	%	1.092	1.202	0.864	0.952	0.791	0.878	1.075	1.186
Histidine	%	0.357	0.397	0.269	0.299	0.248	0.275	0.323	0.358
Phenylalanine	%	0.647	0.708	0.501	0.557	0.462	0.513	0.587	0.652
Phe + Tyr	%	1.179	1.298	0.915	1.017	0.844	0.937	1.067	1.186
Essential Nitrogen	%	1.281	1.423	0.992	1.079	0.896	0.995	1.125	1.249

Nutritional Requirements of White and Brown Layers

Table 3.14 - Equations Used to Estimate Metabolizable Energy (ME) Requirements of White and Brown Layers (kcal/bird/day)^{1,2}

$$\text{ME (kcal/bird/day)} = 113 \times W^{0.75} + 6.68 \times G + 2.4 \times \text{Egg}$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day) = % Lay ÷ 100 × Egg Weight

Temperature: Thermoneutral temperature (TN) and temperature range (TR) were considered according to the bird's age: TN = 24° C,

TR = 16 to 27° C.

Effect of temperature (T°C) of 27°C on maintenance ME requirement (ME_m):

T° C > TN

$$\text{ME}_m = 113 + 0.88 \times (T^\circ \text{C} - \text{TN})$$

$$\text{ME}_m = 113 + 0.88 \times (27 - 24) = 113 + 0.88 \times 3 = 115.6 \text{ kcal/bird/day}$$

Effect of temperature (T°C) of 16°C on maintenance ME requirement (ME_m):

T° C < TN

$$\text{ME}_m = 113 + 6.73 \times (\text{TN} - T^\circ \text{C})$$

$$\text{ME}_m = 113 + 6.73 \times (23 - 17) = 113 + 6.73 \times 6 = 153 \text{ kcal/bird/day}$$

Example: High Performance White and Brown Layers

Parameters	Layer	
	White	Brown
Age (weeks/days)	33(231)	40(280)
W (kg)	1.537	1.858
W ^{0.75}	1.380	1.591
G (g/bird/day)	0.4	0.1
Egg Mass (g/bird/day)	60.2	61.3
ME Req. Maintenance (kcal/day)	156	180
ME Req. Gain (kcal/day)	2.86	0.668
ME Req. Egg Mass (kcal/day)	144	147.1
ME Req. Total (kcal/day)	303	327
Estimated Feed Intake (g/day)	105	115

¹ Equations were adapted from Sakomura & Rostagno (2016), Neme et al. (2005), Sakomura et al. (2004), and Sakomura et al. (2005).

² Considering dietary ME of 2.9 kcal/g for white layers and 2.85 kcal/g for brown layers.

Table 3.15 - Equations Used to Estimate Net Energy (NE) Requirements of White and Brown Layers (kcal/bird/day)¹

$$\text{NE (kcal/bird/day)} = 92.3 \times W^{0.75} + 4.34 \times G + 1.54 \times \text{Egg}$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day); Egg = Egg Mass (g/bird/day)

Example: High Performance White and Brown Layers

Parameters	Layers	
	White	Brown
Age (weeks/days)	33(231)	40(280)
W (kg)	1.537	1.858
W ^{0.75}	1.380	1.591
G (g/bird/day)	0.4	0.1
Egg Mass (g/bird/day)	60.2	61.3
NE Req. Maintenance (kcal/day)	127	146.9
NE Req. Gain (kcal/day)	1.86	0.3
NE Req. Egg Mass (kcal/day)	92.7	94.36
NE Req. Total (kcal/day)	222	242
Estimated Feed Intake (g/day)	105	115
Dietary NE (kcal/kg)	2122	2103

¹ Equations were adapted from Horna (2022) (Doctoral Thesis, UNESP – Jaboticabal).

² Considering dietary ME of 2.9 kcal/g for white layers and 2.85 kcal/g for brown layers, dietary NE was calculated for white layers (222 x 1000/105 = 2122 kcal/kg) and brown layers (242 x 1000/115) = 2103 kcal/kg).

Table 3.16 - Equations Used to Estimate Standardized Digestible Lysine (SID Lys) Requirements of White and Brown Layers (g/bird/day and %)^{1, 2, 3}

$$\text{SID Lys (g/bird/day)} = \text{Maintenance Req.} + \text{Wt Gain Req.} + \text{Egg Req.}$$

$$\text{SID Lys Req. (g/bird/day)} = [45.1 \times W^{0.75} + (55 + 12 \times G) / 0.80 + 11.5 \times \text{Egg}] / 1000$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day)

Example: High Performance White and Brown Layers

Parameters	Layers	
	White	Brown
Age (weeks/days)	33(231)	40(280)
W (kg)	1.537	1.858
$W^{0.75}$	1.380	1.591
G (g/bird/day)	0.4	0.1
Intake (g)	105	115
Egg Mass (g/bird/day)	60.2	61.3
SID Lys Maintenance (g/bird/day)	0.065	0.072
SID Lys Gain (g/bird/day)	0.075	0.070
SID Lys Egg Mass (g/bird/day)	0.692	0.705
SID Lys Req. (g/day)	0.829	0.847
SID Lys Req. (%)	0.79	0.74

¹ Daily maintenance SID Lys requirement (Siqueira et al., 2011) and for gain were estimated at UNESP – Jaboticabal.

² Equations were adapted from Sakomura & Rostagno (2016).

³ Utilization efficiency of SID Lysine = 0.80.

Table 3.17 - Standardized Digestible Lysine (SID Lys), ME, and NE Requirements of High Performance White Layers

Age Weeks	Weight kg	Gain g/day	Production %	Egg Weight g	Egg Mass g/bird/day	SID Lys g/day	ME kcal/day	NE kcal/day	Intake g/day	Dietary SID Lys %
19-24	1.23-1.44	-	-	-	-	0.761	295	216	-	0.747
25	1.47	4	95.1	55.4	52.7	0.791	302	220	104	0.760
26	1.49	3	97.1	56.7	55.0	0.814	307	224	106	0.768
27	1.51	3	98.4	57.5	56.6	0.824	309	225	106	0.774
28	1.52	1	99.1	58.2	57.7	0.811	301	220	104	0.783
29	1.52	1.0	99.4	58.9	58.5	0.819	302	221	104	0.786
30	1.53	0.6	99.6	59.4	59.1	0.819	301	220	104	0.789
31	1.53	0.4	99.5	59.8	59.5	0.822	301	221	104	0.791
32	1.53	0.4	99.4	60.2	59.9	0.826	302	221	104	0.792
33	1.54	0.4	99.2	60.7	60.2	0.830	303	222	105	0.793
34	1.54	0.4	98.9	61.0	60.4	0.832	304	222	105	0.794
35	1.54	0.4	98.7	61.4	60.6	0.834	305	223	105	0.794
36	1.55	0.4	98.4	61.7	60.7	0.836	305	223	105	0.794
37	1.55	0.4	98.1	62.0	60.8	0.837	306	224	105	0.794
38	1.55	0.4	97.8	62.2	60.8	0.837	306	224	105	0.793
39	1.56	0.4	97.4	62.4	60.8	0.837	306	224	106	0.793
40	1.56	0.4	97.1	62.5	60.7	0.836	306	224	106	0.792
41	1.56	0.4	96.8	62.7	60.7	0.836	306	224	106	0.791
42	1.56	0.4	96.5	62.8	60.6	0.835	306	224	106	0.791
43	1.57	0.4	96.2	63.0	60.6	0.835	306	224	106	0.790
44	1.57	0.4	95.8	63.1	60.5	0.833	306	224	105	0.789
45	1.57	0.4	95.5	63.2	60.4	0.832	306	224	106	0.789
46	1.57	0.3	95.2	63.3	60.3	0.830	305	224	105	0.788
47	1.58	0.3	94.9	63.4	60.2	0.829	305	224	105	0.787
48	1.58	0.3	94.5	63.5	60.1	0.827	305	224	105	0.786
49	1.58	0.3	94.2	63.6	60.0	0.826	305	224	105	0.785
50	1.58	0.3	93.9	63.8	59.9	0.825	305	224	105	0.785
51	1.58	0.3	93.6	63.9	59.7	0.824	305	224	105	0.784
52	1.59	0.1	93.2	64.0	59.6	0.820	304	223	105	0.783
53	1.59	0.1	92.9	64.0	59.5	0.818	303	223	105	0.782
54	1.59	0.1	92.6	64.1	59.4	0.817	303	223	105	0.782
55	1.59	0.1	92.3	64.2	59.2	0.816	303	222	104	0.781
56	1.59	0.1	91.9	64.3	59.1	0.814	303	222	104	0.780
57	1.59	0.1	91.6	64.4	59.0	0.813	302	222	104	0.779
58	1.59	0.1	91.3	64.5	58.8	0.811	302	222	104	0.779
59	1.59	0.1	91.0	64.5	58.6	0.809	302	222	104	0.777
60	1.59	0.1	90.6	64.6	58.5	0.808	302	222	104	0.777
61	1.59	0.1	90.3	64.6	58.3	0.805	301	221	104	0.775
62	1.60	0.1	90.0	64.6	58.1	0.803	301	221	104	0.774
63	1.60	0.1	89.7	64.7	58.0	0.802	301	221	104	0.774
64	1.60	0.1	89.3	64.7	57.8	0.799	300	221	103	0.772
65	1.60	0.1	89.0	64.8	57.6	0.798	300	221	103	0.772
66	1.60	0.1	88.7	64.8	57.4	0.796	299	220	103	0.770
67	1.60	0.1	88.4	64.8	57.3	0.794	299	220	103	0.769
68	1.60	0.1	88.0	64.9	57.1	0.792	299	220	103	0.769
69	1.60	0.1	87.7	64.9	56.9	0.790	299	220	103	0.767
70	1.60	0.1	87.4	65.0	56.8	0.788	298	220	103	0.766
71	1.60	0.1	87.1	65.0	56.6	0.786	298	219	103	0.765
72	1.61	0.1	86.7	65.1	56.4	0.784	298	219	103	0.764
73	1.61	0.1	86.4	65.1	56.2	0.782	297	219	102	0.763
74	1.61	0.1	86.1	65.1	56.1	0.780	297	219	102	0.762
75	1.61	0.1	85.7	65.2	55.9	0.778	296	218	102	0.761
76	1.61	0.1	85.4	65.2	55.7	0.776	296	218	102	0.760
77	1.61	0.1	85.1	65.2	55.5	0.774	296	218	102	0.759
78	1.61	0.1	84.8	65.3	55.3	0.772	295	218	102	0.758
79	1.61	0.1	84.4	65.3	55.2	0.770	295	218	102	0.757
80	1.61	0.1	84.1	65.3	55.0	0.767	295	217	102	0.756

Table 3.18 - Standardized Digestible Lysine (SID Lys), ME, and NE Requirements of Standard Performance White Layers

Age	Weight	Gain	Production	Egg Weight	Egg Mass	SID Lys	ME	NE	Intake	Dietary
Weeks	Kg	g/day	%	g	g/bird/day	g/day	kcal/day	kcal/day	g/day	SID Lys
										%
19-24	1.23-1.44	-	-	-	-	0.705	284	208	-	0.721
25	1.47	3.7	74.2	48.1	35.7	0.731	289	212	100	0.733
26	1.49	3.4	82.1	50.0	41.0	0.752	294	216	102	0.741
27	1.51	2.9	87.1	51.4	44.8	0.761	296	217	102	0.746
28	1.52	1.1	90.3	52.7	47.6	0.747	287	211	99	0.754
29	1.52	1.0	92.3	53.8	49.7	0.753	288	212	99	0.757
30	1.53	0.6	93.5	54.7	51.1	0.753	287	211	99	0.760
31	1.53	0.4	94.1	55.3	52.1	0.755	287	212	99	0.762
32	1.53	0.4	94.5	55.9	52.8	0.759	288	212	99	0.763
33	1.54	0.4	94.6	56.4	53.3	0.762	289	213	100	0.764
34	1.54	0.4	94.5	56.8	53.7	0.764	290	213	100	0.765
35	1.54	0.4	94.4	57.2	54.0	0.766	291	214	100	0.765
36	1.55	0.4	94.2	57.7	54.3	0.768	291	214	100	0.765
37	1.55	0.4	94.0	58.0	54.5	0.769	292	215	101	0.765
38	1.55	0.4	93.7	58.3	54.7	0.769	292	215	101	0.764
39	1.56	0.4	93.5	58.6	54.8	0.769	292	215	101	0.764
40	1.56	0.4	93.2	58.9	54.9	0.768	292	215	101	0.763
41	1.56	0.4	92.9	59.1	54.9	0.768	292	215	101	0.762
42	1.56	0.4	92.6	59.3	54.9	0.767	292	215	101	0.762
43	1.57	0.4	92.3	59.4	54.8	0.767	292	215	101	0.761
44	1.57	0.4	92.0	59.5	54.8	0.765	292	215	101	0.760
45	1.57	0.4	91.7	59.7	54.7	0.764	292	215	101	0.759
46	1.57	0.3	91.4	59.8	54.7	0.762	291	215	100	0.759
47	1.58	0.3	91.0	59.9	54.6	0.761	291	215	100	0.758
48	1.58	0.3	90.7	60.1	54.5	0.760	291	215	100	0.757
49	1.58	0.3	90.4	60.2	54.4	0.759	291	215	100	0.756
50	1.58	0.3	90.1	60.3	54.3	0.758	291	215	100	0.755
51	1.58	0.3	89.8	60.4	54.2	0.757	291	215	100	0.755
52	1.59	0.1	89.5	60.5	54.1	0.753	290	214	100	0.754
53	1.59	0.1	89.2	60.6	54.0	0.752	289	214	100	0.753
54	1.59	0.1	88.9	60.7	53.9	0.751	289	214	100	0.753
55	1.59	0.1	88.6	60.8	53.8	0.750	289	214	100	0.752
56	1.59	0.1	88.3	60.8	53.7	0.748	289	213	100	0.751
57	1.59	0.1	88.0	60.9	53.6	0.747	289	213	100	0.750
58	1.59	0.1	87.6	61.0	53.5	0.746	288	213	99	0.749
59	1.59	0.1	87.3	61.0	53.3	0.743	288	213	99	0.748
60	1.59	0.1	87.0	61.1	53.2	0.742	288	213	99	0.748
61	1.59	0.1	86.7	61.2	53.1	0.740	288	213	99	0.746
62	1.60	0.1	86.4	61.2	52.9	0.738	287	212	99	0.745
63	1.60	0.1	86.1	61.3	52.8	0.737	287	212	99	0.744
64	1.60	0.1	85.8	61.3	52.6	0.735	287	212	99	0.743
65	1.60	0.1	85.5	61.3	52.4	0.733	286	212	99	0.742
66	1.60	0.1	85.2	61.4	52.3	0.731	286	212	99	0.741
67	1.60	0.1	84.9	61.4	52.1	0.729	286	212	99	0.740
68	1.60	0.1	84.6	61.5	52.0	0.728	286	211	98	0.740
69	1.60	0.1	84.2	61.5	51.8	0.726	285	211	98	0.738
70	1.60	0.1	83.9	61.6	51.7	0.724	285	211	98	0.737
71	1.60	0.1	83.6	61.7	51.6	0.723	285	211	98	0.736
72	1.61	0.1	83.3	61.7	51.4	0.721	284	211	98	0.735
73	1.61	0.1	83.0	61.7	51.2	0.719	284	210	98	0.734
74	1.61	0.1	82.7	61.8	51.1	0.717	284	210	98	0.733
75	1.61	0.1	82.4	61.8	50.9	0.715	283	210	98	0.732
76	1.61	0.1	82.1	61.8	50.7	0.714	283	210	98	0.731
77	1.61	0.1	81.8	61.9	50.6	0.711	283	210	97	0.730
78	1.61	0.1	81.5	61.9	50.4	0.710	282	210	97	0.729
79	1.61	0.1	81.2	62.0	50.3	0.708	282	209	97	0.728
80	1.61	0.1	80.8	62.0	50.1	0.706	282	209	97	0.727

Table 3.19 - Standardized Digestible Lysine (SID Lys), ME, and NE Requirements of High Performance Brown Layers

Age Weeks	Weight kg	Gain g/day	Production %	Egg Weight g	Egg Mass g/day	SID Lys g/day	ME kcal/day	NE kcal/day	Intake g/day	Dietary SID Lys %
19-24	1.47-1.77	-	-	-	-	0.828	335	246	-	0.704
25	1.80	4.7	96.4	58.3	56.2	0.856	342	251	120	0.713
26	1.82	1.5	97.9	59.5	58.2	0.831	326	240	115	0.726
27	1.82	1.3	98.6	60.2	59.4	0.842	328	242	115	0.730
28	1.83	1.1	98.9	61.1	60.4	0.852	331	243	116	0.734
29	1.84	1.1	98.9	61.7	61.0	0.859	333	245	117	0.736
30	1.85	1.1	98.8	62.1	61.3	0.862	334	246	117	0.736
31	1.85	0.8	98.5	62.4	61.5	0.860	332	245	117	0.737
32	1.85	0.1	98.3	62.7	61.6	0.850	328	242	115	0.739
33	1.85	0.1	97.9	62.9	61.6	0.850	328	242	115	0.739
34	1.86	0.1	97.6	63.2	61.7	0.851	328	242	115	0.739
35	1.86	0.1	97.2	63.4	61.7	0.851	328	242	115	0.739
36	1.86	0.1	96.9	63.7	61.7	0.850	328	242	115	0.739
37	1.86	0.1	96.5	63.8	61.6	0.849	328	242	115	0.738
38	1.86	0.1	96.1	63.9	61.5	0.848	328	242	115	0.738
39	1.86	0.1	95.7	64.1	61.4	0.847	328	242	115	0.737
40	1.86	0.1	95.4	64.3	61.3	0.846	327	242	115	0.737
41	1.86	0.1	95.0	64.4	61.2	0.845	327	241	115	0.736
42	1.86	0.1	94.6	64.6	61.1	0.844	327	241	115	0.736
43	1.86	0.1	94.2	64.8	61.1	0.844	327	241	115	0.736
44	1.86	0.1	93.8	65.0	61.0	0.843	327	241	115	0.735
45	1.86	0.1	93.5	65.2	60.9	0.842	327	241	115	0.735
46	1.86	0.1	93.1	65.3	60.8	0.840	326	241	115	0.734
47	1.86	0.1	92.7	65.3	60.7	0.839	326	241	114	0.733
48	1.86	0.1	92.3	65.6	60.5	0.838	326	241	114	0.733
49	1.86	0.1	91.9	65.7	60.4	0.837	326	241	114	0.732
50	1.86	0.1	91.6	65.8	60.3	0.835	325	240	114	0.731
51	1.86	0.1	91.2	65.9	60.1	0.833	325	240	114	0.731
52	1.86	0.1	90.8	66.0	59.9	0.831	325	240	114	0.730
53	1.86	0.1	90.4	66.1	59.8	0.829	324	240	114	0.729
54	1.87	0.1	90.0	66.2	59.6	0.827	324	239	114	0.728
55	1.87	0.1	89.7	66.2	59.4	0.824	323	239	113	0.727
56	1.87	0.1	89.3	66.3	59.1	0.822	323	239	113	0.726
57	1.87	0.1	88.9	66.4	59.0	0.820	322	239	113	0.725
58	1.87	0.1	88.5	66.4	58.8	0.818	322	238	113	0.724
59	1.87	0.1	88.1	66.5	58.6	0.815	322	238	113	0.723
60	1.87	0.1	87.8	66.6	58.4	0.813	321	238	113	0.722
61	1.87	0.1	87.4	66.6	58.2	0.811	321	237	113	0.721
62	1.87	0.1	87.0	66.7	58.0	0.809	320	237	112	0.720
63	1.87	0.1	86.6	66.7	57.8	0.806	320	237	112	0.719
64	1.87	0.1	86.2	66.8	57.6	0.804	319	237	112	0.718
65	1.87	0.1	85.8	66.7	57.4	0.802	319	236	112	0.717
66	1.87	0.1	85.5	66.9	57.2	0.800	318	236	112	0.716
67	1.87	0.1	85.1	66.9	57.0	0.797	318	236	112	0.714
68	1.87	0.1	84.7	67.0	56.8	0.795	318	235	111	0.713
69	1.87	0.1	84.3	67.1	56.6	0.792	317	235	111	0.712
70	1.87	0.1	83.9	67.1	56.3	0.790	317	235	111	0.711
71	1.87	0.1	83.6	67.2	56.1	0.787	316	235	111	0.710
72	1.87	0.1	83.2	67.3	56.0	0.786	316	234	111	0.709
73	1.87	0.1	82.8	67.3	55.7	0.783	315	234	111	0.708
74	1.88	0.1	82.4	67.4	55.6	0.781	315	234	110	0.707
75	1.88	0.1	82.0	67.5	55.4	0.779	314	233	110	0.706
76	1.88	0.1	81.7	67.6	55.2	0.777	314	233	110	0.705
77	1.88	0.1	81.3	67.6	55.0	0.774	314	233	110	0.704
78	1.88	0.1	80.9	67.7	54.8	0.772	313	233	110	0.703
79	1.88	0.1	80.5	67.8	54.6	0.770	313	232	110	0.702
80	1.88	0.1	80.1	67.9	54.4	0.768	312	232	110	0.701

Table 3.20 - Standardized Digestible Lysine (SID Lys), ME, and NE Requirements of Standard Performance Brown Layers

Age Weeks	Weight Kg	Gain g/day	Production %	Egg Weight g	Egg Mass g/day	SID Lys g/day	ME kcal/day	NE kcal/day	Intake g/day	Dietary SID Lys %
19-24	1.47-1.77	-	-	-	-	0.768	323	238	-	0.666
25	1.80	4.7	91.6	55.4	50.7	0.793	329	242	118	0.675
26	1.82	1.5	93.0	56.5	52.5	0.766	313	232	112	0.686
27	1.82	1.3	93.7	57.2	53.6	0.775	315	233	112	0.690
28	1.83	1.1	93.9	58.0	54.5	0.784	316	234	113	0.694
29	1.84	1.1	94.0	58.6	55.1	0.791	318	236	114	0.695
30	1.85	1.1	93.8	59.0	55.3	0.794	320	236	114	0.695
31	1.85	0.8	93.6	59.3	55.5	0.791	318	236	114	0.696
32	1.85	0.1	93.3	59.6	55.6	0.781	313	233	112	0.697
33	1.85	0.1	93.0	59.8	55.6	0.781	314	233	112	0.698
34	1.86	0.1	92.7	60.0	55.7	0.781	314	233	112	0.698
35	1.86	0.1	92.4	60.3	55.7	0.782	314	233	112	0.698
36	1.86	0.1	92.0	60.5	55.6	0.781	314	233	112	0.697
37	1.86	0.1	91.7	60.6	55.6	0.780	314	233	112	0.697
38	1.86	0.1	91.3	60.8	55.5	0.779	313	233	112	0.696
39	1.86	0.1	90.9	60.9	55.4	0.779	313	232	112	0.696
40	1.86	0.1	90.6	61.1	55.3	0.778	313	232	112	0.695
41	1.86	0.1	90.2	61.2	55.2	0.777	313	232	112	0.695
42	1.86	0.1	89.9	61.3	55.1	0.775	313	232	112	0.694
43	1.86	0.1	89.5	61.6	55.1	0.775	313	232	112	0.694
44	1.86	0.1	89.1	61.8	55.1	0.775	313	232	112	0.694
45	1.86	0.1	88.8	61.9	55.0	0.774	312	232	112	0.694
46	1.86	0.1	88.4	62.0	54.8	0.772	312	232	111	0.693
47	1.86	0.1	88.1	62.2	54.7	0.771	312	232	111	0.692
48	1.86	0.1	87.7	62.3	54.6	0.770	312	232	111	0.692
49	1.86	0.1	87.3	62.5	54.5	0.769	312	231	111	0.691
50	1.86	0.1	87.0	62.6	54.4	0.767	311	231	111	0.690
51	1.86	0.1	86.6	62.7	54.3	0.766	311	231	111	0.690
52	1.86	0.1	86.3	62.7	54.1	0.764	311	231	111	0.689
53	1.86	0.1	85.9	62.8	53.9	0.762	310	231	111	0.688
54	1.87	0.1	85.5	62.8	53.8	0.760	310	230	111	0.687
55	1.87	0.1	85.2	62.9	53.6	0.758	309	230	110	0.686
56	1.87	0.1	84.8	62.9	53.4	0.756	309	230	110	0.685
57	1.87	0.1	84.4	63.0	53.2	0.754	309	230	110	0.684
58	1.87	0.1	84.1	63.1	53.0	0.752	308	229	110	0.683
59	1.87	0.1	83.7	63.1	52.9	0.750	308	229	110	0.682
60	1.87	0.1	83.4	63.2	52.7	0.748	308	229	110	0.681
61	1.87	0.1	83.0	63.3	52.5	0.746	307	229	110	0.680
62	1.87	0.1	82.6	63.4	52.4	0.744	307	228	110	0.679
63	1.87	0.1	82.3	63.4	52.1	0.742	306	228	109	0.678
64	1.87	0.1	81.9	63.5	52.0	0.740	306	228	109	0.677
65	1.87	0.1	81.6	63.5	51.8	0.738	306	228	109	0.676
66	1.87	0.1	81.2	63.6	51.6	0.735	305	227	109	0.675
67	1.87	0.1	80.8	63.6	51.4	0.733	305	227	109	0.674
68	1.87	0.1	80.5	63.7	51.2	0.731	304	227	109	0.673
69	1.87	0.1	80.1	63.7	51.0	0.729	304	227	109	0.672
70	1.87	0.1	79.8	63.8	50.9	0.727	303	226	108	0.671
71	1.87	0.1	79.4	63.8	50.7	0.725	303	226	108	0.670
72	1.87	0.1	79.0	63.9	50.5	0.723	303	226	108	0.669
73	1.87	0.1	78.7	64.0	50.3	0.721	302	226	108	0.668
74	1.88	0.1	78.3	64.1	50.2	0.719	302	225	108	0.667
75	1.88	0.1	77.9	64.1	50.0	0.717	301	225	108	0.666
76	1.88	0.1	77.6	64.2	49.8	0.715	301	225	108	0.665
77	1.88	0.1	77.2	64.2	49.6	0.713	301	225	107	0.664
78	1.88	0.1	76.9	64.3	49.5	0.711	300	224	107	0.663
79	1.88	0.1	76.5	64.4	49.3	0.709	300	224	107	0.661
80	1.88	0.1	76.1	64.5	49.1	0.707	300	224	107	0.661

Table 3.21 - Equations Used to Estimate Total Calcium, Standardized Digestible Phosphorus (Dig. P), and Available Phosphorus (Pav) Requirements of White and Brown Layers^{1,2}

$$\text{Calcium (g/bird/day)} = \text{Maintenance Req.} + \text{Gain Req.} + \text{Egg Req.}$$

$$\text{Calcium (g/bird/day)} = [(70 \times W^{0.75} + 8.29 \times G + 40 \times \text{Egg}) / (0.57-9.5 \times 10^{-6} \times t^2)] / 1000$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);
Egg = Egg Mass (g/bird/day); t = age in weeks.

Example for calcium: White Layers

W = 1.537 kg; $W^{0.75} = 1.380$; G = 0.4 g/bird/day; Egg = 60.2;
t = age 33 weeks; Estimated Feed Intake = 105 g/day
Calcium Req. = $[(70 \times 1.380 + 8.29 \times 0.4 + 40 \times 60.2) / (0.57-9.5 \times 10^{-6} \times 33^2)] / 1000 = 4.484 \text{ g/bird/day}$
% Calcium = $(4.484 \times 100) / 105 = 4.270 \%$

$$\text{Dig. P (g/bird/day)} = \text{Maintenance Req.} + \text{Gain Req.} + \text{Egg Req.}$$

$$\text{Dig. P (g/bird/day)} = (70 \times W^{0.75} + 4.0 \times G + 1.8 \text{ Egg}) / 1000$$

Example for phosphorus: White layers

W = 1.537 kg; $W^{0.75} = 1.380$; G = 0.4 g/bird/day; Egg = 60.2; t = age 33 weeks (231 days); Estimated Feed Intake = 105 g/day
Dig. P = $(70 \times 1.380 + 4 \times 0.4 + 1.8 \times 60.2) / 1000 = 0.207 \text{ g/bird/day}$
Dig. P (%) = $0.207 \times 100/105 = 0.197 \%$
Pav = $0.207 \times 1.11 = 0.229 \text{ g/bird/day}$
Pav (%) = $0.229 \times 100/105 = 0.218 \%$

¹ The maintenance requirements for calcium and phosphorus were adapted from WPSA (1984) and Gopi et al. (2021). Weight gain and egg mass requirements for calcium and phosphorus were obtained from research carried out at Laval University (Canada). The calcium digestibility coefficient was adjusted according to the bird's age.

² Equation was adjusted according to the layer's age (19 to 80 weeks).

Table 3.22 - Total Calcium, Digestible Phosphorus, and Available Phosphorus Requirements of High Performance White Layers, Using Equations in Table 3.21

Age Weeks	Weight kg	Gain g/day	Egg Mass g/bird/day	Intake g/day	Calcium g/day	Dig. P g/day	Pav g/day	Calcium %	Dig. P %	Pav %
19-24	1.23-1.44	-	-	-	3.73	0.197	0.218	3.67	0.193	0.214
25	1.51	3.7	52.7	104	3.95	0.202	0.224	3.80	0.194	0.215
26	1.52	3.4	55.0	106	4.12	0.206	0.228	3.89	0.194	0.216
27	1.53	2.9	56.6	106	4.23	0.207	0.230	3.97	0.195	0.216
28	1.54	1.1	57.7	104	4.28	0.203	0.225	4.13	0.196	0.217
29	1.55	1.0	58.5	104	4.35	0.204	0.226	4.17	0.196	0.217
30	1.55	0.6	59.1	104	4.38	0.204	0.226	4.22	0.196	0.218
31	1.56	0.4	59.5	104	4.42	0.204	0.226	4.25	0.196	0.218
32	1.56	0.4	59.9	104	4.45	0.205	0.229	4.26	0.196	0.218
33	1.57	0.4	60.2	105	4.48	0.207	0.228	4.27	0.197	0.218
34	1.57	0.4	60.4	105	4.49	0.206	0.229	4.29	0.196	0.218
35	1.58	0.4	60.6	105	4.51	0.206	0.229	4.30	0.196	0.218
36	1.58	0.4	60.7	105	4.53	0.207	0.229	4.30	0.196	0.218
37	1.59	0.4	60.8	105	4.54	0.207	0.230	4.31	0.196	0.218
38	1.59	0.4	60.8	105	4.55	0.207	0.230	4.31	0.196	0.218
39	1.59	0.4	60.8	106	4.55	0.207	0.230	4.31	0.196	0.218
40	1.60	0.4	60.7	106	4.55	0.207	0.230	4.31	0.196	0.218
41	1.60	0.4	60.7	106	4.58	0.207	0.230	4.31	0.196	0.218
42	1.60	0.4	60.6	106	4.56	0.207	0.230	4.32	0.196	0.218
43	1.60	0.4	60.6	106	4.56	0.207	0.230	4.32	0.196	0.218
44	1.60	0.4	60.5	105	4.56	0.207	0.230	4.32	0.196	0.218
45	1.60	0.4	60.4	106	4.56	0.207	0.230	4.33	0.196	0.218
46	1.60	0.3	60.3	105	4.56	0.207	0.229	4.33	0.196	0.218
47	1.60	0.3	60.2	105	4.56	0.207	0.229	4.33	0.196	0.218
48	1.60	0.3	60.1	105	4.56	0.206	0.229	4.33	0.196	0.218
49	1.60	0.3	60.0	105	4.56	0.206	0.229	4.34	0.196	0.218
50	1.60	0.3	59.9	105	4.56	0.206	0.229	4.34	0.196	0.218
51	1.60	0.3	59.7	105	4.56	0.206	0.229	4.34	0.196	0.218
52	1.60	0.1	59.6	105	4.56	0.205	0.228	4.35	0.196	0.218
53	1.60	0.1	59.5	105	4.56	0.205	0.228	4.35	0.196	0.218
54	1.60	0.1	59.4	105	4.56	0.205	0.228	4.36	0.196	0.218
55	1.60	0.1	59.2	104	4.56	0.205	0.227	4.36	0.196	0.218
56	1.60	0.1	59.1	104	4.55	0.205	0.227	4.36	0.196	0.218
57	1.60	0.1	59.0	104	4.55	0.204	0.227	4.37	0.196	0.218
58	1.60	0.1	58.8	104	4.55	0.204	0.227	4.37	0.196	0.218
59	1.60	0.1	58.6	104	4.55	0.204	0.226	4.37	0.196	0.217
60	1.60	0.1	58.5	104	4.55	0.204	0.226	4.37	0.196	0.217
61	1.60	0.1	58.3	104	4.54	0.203	0.226	4.37	0.196	0.217
62	1.60	0.1	58.1	104	4.54	0.203	0.225	4.37	0.196	0.217
63	1.60	0.1	58.0	104	4.54	0.203	0.225	4.38	0.196	0.217
64	1.60	0.1	57.8	103	4.53	0.203	0.225	4.38	0.196	0.217
65	1.60	0.1	57.6	103	4.54	0.202	0.225	4.38	0.196	0.217
66	1.60	0.1	57.4	103	4.53	0.202	0.224	4.39	0.196	0.217
67	1.60	0.1	57.3	103	4.53	0.202	0.224	4.39	0.196	0.217
68	1.60	0.1	57.1	103	4.53	0.202	0.224	4.39	0.196	0.217
69	1.60	0.1	56.9	103	4.53	0.201	0.223	4.40	0.196	0.217
70	1.60	0.1	56.8	103	4.52	0.201	0.223	4.40	0.196	0.217
71	1.60	0.1	56.6	103	4.52	0.201	0.223	4.40	0.196	0.217
72	1.60	0.1	56.4	103	4.52	0.201	0.223	4.41	0.195	0.217
73	1.60	0.1	56.2	102	4.52	0.200	0.222	4.41	0.195	0.217
74	1.60	0.1	56.1	102	4.52	0.200	0.222	4.41	0.195	0.217
75	1.60	0.1	55.9	102	4.52	0.200	0.222	4.42	0.195	0.217
76	1.60	0.1	55.7	102	4.52	0.199	0.221	4.42	0.195	0.217
77	1.60	0.1	55.5	102	4.51	0.199	0.221	4.43	0.195	0.217
78	1.60	0.1	55.3	102	4.51	0.199	0.221	4.43	0.195	0.217
79	1.60	0.1	55.2	102	4.51	0.199	0.220	4.44	0.195	0.217
80	1.60	0.1	55.0	102	4.51	0.198	0.220	4.44	0.195	0.217

Table 3.23 - Total Calcium, Digestible Phosphorus, and Available Phosphorus Requirements of Standard Performance White Layers, Using the Equations in Table 3.21

Age Weeks	Weight Kg	Gain g/day	Egg Mass g/bird/day	Intake g/day	Calcium g/day	Dig. P g/day	Pav g/day	Calcium %	Dig. P %	Pav %
19-24	1.23-1.44	-	-	-	3.39	0.166	0.184	3.47	0.171	0.190
25	1.47	3.7	35.7	100	3.59	0.173	0.191	3.59	0.173	0.191
26	1.49	3.4	41.0	102	3.74	0.182	0.202	3.68	0.178	0.198
27	1.51	2.9	44.8	102	3.83	0.188	0.208	3.76	0.184	0.204
28	1.52	1.1	47.6	99	3.88	0.186	0.206	3.92	0.188	0.208
29	1.52	1.0	49.7	99	3.94	0.189	0.210	3.96	0.191	0.212
30	1.53	0.6	51.1	99	3.97	0.191	0.212	4.01	0.193	0.214
31	1.53	0.4	52.1	99	4.00	0.192	0.213	4.04	0.194	0.215
32	1.53	0.4	52.8	99	4.03	0.193	0.214	4.05	0.195	0.216
33	1.54	0.4	53.3	100	4.06	0.194	0.216	4.07	0.194	0.216
34	1.54	0.4	53.7	100	4.07	0.195	0.216	4.08	0.195	0.216
35	1.54	0.4	54.0	100	4.09	0.196	0.217	4.08	0.196	0.217
36	1.55	0.4	54.3	100	4.10	0.197	0.218	4.09	0.197	0.218
37	1.55	0.4	54.5	101	4.12	0.197	0.219	4.10	0.195	0.216
38	1.55	0.4	54.7	101	4.12	0.197	0.219	4.10	0.195	0.217
39	1.56	0.4	54.8	101	4.13	0.198	0.220	4.10	0.196	0.218
40	1.56	0.4	54.9	101	4.13	0.198	0.220	4.10	0.196	0.218
41	1.56	0.4	54.9	101	4.13	0.198	0.220	4.10	0.196	0.218
42	1.56	0.4	54.9	101	4.13	0.198	0.220	4.10	0.196	0.218
43	1.57	0.4	54.8	101	4.14	0.198	0.220	4.10	0.196	0.218
44	1.57	0.4	54.8	101	4.13	0.198	0.220	4.11	0.196	0.218
45	1.57	0.4	54.7	101	4.14	0.198	0.220	4.11	0.196	0.218
46	1.57	0.3	54.7	100	4.13	0.198	0.220	4.12	0.198	0.220
47	1.58	0.3	54.6	100	4.13	0.198	0.220	4.12	0.198	0.220
48	1.58	0.3	54.5	100	4.13	0.198	0.220	4.12	0.198	0.220
49	1.58	0.3	54.4	100	4.13	0.198	0.220	4.12	0.198	0.220
50	1.58	0.3	54.3	100	4.13	0.198	0.219	4.12	0.198	0.219
51	1.58	0.3	54.2	100	4.13	0.197	0.219	4.12	0.197	0.219
52	1.59	0.1	54.1	100	4.13	0.197	0.219	4.14	0.197	0.219
53	1.59	0.1	54.0	100	4.13	0.197	0.218	4.14	0.197	0.218
54	1.59	0.1	53.9	100	4.13	0.197	0.218	4.14	0.197	0.218
55	1.59	0.1	53.8	100	4.13	0.196	0.218	4.14	0.196	0.218
56	1.59	0.1	53.7	100	4.13	0.196	0.218	4.14	0.196	0.218
57	1.59	0.1	53.6	100	4.13	0.196	0.218	4.15	0.196	0.218
58	1.59	0.1	53.5	99	4.13	0.196	0.217	4.15	0.198	0.220
59	1.59	0.1	53.3	99	4.12	0.195	0.217	4.15	0.197	0.219
60	1.59	0.1	53.2	99	4.12	0.195	0.217	4.15	0.197	0.219
61	1.59	0.1	53.1	99	4.12	0.195	0.217	4.15	0.197	0.219
62	1.60	0.1	52.9	99	4.11	0.195	0.217	4.15	0.197	0.219
63	1.60	0.1	52.8	99	4.11	0.195	0.216	4.16	0.197	0.219
64	1.60	0.1	52.6	99	4.11	0.195	0.216	4.16	0.197	0.218
65	1.60	0.1	52.4	99	4.11	0.194	0.216	4.16	0.196	0.218
66	1.60	0.1	52.3	99	4.11	0.194	0.215	4.16	0.196	0.218
67	1.60	0.1	52.1	99	4.10	0.194	0.215	4.17	0.196	0.217
68	1.60	0.1	52.0	98	4.11	0.194	0.215	4.17	0.198	0.219
69	1.60	0.1	51.8	98	4.10	0.193	0.214	4.17	0.197	0.219
70	1.60	0.1	51.7	98	4.10	0.193	0.214	4.17	0.197	0.219
71	1.60	0.1	51.6	98	4.10	0.193	0.214	4.18	0.197	0.218
72	1.61	0.1	51.4	98	4.10	0.193	0.214	4.18	0.197	0.219
73	1.61	0.1	51.2	98	4.10	0.193	0.214	4.18	0.197	0.218
74	1.61	0.1	51.1	98	4.10	0.192	0.214	4.19	0.196	0.218
75	1.61	0.1	50.9	98	4.09	0.192	0.213	4.19	0.196	0.218
76	1.61	0.1	50.7	98	4.09	0.192	0.213	4.19	0.196	0.217
77	1.61	0.1	50.6	97	4.09	0.192	0.213	4.20	0.197	0.219
78	1.61	0.1	50.4	97	4.09	0.191	0.212	4.20	0.197	0.219
79	1.61	0.1	50.3	97	4.09	0.191	0.212	4.21	0.197	0.219
80	1.61	0.1	50.1	97	4.09	0.191	0.212	4.21	0.197	0.218

Table 3.24 - Total Calcium, Digestible Phosphorus, and Available Phosphorus Requirements of High Performance Brown Layers, Using the Equations in Table 3.21

Age Weeks	Weight kg	Gain g/day	Egg Mass g/day	Intake g/day	Calcium g/day	Dig. P g/day	Pav g/day	Calcium %	Dig. P %	Pav %
19-25	1.47-1.77	-	-	-	4.05	0.222	0.247	3.44	0.189	0.210
25	1.80	4.7	56.2	120	4.24	0.227	0.252	3.53	0.189	0.210
26	1.82	1.5	58.2	115	4.34	0.219	0.243	3.79	0.191	0.212
27	1.82	1.3	59.4	115	4.43	0.220	0.245	3.84	0.191	0.212
28	1.83	1.1	60.4	116	4.50	0.222	0.246	3.88	0.191	0.212
29	1.84	1.1	61.0	117	4.55	0.223	0.248	3.90	0.191	0.212
30	1.85	1.1	61.3	117	4.57	0.224	0.249	3.91	0.191	0.212
31	1.85	0.8	61.5	117	4.59	0.223	0.248	3.94	0.192	0.213
32	1.85	0.1	61.6	115	4.59	0.221	0.245	3.99	0.192	0.213
33	1.85	0.1	61.6	115	4.60	0.221	0.245	4.00	0.192	0.213
34	1.86	0.1	61.7	115	4.61	0.221	0.245	4.00	0.192	0.213
35	1.86	0.1	61.7	115	4.61	0.221	0.245	4.01	0.192	0.213
36	1.86	0.1	61.7	115	4.62	0.221	0.245	4.01	0.192	0.213
37	1.86	0.1	61.6	115	4.61	0.221	0.245	4.01	0.192	0.213
38	1.86	0.1	61.5	115	4.61	0.221	0.245	4.01	0.192	0.213
39	1.86	0.1	61.4	115	4.61	0.221	0.245	4.01	0.192	0.213
40	1.86	0.1	61.3	115	4.61	0.220	0.245	4.02	0.192	0.213
41	1.86	0.1	61.2	115	4.61	0.220	0.244	4.02	0.192	0.213
42	1.86	0.1	61.1	115	4.61	0.220	0.244	4.02	0.192	0.213
43	1.86	0.1	61.1	115	4.62	0.220	0.244	4.02	0.192	0.213
44	1.86	0.1	61.0	115	4.62	0.220	0.244	4.03	0.192	0.213
45	1.86	0.1	60.9	115	4.62	0.220	0.244	4.03	0.192	0.213
46	1.86	0.1	60.8	115	4.62	0.220	0.244	4.03	0.192	0.213
47	1.86	0.1	60.7	114	4.62	0.219	0.244	4.03	0.192	0.213
48	1.86	0.1	60.5	114	4.62	0.219	0.243	4.04	0.192	0.213
49	1.86	0.1	60.4	114	4.62	0.219	0.243	4.04	0.192	0.213
50	1.86	0.1	60.3	114	4.61	0.219	0.243	4.04	0.192	0.213
51	1.86	0.1	60.1	114	4.61	0.219	0.243	4.04	0.192	0.213
52	1.86	0.1	59.9	114	4.60	0.218	0.242	4.04	0.192	0.213
53	1.86	0.1	59.8	114	4.60	0.218	0.242	4.04	0.192	0.213
54	1.87	0.1	59.6	114	4.59	0.218	0.241	4.04	0.192	0.213
55	1.87	0.1	59.4	113	4.59	0.217	0.241	4.04	0.191	0.213
56	1.87	0.1	59.1	113	4.58	0.217	0.241	4.04	0.191	0.213
57	1.87	0.1	59.0	113	4.58	0.217	0.240	4.05	0.191	0.212
58	1.87	0.1	58.8	113	4.57	0.216	0.240	4.05	0.191	0.212
59	1.87	0.1	58.6	113	4.56	0.216	0.240	4.05	0.191	0.212
60	1.87	0.1	58.4	113	4.56	0.216	0.239	4.05	0.191	0.212
61	1.87	0.1	58.2	113	4.56	0.215	0.239	4.05	0.191	0.212
62	1.87	0.1	58.0	112	4.55	0.215	0.239	4.05	0.191	0.212
63	1.87	0.1	57.8	112	4.55	0.215	0.238	4.05	0.191	0.212
64	1.87	0.1	57.6	112	4.54	0.214	0.238	4.05	0.191	0.212
65	1.87	0.1	57.4	112	4.54	0.214	0.237	4.05	0.191	0.212
66	1.87	0.1	57.2	112	4.53	0.214	0.237	4.06	0.191	0.212
67	1.87	0.1	57.0	112	4.53	0.213	0.237	4.06	0.191	0.212
68	1.87	0.1	56.8	111	4.52	0.213	0.236	4.06	0.191	0.212
69	1.87	0.1	56.6	111	4.52	0.212	0.236	4.06	0.191	0.212
70	1.87	0.1	56.3	111	4.51	0.212	0.235	4.06	0.191	0.212
71	1.87	0.1	56.1	111	4.51	0.212	0.235	4.06	0.191	0.212
72	1.87	0.1	56.0	111	4.51	0.211	0.235	4.07	0.191	0.212
73	1.87	0.1	55.7	111	4.50	0.211	0.234	4.07	0.191	0.212
74	1.88	0.1	55.6	110	4.50	0.211	0.234	4.07	0.191	0.212
75	1.88	0.1	55.4	110	4.50	0.210	0.234	4.08	0.191	0.212
76	1.88	0.1	55.2	110	4.50	0.210	0.233	4.08	0.191	0.212
77	1.88	0.1	55.0	110	4.49	0.210	0.233	4.08	0.191	0.212
78	1.88	0.1	54.8	110	4.49	0.210	0.233	4.09	0.191	0.212
79	1.88	0.1	54.6	110	4.49	0.209	0.232	4.09	0.191	0.212
80	1.88	0.1	54.4	110	4.49	0.209	0.232	4.10	0.191	0.212

Table 3.25 - Total Calcium, Digestible Phosphorus, and Available Phosphorus Requirements of Standard Performance Brown Layers, Using Equations in Table 3.21

Age Weeks	Weight kg	Gain g/day	Egg Mass g/bird/day	Intake g/day	Calcium g/day	Dig. P g/day	Pav g/day	Calcium %	Dig. P %	Pav %
19-24	1.47-1.77	-	-	-	3.45	0.205	0.225	2.92	0.174	0.191
25	1.80	4.7	51	118	3.88	0.219	0.241	3.29	0.186	0.205
26	1.82	1.5	53	112	3.98	0.211	0.232	3.55	0.188	0.207
27	1.82	1.3	54	112	4.05	0.212	0.233	3.62	0.189	0.208
28	1.83	1.1	55	113	4.12	0.214	0.235	3.65	0.189	0.208
29	1.84	1.1	55	114	4.13	0.214	0.235	3.62	0.188	0.206
30	1.85	1.1	55	114	4.13	0.214	0.236	3.62	0.188	0.207
31	1.85	0.8	56	114	4.20	0.215	0.237	3.69	0.189	0.207
32	1.85	0.1	56	112	4.20	0.212	0.233	3.75	0.189	0.208
33	1.85	0.1	56	112	4.20	0.212	0.233	3.75	0.189	0.208
34	1.86	0.1	56	112	4.21	0.213	0.234	3.76	0.190	0.209
35	1.86	0.1	56	112	4.21	0.213	0.234	3.76	0.190	0.209
36	1.86	0.1	56	112	4.22	0.213	0.234	3.77	0.190	0.209
37	1.86	0.1	56	112	4.22	0.213	0.234	3.77	0.190	0.209
38	1.86	0.1	55	112	4.16	0.211	0.232	3.71	0.188	0.207
39	1.86	0.1	55	112	4.16	0.211	0.232	3.72	0.188	0.207
40	1.86	0.1	55	112	4.17	0.211	0.232	3.72	0.188	0.207
41	1.86	0.1	55	112	4.17	0.211	0.232	3.73	0.188	0.207
42	1.86	0.1	55	112	4.18	0.211	0.232	3.73	0.188	0.207
43	1.86	0.1	55	112	4.19	0.211	0.232	3.74	0.188	0.207
44	1.86	0.1	55	112	4.19	0.211	0.232	3.74	0.188	0.207
45	1.86	0.1	55	112	4.20	0.211	0.232	3.75	0.188	0.207
46	1.86	0.1	55	111	4.20	0.211	0.232	3.79	0.190	0.209
47	1.86	0.1	55	111	4.21	0.211	0.232	3.79	0.190	0.209
48	1.86	0.1	55	111	4.22	0.211	0.232	3.80	0.190	0.209
49	1.86	0.1	55	111	4.23	0.211	0.232	3.81	0.190	0.209
50	1.86	0.1	54	111	4.16	0.209	0.230	3.75	0.188	0.207
51	1.86	0.1	54	111	4.17	0.209	0.230	3.75	0.188	0.207
52	1.86	0.1	54	111	4.17	0.209	0.230	3.76	0.188	0.207
53	1.86	0.1	54	111	4.18	0.209	0.230	3.77	0.188	0.207
54	1.87	0.1	54	111	4.19	0.210	0.230	3.78	0.189	0.208
55	1.87	0.1	54	110	4.20	0.210	0.230	3.82	0.190	0.210
56	1.87	0.1	53	110	4.13	0.208	0.229	3.76	0.189	0.208
57	1.87	0.1	53	110	4.14	0.208	0.229	3.76	0.189	0.208
58	1.87	0.1	53	110	4.15	0.208	0.229	3.77	0.189	0.208
59	1.87	0.1	53	110	4.16	0.208	0.229	3.78	0.189	0.208
60	1.87	0.1	53	110	4.17	0.208	0.229	3.79	0.189	0.208
61	1.87	0.1	53	110	4.18	0.208	0.229	3.80	0.189	0.208
62	1.87	0.1	52	110	4.11	0.206	0.227	3.74	0.187	0.206
63	1.87	0.1	52	109	4.12	0.206	0.227	3.78	0.189	0.208
64	1.87	0.1	52	109	4.13	0.206	0.227	3.79	0.189	0.208
65	1.87	0.1	52	109	4.14	0.206	0.227	3.80	0.189	0.208
66	1.87	0.1	52	109	4.15	0.206	0.227	3.81	0.189	0.208
67	1.87	0.1	51	109	4.08	0.204	0.225	3.75	0.187	0.206
68	1.87	0.1	51	109	4.09	0.204	0.225	3.75	0.187	0.206
69	1.87	0.1	51	109	4.10	0.204	0.225	3.76	0.187	0.206
70	1.87	0.1	51	108	4.11	0.204	0.225	3.81	0.189	0.208
71	1.87	0.1	51	108	4.12	0.204	0.225	3.82	0.189	0.208
72	1.87	0.1	51	108	4.13	0.204	0.225	3.83	0.189	0.208
73	1.87	0.1	50	108	4.07	0.202	0.223	3.77	0.187	0.206
74	1.88	0.1	50	108	4.08	0.203	0.223	3.78	0.188	0.207
75	1.88	0.1	50	108	4.09	0.203	0.223	3.79	0.188	0.207
76	1.88	0.1	50	108	4.10	0.203	0.223	3.80	0.188	0.207
77	1.88	0.1	50	107	4.11	0.203	0.223	3.84	0.190	0.208
78	1.88	0.1	49	107	4.05	0.201	0.221	3.78	0.188	0.207
79	1.88	0.1	49	107	4.06	0.201	0.221	3.79	0.188	0.207
80	1.88	0.1	49	107	4.07	0.201	0.221	3.81	0.188	0.207

Table 3.26 - Amino Acids to Lysine Ratios Used to Determine the Amino Acid Requirements of White and Brown Layers¹

Amino Acids	Digestible	Total
Lysine	100	100
Methionine	46	45
Met + Cys	92	91
Threonine	77	80
Tryptophan	23	23
Arginine	105	101
Gly + Ser	79	82
Valine	90	90
Isoleucine	80	80
Leucine	122	119
Histidine	28	27
Phenylalanine	64	62
Phe + Tyr	116	113

¹ The amino acids to lysine ratios were obtained from Soares et al. (2019).

Table 3.27 - Example to Calculate the Digestible Essential Nitrogen (Dig. Ne), Total Essential Nitrogen (Net), and Digestible and Total Crude Protein Requirements of High Performance White Layers¹

	N (%)	SID AA Req. (g/day)	Dig. Ne (g/day)	Total AA Req. (g/day)	Net (g/day)
Lysine	19.16	0.803	0.154	0.892	0,171
Methionine	9.39	0.369	0.035	0.410	0,038
Threonine	11.76	0.618	0.073	0.714	0,084
Tryptophan	13.72	0.185	0.025	0.205	0,028
Arginine	32.16	0.843	0.271	0.901	0,290
Gly + Ser	15.99	0.618	0.099	0.731	0,117
Valine	11.96	0.747	0.089	0.803	0,096
Isoleucine	10.68	0.642	0.069	0.714	0,076
Leucine	10.68	0.980	0.105	1.061	0,113
Histidine	27.08	0.225	0.061	0.241	0,065
Phenylalanine	8.48	0.515	0.044	0.553	0,047
Ne Req.			1.024		1.122
Total N Req. ²			2.328		2.550
Protein Req., g/d ³			14.55		15.94

¹Example for white layers (1.550 kg of weight, gain of 0.4 g, and 62 g of egg mass).

²Ne: Total N ratio of 44%.

³Conversion factor of N to protein: 6.25.

- Total lysine requirement was calculated considering 90.0% the ileal digestibility of lysine in the diet. Total amino acid to total lysine ratios were used (table 3.26) to estimate total amino acid requirements.

- SID Lys: Digestible Protein ratio = 5.52%

- SID Lys: Total Protein ratio = 5.04%

- Example: SID Lys = $(0.803 \times 100)/5.52 = 14.6$ Digestible Protein Requirement (g/day). Considering feed intake of 105 g/day: $(14.55 \times 100)/105 = 13.9$ % Digestible Protein.

- Example: SID Lys = $(0.803 \times 100)/5.04 = 15.93$ Total Protein Requirement (g/day). Considering feed intake of 105 g/day: $15.93 \times 100/105 = 15,2\%$ Total Protein.

Table 3.28 - Nutritional Requirements of High Performance White Layers (g/day)

Nutrients		White Layers					
Average Weight	kg	1.500		1.550		1.600	
Gain,	g/day	0.4		0.3		0.1	
Egg Mass	g/day	62		58		54	
Metabolizable Energy	kcal/day	305		298		291	
Net Energy	kcal/day	222		219		215	
Diet Metab Energy	kcal/kg	2.900		2.900		2.900	
Diet Net Energy	kcal/kg	2116		2128		2141	
Intake	g/day	105.0		102.8		100.4	
Total Crude Protein	g/day	16.85		15.94		14.99	
Digestible Protein	g/day	15.38		14.55		13.69	
Calcium	g/day	4.52		4.25		3.97	
Available Phosphorus	g/day	0.230		0.224		0.217	
Digestible Phosphorus	g/day	0.207		0.201		0.196	
Potassium	g/day	0.560		0.548		0.535	
Sodium	g/day	0.223		0.218		0.213	
Chlorine	g/day	0.204		0.200		0.195	
Linoleic Acid	g/day	1.335		1.306		1.275	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	g/day	0.849	0.943	0.803	0.892	0.755	0.839
Methionine	g/day	0.390	0.424	0.369	0.401	0.347	0.378
Met + Cys	g/day	0.781	0.858	0.739	0.812	0.695	0.763
Threonine	g/day	0.654	0.754	0.618	0.714	0.582	0.671
Tryptophan	g/day	0.195	0.217	0.185	0.205	0.174	0.193
Arginine	g/day	0.891	0.952	0.843	0.901	0.793	0.847
Gly + Ser	g/day	0.671	0.773	0.634	0.731	0.597	0.688
Valine	g/day	0.764	0.849	0.723	0.803	0.680	0.755
Isoleucine	g/day	0.679	0.754	0.642	0.714	0.604	0.671
Leucine	g/day	1.036	1.122	0.980	1.061	0.922	0.998
Histidine	g/day	0.238	0.255	0.225	0.241	0.212	0.227
Phenylalanine	g/day	0.543	0.585	0.514	0.553	0.483	0.520
Phe + Tyr	g/day	0.985	1.066	0.931	1.008	0.876	0.948
Essential Nitrogen	g/day	1.083	1.186	1.024	1.122	0.964	1.055

Table 3.29 - Nutritional Requirements of High Performance White Layers (%)

Nutrients		White Layers					
Average Weight	kg	1.500		1.550		1.600	
Gain,	g/day	0.4		0.3		0.1	
Egg Mass	g/day	62		58		54	
Metabolizable Energy	kcal/day	305		298		291	
Net Energy	kcal/day	222		219		215	
Diet Metab Energy	kcal/kg	2.900		2.900		2.900	
Diet Net Energy	kcal/kg	2116		2128		2141	
Intake	g/day	105.0		102.8		100.4	
Total Crude Protein	%	16.05		15.51		14.96	
Digestible Protein	%	14.64		14.15		13.64	
Calcium	%	4.31		4.13		3.95	
Available Phosphorus	%	0.218		0.218		0.217	
Digestible Phosphorus	%	0.197		0.195		0.195	
Potassium	%	0.533		0.533		0.533	
Sodium	%	0.212		0.212		0.212	
Chlorine	%	0.195		0.195		0.195	
Linoleic Acid	%	1.270		1.270		1.270	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	%	0.808	0.898	0.781	0.868	0.753	0.837
Methionine	%	0.372	0.404	0.359	0.391	0.346	0.377
Met + Cys	%	0.743	0.817	0.718	0.790	0.693	0.762
Threonine	%	0.622	0.718	0.601	0.694	0.580	0.670
Tryptophan	%	0.186	0.207	0.180	0.200	0.173	0.193
Arginine	%	0.849	0.907	0.820	0.877	0.790	0.845
Gly + Ser	%	0.638	0.736	0.617	0.712	0.595	0.686
Valine	%	0.727	0.808	0.703	0.781	0.677	0.753
Isoleucine	%	0.646	0.718	0.625	0.694	0.602	0.670
Leucine	%	0.986	1.069	0.953	1.033	0.918	0.996
Histidine	%	0.226	0.242	0.219	0.234	0.211	0.226
Phenylalanine	%	0.517	0.557	0.500	0.538	0.482	0.519
Phe + Tyr	%	0.937	1.015	0.906	0.981	0.873	0.946
Essential Nitrogen	%	1.031	1.130	0.996	1.092	0.960	1.053

Table 3.30 - Nutritional Requirements of Standard Performance White Layers (g/bird/day)

Nutrients		White Layers					
Average Weight	kg	1.500		1.550		1.600	
Gain	g/day	0.4		0.3		0.1	
Egg Mass	g/day	58		54		50	
Metabolizable Energy	kcal/day	295		289		281	
Net Energy	kcal/day	216		213		209	
Diet Metab Energy	kcal/kg	2.900		2.900		2.900	
Diet Net Energy	kcal/kg	2125		2137		2151	
Intake	g/day	101.7		99.5		97.0	
Total Crude Protein	g/day	15.94		15.03		14.08	
Digestible Protein	g/day	14.53		14.53		12.84	
Calcium	g/day	4.32		4.04		3.75	
Available Phosphorus	g/day	0.223		0.217		0.211	
Digestible Phosphorus	g/day	0.201		0.196		0.190	
Potassium	g/day	0.530		0.519		0.506	
Sodium	g/day	0.212		0.208		0.202	
Chlorine	g/day	0.191		0.187		0.182	
Linoleic Acid	g/day	1.273		1.245		1.214	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	g/day	0.803	0.892	0.757	0.841	0.709	0.788
Methionine	g/day	0.369	0.401	0.348	0.378	0.326	0.355
Met + Cys	g/day	0.739	0.812	0.696	0.765	0.653	0.717
Threonine	g/day	0.618	0.714	0.583	0.673	0.546	0.630
Tryptophan	g/day	0.185	0.205	0.174	0.193	0.163	0.181
Arginine	g/day	0.843	0.901	0.795	0.849	0.745	0.796
Gly + Ser	g/day	0.634	0.731	0.598	0.690	0.560	0.646
Valine	g/day	0.723	0.803	0.681	0.757	0.638	0.709
Isoleucine	g/day	0.642	0.714	0.606	0.673	0.568	0.630
Leucine	g/day	0.980	1.061	0.923	1.001	0.865	0.938
Histidine	g/day	0.225	0.241	0.212	0.227	0.199	0.213
Phenylalanine	g/day	0.514	0.553	0.484	0.521	0.454	0.489
Phe + Tyr	g/day	0.931	1.008	0.878	0.950	0.823	0.890
Essential Nitrogen	g/day	1.023	1.122	0.964	1.058	0.904	0.991

Table 3.31 - Nutritional Requirements of Standard Performance White Layers (%)

Nutrients		White Layers					
Average Weight	kg	1.500		1.550		1.600	
Gain	g/day	0.4		0.3		0.1	
Egg Mass	g/day	58		54		50	
Metabolizable Energy	kcal/day	295		289		281	
Net Energy	kcal/day	216		213		209	
Diet Metab Energy	kcal/kg	2800		2800		2800	
Diet Net Energy	kcal/kg	2125		2137		2151	
Intake	g/day	101.7		99.5		97.0	
Total Crude Protein	%	15.67		15.11		14.50	
Digestible Protein	%	14.28		13.76		13.23	
Calcium	%	4.24		4.06		3.87	
Available Phosphorus	%	0.219		0.218		0.217	
Digestible Phosphorus	%	0.198		0.197		0.211	
Potassium	%	0.510		0.521		0.535	
Sodium	%	0.204		0.209		0.214	
Chlorine	%	0.184		0.188		0.192	
Linoleic Acid	%	1.224		1.251		1.283	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	%	0.789	0.877	0.761	0.846	0.731	0.812
Methionine	%	0.363	0.395	0.350	0.381	0.336	0.365
Met + Cys	%	0.726	0.798	0.700	0.770	0.673	0.739
Threonine	%	0.608	0.702	0.586	0.677	0.563	0.650
Tryptophan	%	0.182	0.202	0.175	0.195	0.168	0.187
Arginine	%	0.829	0.886	0.799	0.854	0.768	0.820
Gly + Ser	%	0.623	0.719	0.601	0.694	0.578	0.666
Valine	%	0.710	0.789	0.685	0.761	0.658	0.731
Isoleucine	%	0.631	0.702	0.609	0.677	0.585	0.650
Leucine	%	0.963	1.044	0.928	1.007	0.892	0.966
Histidine	%	0.221	0.237	0.213	0.228	0.205	0.219
Phenylalanine	%	0.505	0.544	0.487	0.525	0.468	0.503
Phe + Tyr	%	0.915	0.991	0.882	0.956	0.848	0.918
Essential Nitrogen	%	1.005	1.103	0.969	1.064	0.931	1.021

Table 3.32 - Nutritional Program Developed as a Function of Laying Rate of High Performance White Layers (g/bird/day)

Laying Rate, %	Nutritional Program					
	99 to 90		90 - 85		< 85	
Average Weight, kg	1.561		1.597		1.609	
Metabolizable Energy, kcal/day	305		300		296	
Net Energy, kcal/day	224		221		218	
Diet Metab Energy	2900		2900		2900	
Diet Net Energy	2123		2132		2138	
Intake, g/bird/day	104.5		102.7		101.6	
Crude Protein, g/day	16.46		15.88		15.40	
Digestible Protein, g/day	14.99		14.49		14.04	
Calcium, g/day	4.56		4.54		4.52	
Available Phosphorus, g/day	0.229		0.225		0.221	
Digestible Phosphorus, g/day	0.206		0.203		0.199	
Potassium, g/day	0.513		0.512		0.502	
Sodium, g/day	0.204		0.204		0.200	
Chlorine, g/day	0.188		0.187		0.183	
Linoleic Acid, g/day	1.224		1.220		1.196	
Amino Acids	SID	Total	SID	Total	SID	Total
Lysine, g/day	0.829	0.921	0.800	0.889	0.776	0.862
Methionine	0.381	0.414	0.368	0.400	0.357	0.388
Met + Cys, g/day	0.762	0.838	0.736	0.809	0.714	0.784
Threonine, g/day	0.638	0.737	0.616	0.711	0.598	0.690
Tryptophan, g/day	0.191	0.212	0.184	0.204	0.179	0.198
Arginine, g/day	0.870	0.930	0.841	0.898	0.815	0.871
Gly + Ser, g/day	0.655	0.755	0.632	0.729	0.613	0.707
Valine, g/day	0.746	0.829	0.720	0.800	0.699	0.776
Isoleucine, g/day	0.663	0.737	0.640	0.711	0.621	0.690
Leucine, g/day	1.011	1.096	0.977	1.058	0.947	1.026
Histidine, g/day	0.232	0.249	0.224	0.240	0.217	0.233
Phenylalanine	0.531	0.571	0.512	0.551	0.497	0.534
Phe + Tyr, g/day	0.961	1.041	0.929	1.005	0.900	0.974
Essential Nitrogen, g/day	1.056	1.159	1.020	1.118	0.989	1.084

Table 3.33 - Nutritional Program Developed as a Function of Laying Rate of High Performance White Layers (%)

Laying Rate, %	Nutritional Program					
	99 to 90		90 - 85		< 85	
Average Weight, kg	1.561		1.597		1.609	
Metabolizable Energy, kcal/day	305		300		296	
Net Energy, kcal/day	224		221		218	
Diet Metab Energy	2900		2900		2900	
Diet Net Energy	2123		2132		2138	
Intake, g/bird/day	104.5		102.7		101.6	
Crude Protein, %	15.67		15.36		15.09	
Digestible Protein, %	14.35		14.10		13.83	
Calcium, %	4.36		4.40		4.44	
Available Phosphorus, %	0.218		0.217		0.217	
Digestible Phosphorus, %	0.196		0.196		0.195	
Potassium, %	0.492		0.498		0.494	
Sodium, %	0.196		0.198		0.197	
Chlorine, %	0.180		0.182		0.180	
Linoleic Acid, %	1.172		1.188		1.177	
Amino Acids	SID	Total	SID	Total	SID	Total
Lysine, %	0.789	0.877	0.773	0.859	0.760	0.844
Methionine, %	0.363	0.395	0.356	0.387	0.350	0.380
Met + Cys, %	0.726	0.798	0.711	0.782	0.699	0.768
Threonine, %	0.608	0.702	0.595	0.687	0.585	0.675
Tryptophan, %	0.182	0.202	0.178	0.198	0.175	0.194
Arginine, %	0.829	0.886	0.812	0.868	0.798	0.852
Gly + Ser, %	0.623	0.719	0.611	0.704	0.600	0.692
Valine, %	0.710	0.789	0.696	0.773	0.684	0.760
Isoleucine, %	0.631	0.702	0.618	0.687	0.608	0.675
Leucine, %	0.963	1.044	0.943	1.022	0.927	1.004
Histidine, %	0.221	0.237	0.216	0.232	0.213	0.228
Phenylalanine, %	0.505	0.544	0.495	0.533	0.486	0.523
Phe + Tyr, %	0.915	0.991	0.897	0.971	0.882	0.954
Essential Nitrogen, %	1.010	1.103	0.993	1.081	0.973	1.062

Table 3.34 - Nutritional Requirements of High Performance Brown Layers (g/bird/day)

Nutrients		Brown Layers					
Average Weight	kg	1.800		1.850		1.900	
Gain	g/day	0.4		0.3		0.1	
Egg Mass	g/day	62		58		54	
Metabolizable Energy	kcal/day	327		320		313	
Net Energy	kcal/day	241		237		233	
Diet Metab Energy	kcal/kg	2850		2850		2850	
Diet Net Energy	kcal/kg	2097		2108		2120	
Intake	g/day	114.8		112.4		109.9	
Total Crude Protein	g/day	17.03		16.12		15.17	
Digestible Protein	g/day	15.52		14.69		13.83	
Calcium	g/day	4.63		4.35		4.06	
Available Phosphorus	g/day	0.245		0.239		0.232	
Digestible Phosphorus	g/day	0.220		0.215		0.209	
Potassium	g/day	0.516		0.506		0.494	
Sodium	g/day	0.206		0.201		0.197	
Chlorine	g/day	0.189		0.185		0.181	
Linoleic Acid	g/day	1.231		1.206		1.179	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	g/day	0.858	0.953	0.812	0.902	0.764	0.849
Methionine	g/day	0.395	0.429	0.373	0.406	0.352	0.382
Met + Cys	g/day	0.789	0.867	0.747	0.821	0.703	0.773
Threonine	g/day	0.661	0.762	0.625	0.722	0.588	0.679
Tryptophan	g/day	0.197	0.219	0.187	0.207	0.176	0.195
Arginine	g/day	0.901	0.963	0.852	0.911	0.802	0.857
Gly + Ser	g/day	0.678	0.781	0.641	0.740	0.604	0.696
Valine	g/day	0.772	0.858	0.731	0.812	0.688	0.764
Isoleucine	g/day	0.686	0.762	0.649	0.722	0.611	0.679
Leucine	g/day	1.047	1.134	0.990	1.073	0.932	1.010
Histidine	g/day	0.240	0.257	0.227	0.244	0.214	0.229
Phenylalanine	g/day	0.549	0.591	0.520	0.559	0.489	0.526
Phe + Tyr	g/day	0.995	1.077	0.942	1.019	0.887	0.959
Essential Nitrogen	g/day	1.093	1.199	1.034	1.135	0.974	1.068

Table 3.35 - Nutritional Requirements of High Performance Brown Layers (%)

Nutrients		Brown Layers					
Average Weight	kg	1.800		1.850		1.900	
Gain	g/day	0.4		0.3		0.1	
Egg Mass	g/day	62		58		54	
Metabolizable Energy	kcal/day	327		320		313	
Net Energy	kcal/day	241		237		233	
Diet Metab Energy	kcal/kg	2850		2850		2850	
Diet Net Energy	kcal/kg	2097		2108		2120	
Intake	g/day	114.8		112.4		109.9	
Total Crude Protein	%	14.83		14.33		13.81	
Digestible Protein	%	13.53		13.06		12.59	
Calcium	%	4.10		4.03		3.86	
Available Phosphorus	%	0.213		0.212		0.211	
Digestible Phosphorus	%	0.192		0.191		0.191	
Potassium	%	0.441		0.450		0.460	
Sodium	%	0.175		0.179		0.183	
Chlorine	%	0.161		0.164		0.168	
Linoleic Acid	%	1.051		1.073		1.098	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	%	0.747	0.830	0.722	0.802	0.696	0.773
Methionine	%	0.344	0.374	0.332	0.361	0.320	0.348
Met + Cys	%	0.688	0.755	0.664	0.730	0.640	0.703
Threonine	%	0.576	0.664	0.556	0.642	0.536	0.618
Tryptophan	%	0.172	0.191	0.166	0.184	0.160	0.178
Arginine	%	0.785	0.838	0.758	0.810	0.730	0.781
Gly + Ser	%	0.591	0.681	0.570	0.658	0.549	0.634
Valine	%	0.673	0.747	0.650	0.722	0.626	0.696
Isoleucine	%	0.598	0.664	0.578	0.642	0.556	0.618
Leucine	%	0.912	0.988	0.881	0.954	0.849	0.920
Histidine	%	0.209	0.224	0.202	0.217	0.195	0.209
Phenylalanine	%	0.478	0.515	0.462	0.497	0.445	0.479
Phe + Tyr	%	0.867	0.938	0.837	0.906	0.807	0.873
Essential Nitrogen	%	0.952	1.044	0.920	1.009	0.886	0.972

Table 3.36 - Nutritional Requirements of Standard Performance Brown Layers (g/bird/day)

Nutrients		Brown Layers					
Average Weight	kg	1.800		1.850		1.900	
Gain	g/day	0.4		0.3		0.1	
Egg Mass	g/day	58		54		50	
Metabolizable Energy	kcal/day	317		311		304	
Net Energy	kcal/day	234		231		227	
Diet Metab Energy	kcal/kg	2850		2850		2850	
Diet Net Energy	kcal/kg	2068		2080		2092	
Intake	g/day	113.4		111.0		108.4	
Total Crude Protein	g/day	16.12		15.20		14.26	
Digestible Protein	g/day	14.69		13.86		13.00	
Calcium	g/day	4.34		4.06		3.78	
Available Phosphorus	g/day	0.238		0.232		0.226	
Digestible Phosphorus	g/day	0.215		0.209		0.204	
Potassium	g/day	0.499		0.489		0.478	
Sodium	g/day	0.200		0.196		0.191	
Chlorine	g/day	0.180		0.176		0.172	
Linoleic Acid	g/day	1.199		1.174		1.146	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	g/day	0.812	0.902	0.766	0.851	0.718	0.798
Methionine	g/day	0.373	0.406	0.352	0.383	0.330	0.359
Met + Cys	g/day	0.747	0.821	0.705	0.774	0.661	0.726
Threonine	g/day	0.625	0.722	0.590	0.681	0.553	0.638
Tryptophan	g/day	0.187	0.207	0.176	0.196	0.165	0.184
Arginine	g/day	0.852	0.911	0.804	0.860	0.754	0.806
Gly + Ser	g/day	0.641	0.740	0.605	0.698	0.567	0.654
Valine	g/day	0.731	0.812	0.689	0.766	0.646	0.718
Isoleucine	g/day	0.649	0.722	0.613	0.681	0.575	0.638
Leucine	g/day	0.990	1.073	0.934	1.013	0.876	0.950
Histidine	g/day	0.227	0.244	0.214	0.230	0.201	0.215
Phenylalanine	g/day	0.520	0.559	0.490	0.528	0.460	0.495
Phe + Tyr	g/day	0.942	1.019	0.888	0.962	0.833	0.902
Essential Nitrogen	g/day	1.034	1.135	0.976	1.070	0.915	1.004

Table 3.37 - Nutritional Requirements of Standard Performance Brown Layers (%)

Nutrients		Brown Layers					
Average Weight	kg	1.800		1.850		1.900	
Gain	g/day	0.4		0.3		0.1	
Egg Mass	g/day	58		54		50	
Metabolizable Energy	kcal/day	317		311		304	
Net Energy	kcal/day	234		231		227	
Diet Metab Energy	kcal/kg	2.850		2.850		2.850	
Diet Net Energy	kcal/kg	2068		2080		2092	
Intake	g/day	113.4		111.0		108.4	
Total Crude Protein	%	14.22		13.71		13.17	
Digestible Protein	%	12.96		12.48		11.99	
Cálcio	%	3.83		3.66		3.48	
Available Phosphorus	%	0.227		0.209		0.202	
Digestible Phosphorus	%	0.205		0.189		0.182	
Potassium	%	0.441		0.441		0.441	
Sodium	%	0.176		0.176		0.176	
Chlorine	%	0.159		0.159		0.159	
Linoleic Acid	%	1.057		1.057		1.057	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	%	0.716	0.796	0.690	0.767	0.663	0.737
Methionine	%	0.329	0.358	0.317	0.345	0.305	0.332
Met + Cys	%	0.659	0.724	0.635	0.698	0.610	0.671
Threonine	%	0.551	0.637	0.531	0.614	0.510	0.590
Tryptophan	%	0.165	0.183	0.159	0.176	0.152	0.170
Arginine	%	0.752	0.804	0.724	0.775	0.696	0.744
Gly + Ser	%	0.566	0.635	0.545	0.629	0.523	0.604
Valine	%	0.644	0.716	0.621	0.690	0.596	0.663
Isoleucine	%	0.573	0.637	0.552	0.614	0.530	0.590
Leucine	%	0.874	0.947	0.842	0.913	0.808	0.877
Histidine	%	0.200	0.215	0.193	0.207	0.186	0.199
Phenylalanine	%	0.458	0.494	0.442	0.476	0.424	0.457
Phe + Tyr	%	0.831	0.899	0.800	0.867	0.769	0.833
Essential Nitrogen	%	0.912	1.001	0.879	0.965	0.844	0.927

Table 3.38 - Nutritional Program Developed as a Function of Laying Rate of High Performance Brown Layers (g/bird/day)

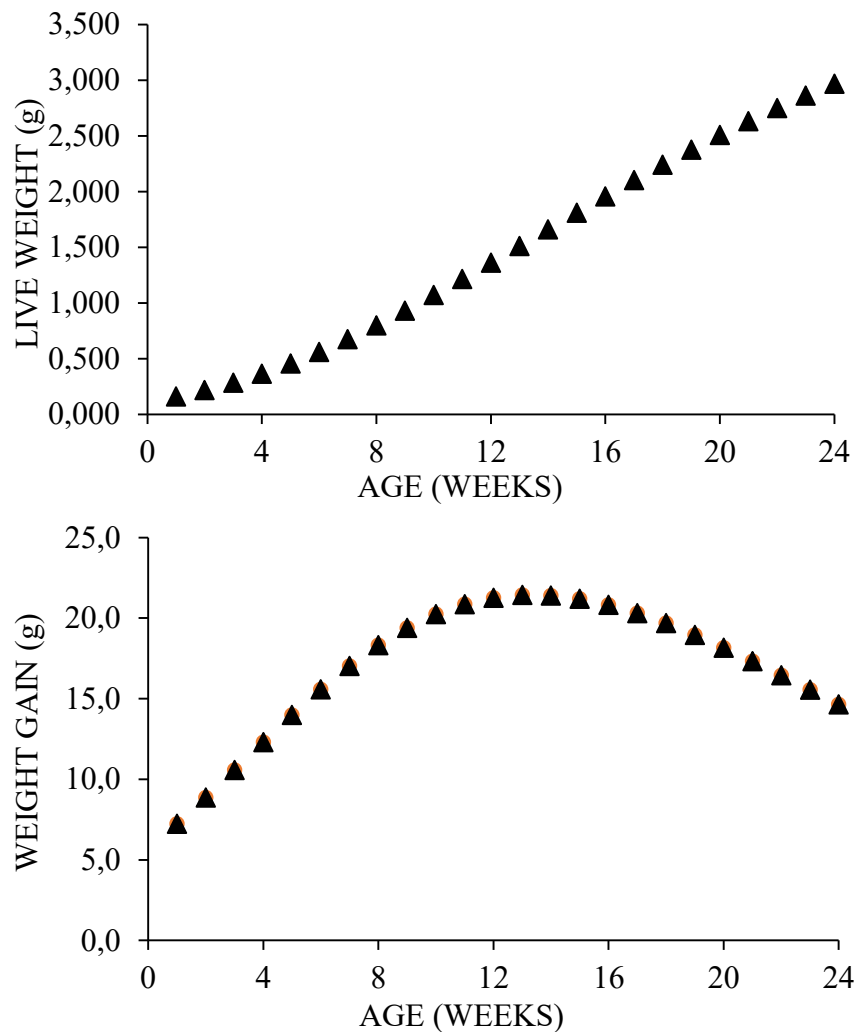
Laying Rate, %	Nutritional Program					
	99 to 90		90 - 85		< 85	
Average Weight, kg	1.857		1.866		1.874	
Metabolizable Energy, kcal/day	328		323		316	
Net Energy, kcal/day	242		239		234	
Diet Metab Energy	2850		2850		2850	
Diet Net Energy	2102		2108		2115	
Intake, g/bird/day	115		113		111	
Crude Protein, g/day	16.83		16.34		15.61	
Digestible Protein, g/day	15.96		15.50		14.81	
Calcium, g/day	4.61		4.58		4.51	
Available Phosphorus, g/day	0.245		0.241		0.235	
Digestible Phosphorus, g/day	0.221		0.217		0.212	
Potassium, g/day	0.579		0.585		0.573	
Sodium, g/day	0.230		0.233		0.228	
Chlorine, g/day	0.212		0.214		0.209	
Linoleic Acid, g/day	1.381		1.394		1.367	
Amino Acids	SID	Total	SID	Total	SID	Total
Lysine, g/day	0.848	0.942	0.823	0.914	0.787	0.874
Methionine, g/day	0.390	0.424	0.379	0.411	0.362	0.393
Met + Cys, g/day	0.780	0.857	0.757	0.832	0.724	0.795
Threonine, g/day	0.653	0.754	0.634	0.731	0.606	0.699
Tryptophan, g/day	0.195	0.217	0.189	0.210	0.181	0.201
Arginine, g/day	0.890	0.951	0.864	0.923	0.826	0.883
Gly + Ser, g/day	0.670	0.772	0.650	0.749	0.621	0.717
Valine, g/day	0.763	0.848	0.741	0.823	0.708	0.787
Isoleucine, g/day	0.678	0.754	0.658	0.731	0.629	0.699
Leucine, g/day	1.034	1.121	1.004	1.088	0.960	1.040
Histidine, g/day	0.237	0.254	0.230	0.247	0.220	0.236
Phenylalanine, g/day	0.543	0.584	0.527	0.567	0.504	0.542
Phe + Tyr, g/day	0.984	1.064	0.955	1.033	0.912	0.988
Essential Nitrogen, g/day	1.124	1.185	1.091	1.150	1.043	1.099

Table 3.39 - Nutritional Program Developed as a Function of Laying Rate of High Performance Brown Layers (%)

Laying Rate, %	Nutritional Program					
	99 to 90		90 - 85		< 85	
Average Weight, kg	1.857		1.866		1.874	
Metabolizable Energy, kcal/day	328		323		316	
Net Energy, kcal/day	242		239		234	
Diet Metab Energy	2850		2850		2850	
Diet Net Energy	2102		2108		2115	
Intake, g/bird/day	115		113		111	
Crude Protein, %	14.62		14.42		14.08	
Digestible Protein, %	13.88		13.67		13.36	
Calcium, %	4.01		4.04		4.07	
Available Phosphorus, %	0.213		0.213		0.212	
Digestible Phosphorus, %	0.192		0.191		0.191	
Potassium, %	0.503		0.516		0.517	
Sodium, %	0.200		0.205		0.206	
Chlorine, %	0.184		0.188		0.189	
Linoleic Acid, %	1.201		1.230		1.233	
Amino Acids	SID	Total	SID	Total	SID	Total
Lysine, %	0.736	0.818	0.726	0.807	0.709	0.788
Methionine, %	0.339	0.368	0.334	0.363	0.326	0.355
Met + Cys, %	0.677	0.744	0.668	0.734	0.653	0.717
Threonine, %	0.567	0.654	0.559	0.646	0.546	0.630
Tryptophan, %	0.169	0.188	0.167	0.186	0.163	0.181
Arginine, %	0.773	0.826	0.762	0.815	0.745	0.796
Gly + Ser, %	0.582	0.671	0.574	0.662	0.560	0.646
Valine, %	0.663	0.736	0.654	0.726	0.639	0.709
Isoleucine, %	0.589	0.654	0.581	0.646	0.568	0.630
Leucine, %	0.898	0.973	0.886	0.960	0.866	0.938
Histidine	0.206	0.221	0.203	0.218	0.199	0.213
Phenylalanine, %	0.471	0.507	0.465	0.500	0.454	0.489
Phe + Tyr, %	0.854	0.924	0.842	0.912	0.823	0.890
Essential Nitrogen, %	0.977	1.029	0.962	1.015	0.940	0.991

Nutritional Requirements of Broiler Breeder Pullets

Table 3.40 - Live Weight and Daily Weight Gain Curves According to the Gompertz Equation and the Derivative for Broiler Breeder Pullets



Equation parameters for broiler breeder pullets: $W_m = 4.255$; $b = 0.014$; $t^* = 93.5$; where W = weight (kg); G = weight gain (g/day); t = age (days); W_m = mature body weight (kg); b = maturity rate (g/day per g); t^* = age at maximum growth rate (days). The parameters were obtained by adjusting the Gompertz equation according to the weights presented in the lineage guidelines (Cobb, 2020; Ross, 2021).

Table 3.41 - Equations Used to Estimate Metabolizable Energy (ME) Requirements of Broiler Breeder Pullets (kcal/bird/day)^{1,2}

1 to 15 weeks:

$$\text{ME (kcal/bird/day)} = 113 \times W^{0.75} + (4.0 + 0.56 \times W) \times G$$

16 to 18 weeks:

$$\text{ME (kcal/bird/day)} = 113 \times W^{0.75} + (4.0 + 0.56 \times W) \times G + 2.4 \times \text{Egg}$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day)

Thermoneutral temperature (TN) and temperature range (TR) were considered according to the bird's age: 8 to 14 days, TN = 29° C, TR = 26 – 32° C; 15 to 21 days, TN = 26° C, TR = 23 – 29° C; 22 to 28 days, TN = 23° C, TR = 18 – 28° C; 29 to 126 days, TN = 20° C, TR = 16 – 27° C.

Example: Broiler Breeder Pullets

Age: 12 weeks (84 days)

W = 1.362 kg, where $W^{0.75} = 1.261$, G = 21.25 g/bird/day

ME Req. = $(113 \times 1.261) + (4.0 + 0.559 \times 1.362) \times 21.25$

ME Req. = $142.47 + 4.76 \times 21.25 = 244$ kcal/bird/day

Dietary ME² = 2.800 Kcal/g; Estimated Feed Intake = 87 g/day

Effect of temperature (T°C) of 27°C on maintenance ME requirement (ME_m):

T° C > TN

$$\text{ME}_m = 113 + 0.88 \times (T^\circ \text{C} - \text{TN})$$

$$\text{ME}_m = 113 + 0.88 \times (27 - 20)$$

$$\text{ME}_m = 113 + 0.88 \times 7 = 119.16 \text{ kcal/bird/day}$$

Effect of temperature (T°C) of 16°C on maintenance ME requirement (ME_m):

T° C < TN

$$\text{ME}_m = 113 + 6.73 \times (\text{TN} - T^\circ \text{C}) = 113 + 6.73 \times (20 - 16)$$

$$\text{ME}_m = 113 + 6.73 \times 4 = 139.92 \text{ kcal/bird/day}$$

¹ Equations adapted from Sakomura & Rostagno (2016), Sakomura et al. (2003), Sakomura et al. (2004), and Neme et al. (2005).

² Considering dietary ME during the grower phase of broiler breeder pullets: 1 to 4 weeks = 2.900 kcal/g and 5 to 24 weeks = 2.800 kcal/g.

Table 3.42 - Equations Used to Estimate Net Energy (NE) Requirements of Broiler Breeder Pullets (kcal/ave/dia)^{1,2}

1 to 15 weeks:

$$\text{NE (kcal/bird/day)} = 92.3 \times W^{0.75} + (2.24 + 0.486 \times W) \times G$$

16 to 18 weeks:

$$\text{NE (kcal/bird/d)} = 92.23 \times W^{0.75} + (2.24 + 0.486 \times W) \times G + 1.54 \times \text{Egg}$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day)

Example: Broiler Breeder Pullets

Age: 12 weeks (84 days)

W = 1.362 kg, where: $W^{0.75} = 1.261$, G = 21.25 g/bird/day

$$\text{NE Req.} = (92.3 \times 1.261) + (2.24 + 0.486 \times 1.362) \times 21.25$$

$$\text{NE Req.} = 116.34 + 2.90 \times 21.25 = 177.91 \text{ kcal/bird/day}$$

Estimated Feed Intake = 87 g/day

$$\text{Dietary NE}^2 = 2.045 \text{ kcal/g}$$

¹ Equations developed at UNESP – Jaboticabal, Horna (2022) (Doctoral Thesis, UNESP – Jaboticabal).

² Feed intake determined considering 2.8 kcal/g ME, and dietary NE calculated ($177.91/79.4 = 2.045 \text{ kcal/g}$).

Table 3.43 - Equations Used to Estimate Standardized Digestible Lysine (SID Lys) Requirements of Broiler Breeder Pullets (g/bird/day and %)^{1,2}

1 to 15 weeks:

SID Lys (g/bird/day) = Maintenance Req. + Gain Req.

$$\text{SID Lys (g/bird/day)} = [45.1 \times W^{0.75} + (14.7 + 5.3 \times W - 0.444 \times W^2) \times G] / 1000$$

16 to 18 weeks:

SID Lys (g/bird/day) = Maintenance Req. + Gain Req. + Egg Req.

$$\text{SID Lys (g/bird/day)} = [45.1 \times W^{0.75} + (14.7 + 5.2 \times W - 0.444 \times W^2) \times G + 9.46 \times \text{Egg}] / 100$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day)

Example:

Parameters	Broiler Breeder Pullets
Age (weeks/days)	12(84)
W (kg)	1.362
$W^{0.75}$	1.261
G (g/bird/day)	21.25
Intake (g)	87
Egg Mass (g/bird/day)	-
SID Lys Maintenance (g/bird/day)	0.057
SID Lys Gain (g/bird/day)	0.446
SID Lys Egg Mass (g/bird/day)	-
SID Lys Req. (g/day)	0.502
SID Lys Req. (%)	0.58

¹ Daily maintenance requirement of SID Lys was reported by Siqueira et al. (2011) and gain requirement were estimated at UNESP – Jaboticabal.

² Equations adapted from Sakomura & Rostagno (2016).

Table 3.44 - Performance and Standardized Digestible Lysine (SID Lys) ¹ and Metabolizable Energy (ME) Requirements of Broiler Breeder Pullets Using the Equations in Tables 3.40, 3.41, 3.42, and 3.43

Age Week (Days)	Weight kg	Gain g/day	SID Lys g/day	ME kcal/day	NE kcal/day	Intake g/day	Cumulative Intake g	Lys/ME %/Mcal	SID Lys %
1 (7)	0.161	7.2	0.124	58	40	20	128	0.212	0.615
2 (14)	0.218	8.9	0.155	73	50	25	288	0.213	0.618
3 (21)	0.286	10.6	0.188	88	61	30	484	0.214	0.620
4 (28)	0.366	12.3	0.225	105	73	36	720	0.214	0.621
5 (35)	0.458	14.0	0.263	122	86	44	1007	0.215	0.601
6 (42)	0.561	15.6	0.302	140	99	50	1339	0.215	0.601
7 (49)	0.676	17.0	0.340	159	113	57	1716	0.214	0.600
8 (56)	0.799	18.3	0.378	177	126	63	2139	0.214	0.598
9 (63)	0.931	19.4	0.414	195	140	70	2607	0.213	0.595
10 (70)	1.070	20.2	0.447	212	153	76	3119	0.211	0.591
11 (77)	1.214	20.9	0.477	228	166	82	3672	0.209	0.585
12 (84)	1.362	21.3	0.502	244	178	87	4265	0.206	0.577
13 (91)	1.511	21.4	0.523	258	190	92	4895	0.203	0.568
14 (98)	1.661	21.4	0.539	271	200	97	5558	0.199	0.557
15 (105)	1.811	21.2	0.551	283	210	101	6253	0.195	0.545
16 (112)	1.958	20.8	0.557	293	219	105	6975	0.190	0.532
17 (119)	2.102	20.3	0.559	302	227	108	7721	0.185	0.518
18 (126)	2.242	19.7	0.557	310	235	111	8489	0.180	0.503
19 (133)	2.377	19.0	0.565	321	243	115	9280	0.176	0.493
20 (140)	2.507	18.2	0.669	330	251	118	10095	0.203	0.568
21 (147)	2.631	17.3	0.721	338	258	121	10932	0.213	0.597
22 (154)	2.749	16.4	0.770	346	264	123	11788	0.223	0.624
23 (161)	2.862	15.6	0.818	352	270	126	12661	0.232	0.650
24 (168)	2.967	14.7	0.864	358	275	128	13551	0.241	0.675

¹ Broiler breeder pullets (19, 20, 21, 22, 23 to 24 weeks): extra requirement of +0.100, 0.150, 0.200, 0.250, and 0.300 g SID Lys /day, respectively, for reproductive tract development.

Table 3.45 - Amino Acid to Lysine Ratio (%) Used to Estimate Amino Acid Requirement of Broiler Breeder Pullets¹

Phase	Starter		Grower		Developer/Pre Lay	
Weeks	1 to 4		5 to 12		13 to 24	
Days	1 - 42 days		43-84 days		44-126 days	
Amino Acids	SID	Total	SID	Total	SID	Total
Lysine	100	100	100	100	100	100
Methionine	41	41	44	45	46	46
Met, + Cys	73	73	79	80	83	83
Threonine	68	71	67	70	70	73
Tryptophan	18	18	21	21	21	21
Arginine	108	106	109	107	109	107
Gly + Ser	138	142	135	139	111	109
Valine	77	79	79	80	83	85
Isoleucine	70	71	74	75	76	76
Leucine	113	112	119	118	130	130
Histidine	37	37	37	37	39	39
Phenylalanine	67	67	69	69	71	71
Phe + Tyr	122	122	126	126	129	129

¹ Determined in research carried out at UNESP – Jaboticabal, Dorigam (2016) (Doctoral Thesis).

² Ne: Total N ratio of 50 %.

-Total lysine requirement was calculated considering 90.0% the ileal digestibility of lysine in the diet. The total amino acid to total lysine ratios were used (Table 3.45) to estimate total amino acid requirements.

- To calculate dietary digestible and total proteins, the Ne: Total N ratio was 50%.

- SID Lys to digestible protein average ratio was 5.87±0.1 %.

- SID Lys to total protein average ratio was 5.41±0.2%.

Table 3.46 - Equations Used to Estimate Total Calcium, Standardized Digestible Phosphorus (Dig. P), and Available Phosphorus (Pav) Requirements of Broiler Breeder Pullets¹

Total calcium (g/bird/day) = Maintenance Req. + Gain Req. + Egg Req.

1 to 15 weeks:

$$\text{Total calcium (g/bird/day)} = [(70 \times W^{0.75} + 8.29 \times G)/0.37] / 1000$$

16 to 18 weeks:

$$\text{Total calcium (g/bird/d)} = [(70 \times W^{0.75} + 8.29 \times G + 40 \times \text{Egg})/0.37] / 1000$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day)

Example for calcium: Broiler Breeder Pullets

Age: 13 weeks (91 days)

W = 1.511 kg; $W^{0.75} = 1.363$; G = 21.43 g/bird/day

Estimated Feed Intake = 92.1 g/day

$$\text{Calcium Req.} = [(70 \times 1.363 + 8.29 \times 21.43)/0.37] / 1000 = 0.721 \text{ g/bird/day}$$

$$\% \text{ Calcium} = (0.721 \times 100)/92.1 = 0.783 \%$$

Dig. P (g/bird/day) = Maintenance Req. + Gain Req. + Egg Req.

$$1 \text{ to } 15 \text{ weeks: Dig. P (g/bird/day)} = [70 \times W^{0.75} + 6.64 \times G] / 1000$$

$$15 \text{ to } 18 \text{ weeks: Dig. P (g/bird/day)} = [70 \times W^{0.75} + 6.64 \times G + 1.8 \text{ Egg}] / 1000$$

Example for phosphorus: Broiler Breeder Pullets

Age: 13 weeks (91 d), W = 1.511 kg; $W^{0.75} = 1.363$ kg; G = 21.43 g/bird/d

Estimated Feed Intake = 92.1 g/day

$$\text{Dig. P (g/bird/day)} = [70 \times 1.363 + 6.64 \times 21.43] / 1000 = 0.238 \text{ g/bird/day}$$

$$\text{Pav} = 0.238 \times 1.18 = 0.280 \text{ g/bird/day}$$

$$\text{Pav (\%)} = 0.280 \times 100/92.1 = 0.305 \%$$

¹The maintenance requirements for calcium and phosphorus of 70 mg/kg^{0.75} were adapted from WPSA (1984) and Gopi et al. (2021). Weight gain requirements for calcium and phosphorus (8.29 and 6.64 mg/g, respectively), and calcium and phosphorus requirements for egg mass (40 and 1.8 mg/g) were obtained from research carried out at Laval University. A calcium digestibility coefficient of 0.37 was obtained from the information reported by Mutucumarana et al. (2014).

Table 3.47 - Total Calcium, Digestible Phosphorus, and Available Phosphorus Requirements of Broiler Breeder Pullets, Using the Equations in Table 3.46

Age Weeks (days)	Weight Kg	Gain g/day	Intake g/day	Calcium g/day	Dig. P g/day	Pav g/day	Calcium %	Dig P. %	Pav %
1 (7)	0.161	7.2	20	0.210	0.066	0.078	1.045	0.327	0.386
2 (14)	0.218	8.9	25	0.259	0.081	0.096	1.035	0.324	0.383
3 (21)	0.286	10.6	30	0.311	0.098	0.115	1.023	0.321	0.379
4 (28)	0.366	12.3	36	0.365	0.115	0.135	1.008	0.317	0.374
5 (35)	0.458	14.0	44	0.419	0.132	0.156	0.957	0.301	0.356
6 (42)	0.561	15.6	50	0.472	0.149	0.176	0.940	0.297	0.350
7 (49)	0.676	17.0	57	0.523	0.165	0.195	0.922	0.291	0.344
8 (56)	0.799	18.3	63	0.570	0.181	0.213	0.902	0.286	0.337
9 (63)	0.931	19.4	70	0.614	0.195	0.230	0.882	0.280	0.331
10 (70)	1.070	20.2	76	0.652	0.208	0.245	0.862	0.275	0.324
11 (77)	1.214	20.9	82	0.686	0.219	0.259	0.841	0.269	0.318
12 (84)	1.362	21.3	87	0.715	0.229	0.271	0.821	0.264	0.311
13 (91)	1.511	21.4	92	0.738	0.238	0.281	0.801	0.258	0.305
14 (98)	1.661	21.4	97	0.756	0.245	0.289	0.782	0.253	0.298
15 (105)	1.811	21.2	101	0.770	0.250	0.295	0.763	0.248	0.292
16 (112)	1.958	20.8	105	0.780	0.254	0.300	0.745	0.243	0.286
17 (119)	2.102	20.3	108	0.785	0.257	0.303	0.727	0.238	0.281
18 (126)	2.242	19.7	111	0.788	0.259	0.306	0.710	0.234	0.276
19 (133)	2.377	19.0	115	0.936	0.262	0.310	0.817	0.229	0.270
20 (140)	2.507	18.2	118	1.081	0.265	0.313	0.918	0.225	0.265
21 (147)	2.631	17.3	121	1.225	0.267	0.315	1.014	0.221	0.261
22 (154)	2.749	16.4	123	1.367	0.269	0.317	1.108	0.218	0.257
23 (161)	2.862	15.6	126	1.508	0.270	0.318	1.199	0.214	0.253
24 (168)	2.967	14.7	128	1.648	0.270	0.319	1.288	0.211	0.249

Table 3.48 - Nutritional Requirements of Broiler Breeder Pullets, According to Growing Phase (g/day)

Phase		Starter		Grower/ Developer			Pre Lay		
Age (Week)		1-4		5-12		13-18		19-24	
Average Weight	kg	0.222		0.809		1.821		2.640	
Gain	g/day	9.0		18.4		21.2		17.3	
SID Lysine	g/day	0.225		0.381		0.551		0.745	
Metabolizable Energy	kcal/day	74		178		283		339	
Net Energy	kcal/day	51		127		211		258	
Diet Metab Energy	kcal/kg	2.900		2.800		2.800		2.800	
Diet Net Energy	kcal/kg	2007		1997		2083		2137	
Intake	g/day	25.4		63.7		101.2		121.0	
Nutrients									
Total Crude Protein	g/day	4.20		7.20		10.37		13.91	
Digestible Protein	g/day	3.78		6.49		9.36		12.85	
Calcium	g/day	0.263		0.573		0.771		1.235	
Available Phosphorus	g/day	0.097		0.215		0.295		0.315	
Digestible Phosphorus	g/day	0.082		0.182		0.250		0.267	
Potassium	g/day	0.134		0.332		0.517		0.617	
Sodium	g/day	0.046		0.108		0.162		0.194	
Chlorine	g/day	0.040		0.096		0.152		0.181	
Linoleic Acid	g/day	0.261		0.637		1.012		1.210	
Amino Acids		SID	Total	SID	Total	SID	Total	SID	Total
Lysine	g/day	0.225	0.250	0.381	0.423	0.551	0.612	0.745	0.828
Methionine	g/day	0.091	0.103	0.167	0.190	0.253	0.282	0.344	0.381
Met. + Cys	g/day	0.164	0.183	0.301	0.338	0.457	0.508	0.619	0.687
Threonine	g/day	0.153	0.178	0.255	0.296	0.386	0.447	0.522	0.604
Tryptophan	g/day	0.040	0.045	0.080	0.089	0.116	0.129	0.157	0.174
Arginine	g/day	0.243	0.265	0.415	0.453	0.601	0.655	0.812	0.886
Gly + Ser	g/day	0.310	0.355	0.514	0.588	0.612	0.667	0.932	0.903
Valine	g/day	0.173	0.198	0.301	0.338	0.457	0.520	0.619	0.704
Isoleucine	g/day	0.157	0.178	0.282	0.317	0.419	0.465	0.566	0.629
Leucine	g/day	0.254	0.280	0.453	0.499	0.716	0.796	0.969	1.076
Histidine	g/day	0.083	0.093	0.141	0.157	0.215	0.239	0.291	0.323
Phenylalanine	g/day	0.151	0.168	0.263	0.292	0.391	0.435	0.529	0.588
Phe + Tyr	g/day	0.274	0.305	0.480	0.533	0.711	0.789	0.962	1.068
Essential Nitrogen	g/day	0.302	0.336	0.519	0.576	0.749	0.829	1.028	1.113

Table 3.49 - Nutritional Requirements of Broiler Breeder Pullets, According to the Growing Phase (%)

Phase		Starter		Grower/Developer			Pre Lay		
Age (week)		1-4		5-12		13-18		19-24	
Average Weight	kg	0.222		0.809		1.821		2.640	
Gain	g/day	9.0		18.4		21.2		17.3	
SID Lysine	g/day	0.225		0.381		0.551		0.745	
Metabolizable Energy	kcal/day	74		178		283		339	
Net Energy	kcal/day	51		127		211		258	
Diet Metab Energy	kcal/kg	2.900		2.800		2.800		2.800	
Diet Net Energy	kcal/kg	2.007		1.997		2.083		2.137	
Intake	g/day	25.4		63.7		101.2		121.0	
Nutrients									
Total Crude Protein	%	16.55		11.33		10.33		11.50	
Digestible Protein	%	14.84		10.18		9.26		10.63	
Calcium	%	1.034		0.901		0.762		1.021	
Available Phosphorus	%	0.383		0.337		0.292		0.261	
Digestible Phosphorus	%	0.324		0.286		0.247		0.221	
Potassium	%	0.528		0.521		0.511		0.510	
Sodium	%	0.182		0.169		0.160		0.161	
Chlorine	%	0.159		0.151		0.150		0.149	
Linoleic Acid	%	1.028		1.000		1.000		1.000	
Amino Acids		SID	Total	SID	Total	SID	Total	SID	Total
Lysine	%	0.886	0.984	0.598	0.665	0.545	0.605	0.616	0.684
Methionine	%	0.363	0.403	0.263	0.299	0.251	0.278	0.284	0.315
Met. + Cys	%	0.647	0.718	0.473	0.532	0.452	0.502	0.511	0.568
Threonine	%	0.602	0.699	0.401	0.466	0.382	0.442	0.431	0.499
Tryptophan	%	0.159	0.177	0.126	0.140	0.114	0.127	0.129	0.144
Arginine	%	0.957	1.043	0.652	0.712	0.594	0.647	0.672	0.732
Gly + Ser	%	1.223	1.397	0.808	0.924	0.605	0.659	0.770	0.746
Valine	%	0.682	0.777	0.473	0.532	0.452	0.514	0.511	0.581
Isoleucine	%	0.620	0.699	0.443	0.499	0.414	0.460	0.468	0.520
Leucine	%	1.001	1.102	0.712	0.785	0.709	0.787	0.801	0.889
Histidine	%	0.328	0.364	0.221	0.246	0.213	0.236	0.240	0.267
Phenylalanine	%	0.594	0.659	0.413	0.459	0.387	0.430	0.437	0.486
Phe + Tyr	%	1.081	1.200	0.754	0.838	0.703	0.780	0.795	0.882
Essential Nitrogen	%	1.187	1.324	0.814	0.906	0.741	0.826	0.850	0.920

Nutritional Requirements of Broiler Breeders

Table 3.50 - Equations Used to Estimate Metabolizable Energy (ME) Requirements of Broiler Breeders (kcal/bird/day)^{1,2}

$$\text{ME (kcal/bird/day)} = 113 \times W^{0.75} + 7.62 \times G + 2.4 \times \text{Egg}$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);
Egg = Egg Mass (g/bird/day)

Thermoneutral temperature (TN) and temperature range (TR) were considered as TN = 20° C, TR = 16 – 27° C.

Example: Broiler Breeders

Age: 34 weeks; W = 3.768 kg, $W^{0.75} = 2.705$, G = 3.6 g/day

$$\text{ME Req.} = 113 \times W^{0.75} + 7.62 \times G + 2.4 \times \text{Egg}$$

$$\text{ME Req.} = 305.6 + 27.21 + 125.5 = 458.3 \text{ kcal/bird/day}$$

$$\text{Dietary ME}^2 = 2.750 \text{ kcal/g; Estimated Feed Intake} = 166.7 \text{ g/day}$$

Effect of temperature (T° C) of 25° C on maintenance ME requirement (ME_m):

T° C > TN

$$\text{ME}_m = 113 + 0.88 \times (T^\circ \text{C} - \text{TN})$$

$$\text{ME}_m = 113 + 0.88 \times (25 - 20) = 113 + 0.88 \times 5 = 117.4 \text{ kcal/day}$$

Effect of temperature (T° C) of 17° C on maintenance ME requirement (ME_m):

T° C < TN

$$\text{ME}_m = 113 + 6.73 \times (\text{TN} - T^\circ \text{C})$$

$$\text{ME}_m = 113 + 6.73 \times (20 - 17) = 113 + 6.73 \times 3 = 133.2 \text{ kcal/bird/day}$$

¹ Equations estimated at UNESP – Jaboticabal; Information from Sakomura & Rostagno (2016), Rabello et al. (2006), Sakomura et al. (2004), and Neme et al. (2005).

² Considering dietary ME of 2.750 kcal/g diet for broiler breeders.

Table 3.51 - Equations Used to Estimate Net Energy (NE) Requirements of Broiler Breeders (kcal/bird/day)^{1,2}

$$\text{NE kcal/bird/day} = 92.3 \times W^{0.75} + 3.58 \times G + 1.54 \times \text{Egg}$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);
Egg = Egg Mass (g/bird/day)

Example: Broiler Breeders

Age: 34 weeks; W = 3.768 kg, where: $W^{0.75} = 2.705$

G = 3.6 g/bird/day; Egg = 52.3

$$\text{NE Req.} = 92.3 \times 2.705 + 3.58 \times 3.6 + 1.54 \times 52.3$$

$$\text{NE Req.} = 249.6 + 12.88 + 80.54 = 343.05 \text{ kcal/bird/day}$$

$$\text{Estimated Feed Intake} = 166.7 \text{ g/day}$$

$$\text{Dietary NE}^2 = 2.058 \text{ kcal/g}$$

¹ Equations estimated at UNESP – Jaboticabal; Horna (2022) (Doctoral Thesis, UNESP-Jaboticabal),

² Considering the feed intake determined with ME of 2.900 kcal/g, diet NE was calculated ($343.05/166.7 = 2.058 \text{ kcal/g}$).

Table 3.52 - Equations Used to Estimate Standardized Digestible Lysine (SID Lys) Requirements of Broiler Breeders (g/bird/day and %)^{1,2}

$$\text{Sid Lys (g/bird/day)} = \text{Maintenance Req.} + \text{Gain Req.} + \text{Egg}$$

$$\text{Maintenance Req. (mg/bird/day)} = 45.1 \times W^{0.75}$$

$$\text{Gain Req. (mg/bird/day)} = (55 + 12 \times G)/0.80$$

$$\text{Egg Req. (mg/bird/day)} = 14.5 \times \text{Egg}$$

$$\text{SID Lys (g/bird/d)} = [45.1 \times W^{0.75} + (55 + 12 \times G)/0.80 + 14.5 \times \text{Egg}] / 1000$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);

Egg = Egg Mass (g/bird/day)

Example:

Parameters	Broiler Breeders
Age (weeks/days)	34 (238)
W (kg)	3.768
$W^{0.75}$	2.705
G (g/bird/day)	3.6
Intake (g)	166.7
Egg Mass (g/bird/day)	52.3
SID Lys Maintenance (g/bird/day)	0.122
SID Lys Gain (g/bird/day)	0.123
SID Lys Egg Mass (g/bird/day)	0.758
SID Lys Req. (g/day)	1.002
SID Lys Req. (%)	0.60

¹ Equations estimated at UNESP – Jaboticabal; Daily maintenance requirement of SID Lys estimated from the information reported by Siqueira et al. (2011). Daily gain requirement of SID Lys estimated from Sakomura & Rostagno (2016).

² Utilization Efficiency of SID Lysine for Broiler Breeders = 0.80 during the production phase.

Table 3.53 - Standardized Digestible Lysine (SID Lys), ME, and NE Requirements of Broiler Breeders as a Function of Productivity

Age	Weight	Gain	Production	Egg	Egg Mass	SID Lys	ME	NE	Intake	SID Lys
Weeks	kg	g/day	%	Wt (g)	(g)	Req. (g/day)	(kcal/day)	kcal/day	(g/day)	%
25-28	3.2 - 3.5	-	-	-	-	0.980	487	346	-	0.553
29	3.58	11	83.0	57.7	47.8	1.051	496	355	180	0.583
30	3.64	9	85.8	58.9	50.5	1.048	484	352	176	0.595
31	3.68	6	86.5	59.9	51.7	1.025	468	346	170	0.602
32	3.72	5	86.0	60.7	52.2	1.016	463	344	168	0.603
33	3.74	4	85.1	61.4	52.3	1.007	459	343	167	0.603
34	3.77	4	84.2	62.1	52.3	1.002	458	343	167	0.602
35	3.79	4	83.2	62.8	52.2	1.002	460	344	167	0.599
36	3.82	3	82.2	63.3	52.0	0.994	458	344	166	0.597
37	3.84	3	81.2	63.7	51.7	0.991	458	344	167	0.594
38	3.86	3	80.1	64.2	51.4	0.980	456	343	166	0.591
39	3.88	3	79.0	64.6	51.0	0.976	456	344	166	0.588
40	3.90	2	78.0	65.0	50.7	0.966	454	343	165	0.585
41	3.91	3	76.9	65.3	50.2	0.959	454	343	165	0.581
42	3.93	2	75.8	65.7	49.8	0.954	454	343	165	0.578
43	3.95	3	74.7	66.0	49.3	0.947	454	343	165	0.574
44	3.97	2	73.6	66.4	48.8	0.941	454	344	165	0.570
45	3.98	3	72.6	66.7	48.4	0.935	454	344	165	0.566
46	4.00	3	71.5	67.0	47.9	0.928	454	344	165	0.563
47	4.02	3	70.5	67.3	47.4	0.921	453	344	165	0.559
48	4.04	3	69.4	67.6	46.9	0.914	453	344	165	0.555
49	4.05	3	68.4	67.8	46.4	0.908	453	344	165	0.551
50	4.07	2	67.4	68.1	45.8	0.895	450	343	164	0.547
51	4.08	2	66.3	68.3	45.3	0.887	450	342	163	0.543
52	4.10	2	65.3	68.6	44.8	0.880	449	342	163	0.539
53	4.11	2	64.2	68.9	44.2	0.872	449	342	163	0.534
54	4.13	2	63.2	69.1	43.6	0.864	448	342	163	0.530
55	4.14	2	62.1	69.3	43.0	0.855	448	342	163	0.525
56	4.16	2	61.1	69.5	42.4	0.847	447	342	163	0.521
57	4.17	2	60.0	69.7	41.8	0.839	447	341	162	0.516
58	4.19	2	59.0	69.9	41.2	0.830	446	341	162	0.512
59	4.20	2	57.9	70.0	40.5	0.821	445	341	162	0.507
60	4.22	2	56.8	70.2	39.8	0.811	445	341	162	0.502
61	4.23	2	55.8	70.3	39.2	0.802	444	340	161	0.497
62	4.25	2	54.7	70.4	38.5	0.793	443	340	161	0.492
63	4.26	2	53.5	70.5	37.7	0.782	442	340	161	0.486
64	4.28	2	52.5	70.6	37.0	0.772	441	339	160	0.481
65	4.29	2	51.0	70.9	36.2	0.760	440	339	160	0.475

Table 3.54 - Amino Acid to Lysine Ratio (%) Used to Estimate Amino Acid Requirements of Broiler Breeders¹

Amino Acid	SID	Total
Lysine	100	100
Methionine	45	45
Met + Cys	89	89
Threonine	80	83
Tryptophan	23	23
Arginine	112	109
Gly + Ser	95	98
Valine	90	90
Isoleucine	92	81
Leucine	125	123
Histidine	36	35
Phenylalanine	66	65
Phe + Tyr	113	111

¹The amino acids to lysine ratios utilized were proposed by Dorigam et al. (2017).

- The total lysine requirement was calculated considering 90.0% the ileal digestibility of lysine in the diet. Total amino acid to total lysine ratios were used (table 3.54) to estimate total amino acid requirements.

- To calculate dietary digestible and total proteins the Ne: Total N ratio was 40%.

- SID Lys to Digestible Protein ratio = 4.69%.

- SID Lys to Total Protein = 4.28%.

- Example: SID Lys, g/day = $(0.939 \times 100)/4.69 = 20.0$ g/day of Digestible Protein.
Considering a feed intake of 167.5 g/day; $(20.0 \times 100)/167.5 = 11.9\%$ Digestible Protein.

- Example: SID Lys = $(0.939 \times 100)/4.28 = 21.93$ g/day of Total Protein.

Considering a feed intake of 167.5 g/day; $(21.93 \times 100)/167.5 = 13.1\%$ Total Protein.

Table 3.55 - Equations Used to Estimate Total Calcium, Standardized Digestible Phosphorus (Dig. P), and Available Phosphorus (Pav) Requirements of Broiler Breeders^{1,2}

$$\text{Total Calcium (g/bird/d)} = \text{Maintenance Req} + \text{Gain Req} + \text{Egg Req}$$

$$\text{Total Calcium (g/bird/day)} = [(70 \times W^{0.75} + 8.29 \times G + 40 \times \text{Egg}) / (0.517 + 0.0043 \times t - 0.0001 \times t^2)] / 1000$$

W = Average Body Weight (kg); G = Weight Gain (g/bird/day);
Egg = Egg Mass (g/bird/day); t = bird's age in weeks

Example for calcium: Broiler Breeders

W = 3.743 kg; $W^{0.75} = 2.689$ kg; G = 3.9 g/bird/day; Egg = 52.3 g/bird/day; t = 33 weeks; Estimated Feed Intake = 167 g/day

Calcium Req. = $[(70 \times 2.689 + 8.29 \times 3.9 + 40 \times 52.3) / (0.517 + 0.0043 \times 33 - 0.0001 \times 1089)] / 1000 = 4.20$ g/bird/day

% Calcium = $(4.220 \times 100) / 167 = 2.52$ %

$$\text{Dig. P (g/bird/day)} = \text{Maintenance Req.} + \text{Gain Req.} + \text{Egg Req.}$$

$$\text{Dig. P (g/bird/day)} = (101 \times W^{0.75} + 4.0 \times G + 1.8 \text{ Egg}) / 1000$$

Example for phosphorus: Broiler Breeders

W = 3.74 kg; $W^{0.75} = 2.689$ kg; G = 3.9 g/bird/day; Egg = 52.3 g/bird/day; t = 33 weeks; Estimated Feed Intake = 167 g/day

Dig. P = $(101 \times 2.689 + 4.0 \times 3.9 + 1.8 \times 52.3) / 1000 = 0.381$ g/day

Pav = $0.381 \times 1.05 = 0.400$ g/bird/day

Dig. P (%) = $0.381 \times 100 / 167 = 0.228$ %

Pav (%) = $0.400 \times 100 / 167 = 0.240$ %

¹ The maintenance requirements for calcium of 70 and phosphorus of 101 mg/kg^{0.75} were adapted from WPSA (1984) and Gopi et al. (2021). Weight gain requirements for calcium and phosphorus (8.29 and 4.0 mg/g, respectively), and egg mass requirements for calcium and phosphorus (40 and 1.8 mg/g) were obtained from research carried out at Laval University. The calcium digestibility coefficient was adjusted according to the bird's age.

² The calcium equation was adjusted according to the broiler breeders' age (24 to 65 weeks).

Table 3.56 - Total Calcium, Digestible Phosphorus, and Available Phosphorus Requirements of Broiler Breeders as a Function of Productivity, Using the Equations in Table 3.55

Age Weeks	Weight kg	Gain g/day	Egg Mass g/day	Intake g/day	Calcium g/day	Dig. P g/day	Pav g/day	Calcium %	Dig. P %	Pav %
25-28	3.20-3.50	-	-	-	3.49	0.382	0.401	1.97	0.216	0.226
29	3.58	11.4	47.8	180	3.93	0.395	0.414	2.18	0.219	0.230
30	3.64	8.6	50.5	176	4.09	0.391	0.411	2.32	0.222	0.234
31	3.68	5.7	51.7	170	4.16	0.384	0.403	2.44	0.226	0.237
32	3.72	4.6	52.2	168	4.19	0.383	0.402	2.49	0.228	0.239
33	3.74	3.9	52.3	167	4.20	0.381	0.400	2.52	0.228	0.240
34	3.77	3.6	52.3	167	4.22	0.382	0.401	2.53	0.229	0.240
35	3.79	3.6	52.2	167	4.24	0.383	0.402	2.53	0.229	0.241
36	3.82	3.2	52.0	166	4.24	0.382	0.401	2.55	0.230	0.242
37	3.84	3.2	51.7	167	4.24	0.383	0.402	2.55	0.229	0.241
38	3.86	2.9	51.4	166	4.24	0.382	0.401	2.56	0.230	0.242
39	3.88	2.9	51.0	166	4.24	0.383	0.402	2.55	0.230	0.242
40	3.90	2.5	50.7	165	4.24	0.382	0.401	2.57	0.231	0.243
41	3.91	2.5	50.2	165	4.23	0.381	0.400	2.57	0.231	0.243
42	3.93	2.5	49.8	165	4.24	0.382	0.401	2.57	0.231	0.243
43	3.95	2.5	49.3	165	4.23	0.382	0.401	2.57	0.231	0.243
44	3.97	2.5	48.8	165	4.24	0.382	0.401	2.57	0.231	0.243
45	3.98	2.5	48.4	165	4.24	0.382	0.401	2.57	0.231	0.243
46	4.00	2.5	47.9	165	4.24	0.382	0.401	2.57	0.231	0.243
47	4.02	2.5	47.4	165	4.25	0.382	0.401	2.58	0.232	0.243
48	4.04	2.5	46.9	165	4.25	0.382	0.401	2.58	0.232	0.243
49	4.05	2.5	46.4	165	4.26	0.382	0.401	2.58	0.231	0.243
50	4.07	2.1	45.8	164	4.26	0.380	0.399	2.60	0.232	0.243
51	4.08	2.1	45.3	163	4.26	0.380	0.399	2.61	0.233	0.245
52	4.10	2.1	44.8	163	4.28	0.380	0.399	2.62	0.233	0.245
53	4.11	2.1	44.2	163	4.29	0.380	0.398	2.63	0.233	0.244
54	4.13	2.1	43.6	163	4.30	0.379	0.398	2.64	0.233	0.244
55	4.14	2.1	43.0	163	4.31	0.379	0.398	2.65	0.232	0.244
56	4.16	2.1	42.4	163	4.32	0.379	0.398	2.66	0.232	0.244
57	4.17	2.1	41.8	162	4.33	0.378	0.397	2.67	0.234	0.245
58	4.19	2.1	41.2	162	4.35	0.378	0.397	2.68	0.234	0.245
59	4.20	2.1	40.5	162	4.37	0.378	0.396	2.70	0.233	0.245
60	4.22	2.1	39.8	162	4.38	0.377	0.396	2.71	0.233	0.245
61	4.23	2.1	39.2	161	4.40	0.377	0.396	2.73	0.234	0.246
62	4.25	2.1	38.5	161	4.42	0.377	0.395	2.75	0.234	0.246
63	4.26	2.1	37.7	161	4.44	0.376	0.395	2.76	0.233	0.245
64	4.28	2.1	37.0	160	4.46	0.376	0.394	2.78	0.235	0.246
65	4.29	2.1	36.2	160	4.48	0.395	0.414	2.80	0.219	0.230

Table 3.57 - Nutritional Requirements of Broiler Breeders (g/bird/day)

Nutrients		Broiler Breeders					
Average Weight	kg	3.800		4.050		4.200	
Gain	g/day	4		3		2	
Egg Mass	g/day	52		48		46	
Metabolizable Energy	kcal/day	463		461		457	
Net Energy	kcal/day	346		348		349	
Diet Metab Energy	kcal/kg	2750		2750		2750	
Diet Net Energy	kcal/Kg	2054		2078		2098	
Intake	g/day	168.3		167.5		166.2	
Total Crude Protein	g/day	23.46		21.91		20.96	
Digestible Protein	g/day	21.42		20.00		19.15	
Calcium	g/day	4.23		4.45		4.97	
Available Phosphorus	g/day	0.404		0.406		0.406	
Digestible Phosphorus	g/day	0.384		0.387		0.387	
Potassium	g/day	0.752		0.748		0.743	
Sodium	g/day	0.269		0.267		0.265	
Chlorine	g/day	0.236		0.235		0.233	
Linoleic Acid	g/day	2.15		2.14		2.12	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	g/day	1.005	1.117	0.939	1.043	0.898	0.998
Methionine	g/day	0.452	0.503	0.422	0.469	0.404	0.449
Met + Cys	g/day	0.895	0.994	0.835	0.928	0.799	0.888
Threonine	g/day	0.804	0.927	0.751	0.866	0.718	0.828
Tryptophan	g/day	0.231	0.257	0.216	0.240	0.207	0.230
Arginine	g/day	1.126	1.218	1.051	1.137	1.006	1.088
Gly + Ser	g/day	0.955	1.095	0.892	1.022	0.853	0.978
Valine	g/day	0.905	1.005	0.845	0.939	0.808	0.898
Isoleucine	g/day	0.925	0.905	0.863	0.845	0.826	0.808
Leucine	g/day	1.257	1.374	1.173	1.283	1.123	1.228
Histidine	g/day	0.362	0.391	0.338	0.365	0.323	0.349
Phenylalanine	g/day	0.664	0.726	0.619	0.678	0.593	0.649
Phe + Tyr	g/day	1.136	1.240	1.061	1.158	1.015	1.108
Essential Nitrogen	g/day	1.371	1.503	1.281	1.404	1.225	1.343

Table 3.58 - Nutritional Requirements of Broiler Breeders (%)

Nutrients		Broiler Breeders					
Average Weight	kg	3.800		4.050		4.200	
Gain	g/day	4		3		2	
Egg Mass	g/day	52		48		46	
Metabolizable Energy	kcal/day	463		461		457	
Net Energy	kcal/day	346		348		349	
Diet Metab Energy	kcal/kg	2750		2750		2750	
Diet Net Energy	kcal/Kg	2054		2078		2098	
Intake	g/day	168.3		167.5		166.2	
Crude Protein	%	13.94		13.08		12.61	
Digestible Protein	%	12.73		11.94		11.52	
Calcium	%	2.51		2.66		2.99	
Available Phosphorus	%	0.240		0.242		0.245	
Digestible Phosphorus	%	0.228		0.231		0.233	
Potassium	%	0.447		0.447		0.447	
Sodium	%	0.160		0.160		0.160	
Chlorine	%	0.140		0.1404		0.140	
Linoleic Acid	%	1.276		1.276		1.276	
Amino Acids		SID	Total	SID	Total	SID	Total
Lysine	%	0.589	0.663	0.560	0.622	0.540	0.600
Methionine	%	0.265	0.298	0.252	0.280	0.243	0.270
Met + Cys	%	0.524	0.590	0.499	0.554	0.481	0.534
Threonine	%	0.471	0.550	0.448	0.516	0.432	0.498
Tryptophan	%	0.135	0.152	0.129	0.143	0.124	0.138
Arginine	%	0.660	0.723	0.627	0.678	0.605	0.654
Gly + Ser	%	0.560	0.650	0.532	0.610	0.513	0.588
Valine	%	0.530	0.597	0.504	0.560	0.486	0.540
Isoleucine	%	0.542	0.537	0.515	0.504	0.497	0.586
Leucine	%	0.736	0.815	0.700	0.765	0.675	0.738
Histidine	%	0.212	0.232	0.202	0.218	0.194	0.210
Phenylalanine	%	0.389	0.431	0.370	0.404	0.357	0.390
Phe + Tyr	%	0.666	0.736	0.633	0.690	0.610	0.666
Essential Nitrogen	%	0.589	0.892	0.764	0.837	0.737	0.807

Table 3.59 - Nutritional Program Developed Based on the Laying Rate of Broiler Breeders (g/bird/day)

	Nutritional Program					
Laying Rate, %	87 to 75	75 to 65	< 65			
Average Weight, kg	3.83	4.03	4.20			
Recommended Concentrations						
Metabolizable Energy, kcal/day	458	453	445			
Net Energy, kcal/day	343	344	341			
Diet Metab Energy, kcal/kg	2750	2750	2750			
Diet Net Energy , kcal/kg	2064	2086	2106			
Intake, g/bird/day	167	165	162			
Crude Protein, g/day	22.97	21.30	19.07			
Digestible Protein, g/day	20.96	19.45	17.41			
Calcium, g/day	4.24	4.25	4.37			
Available Phosphorus, g/day	0.398	0.397	0.393			
Digestible Phosphorus, g/day	0.379	0.378	0.374			
Potassium, g/day	0.794	0.735	0.701			
Sodium, g/day	0.284	0.263	0.250			
Chlorine, g/day	0.250	0.231	0.220			
Linoleic Acid, g/day	2.268	2.101	2.003			
Amino Acids						
Amino Acid	SID	Total	SID	Total	SID	Total
Lysine, g/day	0.984	1.093	0.912	1.014	0.816	0.907
Methionine, g/day	0.443	0.491	0.411	0.456	0.367	0.408
Met + Cys, g/day	0.875	0.972	0.812	0.902	0.727	0.807
Threonine, g/day	0.787	0.907	0.730	0.841	0.653	0.753
Tryptophan, g/day	0.226	0.251	0.210	0.233	0.188	0.209
Arginine, g/day	1.102	1.190	1.022	1.104	0.914	0.989
Gly + Ser, g/day	0.934	1.070	0.867	0.993	0.776	0.889
Valine, g/day	0.885	0.983	0.821	0.912	0.735	0.816
Isoleucine, g/day	0.905	0.885	0.839	0.821	0.751	0.735
Leucine, g/day	1.230	1.343	1.141	1.246	1.021	1.116
Histidine, g/day	0.354	0.382	0.328	0.355	0.294	0.318
Phenylalanine, g/day	0.649	0.710	0.602	0.659	0.539	0.590
Phe + Tyr, g/day	1.112	1.212	1.031	1.125	0.923	1.007
Essential Nitrogen, g/day	1.342	1.470	1.245	1.363	1.114	1.221

Table 3.60 - Nutritional Program Developed Based on the Laying Rate of Broiler Breeders (%)

	Nutritional Program					
Laying Rate, %	87 to 75		75 to 65		< 65	
Average Weight, kg	3.83		4.03		4.20	
Recommended Concentrations						
Metabolizable Energy, kcal/day	458		453		445	
Net Energy, Kcal/day	343		344		341	
Diet Metab Energy, kcal/kg	2750		2750		2750	
Diet Net Energy, kcal/kg	2064		2086		2106	
Intake, g/bird/day	167		165		162	
Crude Protein, %	13.75		12.91		11.77	
Digestible Protein, %	12.56		11.79		10.74	
Calcium, %	2.55		2.58		2.70	
Available Phosphorus, %	0.239		0.241		0.243	
Digestible Phosphorus, %	0.228		0.230		0.231	
Potassium, %	0.477		0.446		0.433	
Sodium, %	0.170		0.159		0.155	
Chlorine, %	0.150		0.140		0.136	
Linoleic Acid, %	1.362		1.274		1.237	
Amino Acids	SID	Total	SID	Total	SID	Total
Lysine, %	0.589	0.654	0.553	0.614	0.504	0.560
Methionine, %	0.265	0.294	0.249	0.276	0.227	0.252
Met + Cys, %	0.524	0.582	0.492	0.546	0.449	0.498
Threonine, %	0.471	0.543	0.442	0.510	0.403	0.465
Tryptophan, %	0.135	0.150	0.127	0.141	0.116	0.129
Arginine, %	0.660	0.713	0.619	0.669	0.564	0.610
Gly + Ser, %	0.560	0.641	0.525	0.602	0.479	0.549
Valine, %	0.530	0.589	0.498	0.553	0.454	0.504
Isoleucine, %	0.542	0.530	0.509	0.497	0.464	0.454
Leucine, %	0.736	0.804	0.691	0.755	0.630	0.689
Histidine, %	0.212	0.229	0.199	0.215	0.181	0.196
Phenylalanine, %	0.389	0.425	0.365	0.399	0.333	0.364
Phe + Tyr, %	0.666	0.726	0.625	0.682	0.570	0.622
Essential Nitrogen, %	0.804	0.880	0.755	0.826	0.688	0.754

