SCIENTIC FEEDING OF BROILERS, LAYER AND OTHER BIRDS

Dept. of Animal Nutrition
Co. V. Sc. & AH Jabalpur (M.P.)

Six Major Classes of Nutrients

Carbohydrates

Protein Fats Vitamins

Minerals Water

Water

The water requirement is dependent on

i. Age
ii. Functional status
iii. Environmental temperature
iv. Other factors

Water is given to the birds *ad libitum.* Usually, birds drink water double the quantity of feed. In summer, this can be more than three times the quantity of feed. Water is not restricted to the birds, except under special circumstances, i.e. for initiation of molt in certain programmes.

Energy:

The intake of energy by a chicken is governed by

i. Energy content of the diet
ii. Productive state
iii. Nutritional adequacy
iv. Other factors

Protein

- **Some amino acids have to be provided in diet as the chicken cannot synthesize them or they do so inadequately. Such amino acids are called essential amino acids.**

- **Amino acids required but synthesized in the body adequately are known as non-essential amino acids.**

- **Among the essential amino acids, certain amino acids are likely to be low in practical feeds and these are known as critical amino acids.**

- **Among the critical amino acids, lysine and methionine are the most deficient amino acids and are known as limiting amino acids.**

Fig 3. **Nutritional classification of amino acids**

Non-essential amino acids	Essential amino acids		
	Essential including critical and limiting	*Critical*	*Limiting*
1. Alanine	1. Lysine	1. Lysine	1. Lysine
2. Asparatic acid	2. Methionine	2. Methionine	2. Methionine
3. Glutamic acid	3. Methionine+cystine[1]	3. Methionine+cystine1	3. Threonine
4. Hydroxyproline	4. Tryptophan	4. Tryptophan	
5. Proline	5. Threonine	5. Threonine	
6. Glycine + 7. Serine	6. Arginine	6. Arginine	
	7. Isoleucine	7. Isoleucine	
	8. Leucine		
	9. Valine		
	10. Histidine		
	11. Phenylalanine		
	12. Phenylalanine + Tyrosine[2]		

[1]The requirement for cystine can be met by cystine or methionine.
[2]The requirement for tyrosine can be met by tyrosine or phenylalanine.

Minerals

Several factors influence the requirements of minerals. These are:

i. Breed of the chicken
ii. Age of the chicken
iii. Animal adaptation
iv. Level of production
v. Chemical form
vi. Interrelation with other elements

Essential minerals*	Critical minerals	Remarks
Major Minerals		
Calcium (Ca)	Calcium (Ca)	
Phosphorus (P)	Phosphorus (nonphytin) (NPP)	
Sodium (Na)	Sodium	
Chlorine (Cl)	Chlorine	
Magnesium (Mg)		Not deficient in practical diet
Potassium (K)		Not deficient in practical diet
Sulphur		Not deficient in practical diet

Trace Minerals

Manganese (Mn)	**Manganese (Mn)**
Zinc (Zn)	**Zinc (Zn)**
Iron (Fe)	**Iron (Fe)**
Copper (Cu)	**Copper (Cu)**
Iodine (I)	**Iodine (I)**
Selenium (Se)	**Selenium (Se)****

List of vitamins to be supplemented in poultry diet

Essential Vitamins	Critical Vitamins		Remarks
	Chicks	Layers	
Fat soluble vitamins			
Vitamin A	Vitamin A	Vitamin A	
Vitamin D_3	Vitamin D_3	Vitamin D_3	
Vitamin E	Vitamin E		Improves immunity. Addition may be beneficial under stress conditions
Vitamin K	Vitamin K		

Water soluble vitamins

Thiamine (Vitamin B_1)			Not deficit in practical diets
Riboflavin (Vitamin B_2)	Riboflavin (Vitamin B_2)	Riboflavin (Vitamin B_2)	
Pyridoxine (Vitamin B_6)	Pyridoxine (Vitamin B_6)	Pyridoxine (Vitamin B_6)	Feed ingredients may not supply adequate amounts.
Pantothenic acid	Pantothenic acid	Pantothenic acid	
Niacin	Niacin	Niacin	
Biotin			Feed ingredients supply sufficient biotin and folic acid for growth and egg production

Folic acid		
Choline	**Choline**	**Supplemental choline may be necessary to mobilise fat.**
Vitamin B_{12} (Cyanocobalamin)	**Vitamin B_{12} (Cyanocobalamin)**	**Vitamin B_{12} (Cyanocobalamin)**
Vitamin C		**Improves immunity beneficial under stress**

Vitamin supplements:

- **Natural feedstuffs provide some vitamins for poultry.**
- **Vitamin premixes are commonly used to provide the required vitamins in poultry.**
  - Routinely supplemented
  - Water soluble
    - B-complex vitamins
  - Fat soluble
    - A, D, E and K

Feeding of Broilers

Broilers

- A broiler is any chicken that is bred and raised specifically for meat production.
- Most commercial broilers reach slaughter weight between four and six weeks of age.

Phases

- Commercial White broilers are generally reared under three phases,

  - Pre-starter phase (0-14 days of age)
  - Starter phase (14-21 days of age)
  - Finisher phase (21-42 days of age)

- To achieve 2 to 2.5 kg market body weight.

Nutrient Requirement of Broilers

BIS- 2007

	Pre Starter	Starter	Finisher
	1-7d	8-21d	22 d to market
CP %	23	22	20
ME kcal /kg diet	3000	3100	3200
Ly %	1.3	1.2	1.0
Meth %	o.5	0.5	0.45
Ca %	1.0	1.0	1.0
Av. P %	0.45	0.45	0.45

ICAR-2013

	Pre Starter	Starter	Finisher
	0-14	14-21	21-42
CP %	22	21.50	19.50
ME kcal/ kg diet	3000	3050	3100
Ly %	1.20	1.07	0.94
Meth %	0.52	0.48	0.41
Ca %	1.0	0.95	0.85
Av. P %	0.45	0.40	0.38

NRC-1994

	Pre Starter	Starter	Finisher
	0-3 W	3-6 W	6-8 W
CP %	23	20	18
ME kcal/ kg diet	3200	3200	3200
Ly %	1.1	1.0	1.85
Meth %	0.50	0.38	0.32
Ca %	1.0	0.90	0.80
NPP %	0.45	0.35	0.30
Cu mg/kg	8	8	8
I mg/kg	0.35	0.35	0.35
Fe mg/kg	80	80	80
Mn mg/kg	60	60	60
Zn mg/kg	40	40	40
Se mg/kg	0.15	0.15	0.15
Vit. A IU/Kg	5000	5000	5000
Vit.D3 IU/Kg	2400	2400	2400

Calculation (Factional method) to calculate energy requirement for broilers

Example: Body Weight of broiler = 1.5 kg

NE m req. for adult hen = 83x BW kg $^{0.75}$/kcal/d

NE m req. for broiler =1.5 kg

= 83x $1.5^{0.75}$ kcal/d

= 83x (1.5x1.5x1.5 = 3.375

= $\sqrt{3.375}$ = 1.837

= $\sqrt{1.837}$ = 1.355

= 83x 1.837

= 112 kcal/d

NE m is 82% of ME m

or

ME is 18% higher than NE

ME m = 112/0.82= 137 kcal/d

Activity allowance:

Cage bird = 37% of ME m

Deep litter = 50% of ME m

If broilers are kept is deep litter:

Activity allowance = 137x50% of ME m= 68.5

Total ME req. = ME m + ME activity

= 137+68.5= 205.5 kcal/d

Now ME req. for gain:

Say B.wt. gain in 1.5 kg broiler is = 50g /d

Each gram of tissue gain contain = 18% protein &15% fat

So, 50 g gain will contain =

Protein = 50x18% = 9g x 4.0 kcal = 36 kcal energy

Fat = 50x15% = 7.5g fat x 9.0 kcal = 67.5 kcal energy

Total energy gain due to tissue: = 36+67.5 = 103.5 kcal

Total ME reg. for 1.5 kg broiler:

= ME m + ME activity + ME gain

= 137 + 68.5 + 103.5 = 309 kcal/d

Thumb rule = Energy for growth ranger from approx 1.5-3.0 kcal per gram of body gain

Protein reg. of broiler

Protein reg. for broiler =

Protein reg. for maintenance M

Protein reg. for tissue gain T

Protein reg. for father growth F

$$P = M+T+F$$

Maintenance Requirement:

Maintenance req. of protein =

= 250 mg N/kg BW/d

= 1600 mg CP/kg BW/d

$$\text{Body wt in g} \times \frac{1.6}{1000}$$

Tissue growth

Tissue contain 18% protein

Daily gain (g) x 0.18

Feather growth

Feather comprise: 7% of BW at 4 wk age

Feather contains: 82 % protein

Body wt (g) x0.07 x 0.82

Total protein req. of growing broilers:

$$g/d = \frac{(W \times 0.0016) + (\text{Wt gain} \times 0.18) + (W \times 0.07 \times 0.82)}{0.65}$$

As efficiency of utilization of energy for:

1. Tissue gain = 65%
2. Feather growth =50%
3. egg prod = 50%

BROILER PERFORMANCE GOALS - VENCOBB400

TABLE : 1 (FOR STRAIGHT RUN BIRDS)

Age in Days	Mortality %	Body Wt. (Gms)	Cumulative Feed Consumption (Gms)	Cumulative FCR (Pelleted Feed)
7	0.80	190	182	0.96
14	1.25	450	549	1.22
21	1.50	850	1122	1.32
28	2.00	1375	1966	1.43
35	2.75	1925	3042	1.58
42	3.50	2550	4335	1.70

Efficiency parameters

- **Feed Coversion Ratio**

$$FCR = \frac{\text{Quantity of feed consumed (g)}}{\text{Gain in body weight (g)}}$$

- **Feed Efficiency Ratio**

$$FER = \frac{\text{Gain in body weight (g)}}{\text{Quantity of feed consumed (g)}}$$

- **Performance Index**

$$PI = FER \times Body\ Weight$$

Daily requirement during starting period (0-3 weeks)

CP:	Maintenance	-	2.403 g CP/ kg $W^{0.75}$
	Gain	-	0.292 g CP/ g gain
ME:	Maintenance	-	43.25 kcal/ kg $W^{0.75}$
	Gain	-	3.994 kcal /g gain
Lys:	Maintenance	-	117 mg Lys/ kg $W^{0.75}$
	Gain	-	14.53 mg Lys/ g gain
Met:	Maintenance	-	41.63 mg Met/ kg $W^{0.75}$
	Gain	-	6.6 mg Met/ g gain
Thr:	Maintenance	-	80.4mg/ kg $W^{0.75}$
	Gain	-	10.44 mg/ g gain

Daily requirement during finishing period (4- 6 or 7 weeks)

CP:	Maintenance	-	8.637 g CP/ kg $W^{0.75}$
	Gain	-	0.195 g CP/ g gain
ME:	Maintenance	-	124.442 kcal/ kg $W^{0.75}$
	Gain	-	3.06 kcal /g gain
Lys:	Maintenance	-	408 mg Lys/ kg $W^{0.75}$
	Gain	-	9.632 mg Lys/ g gain
Met:	Maintenance	-	173 mg Met/ kg $W^{0.75}$
	Gain	-	3.81 mg Met/ g gain
Thr:	Maintenance	-	307mg/ kg $W^{0.75}$
	Gain	-	6.923 mg/ g gain

The requirement of other amino acids were calculated as proportion of Lys requirement:

- Arg 110-114
- Ile 73
- Leu 109
- Val 82
- Phe 65
- His 32
- Trp 18%.

Requirement of digestible amino acid was calculated based on the digestibility coefficients:

for Lys 0.90; Met 0.90; Thr 0.84; Arg 00.92; Ile 0.88 Leu 0.93; Val 0.87; Phe 0.89; His 0.88 and Trp 0.91%.

Egg Type Pullets

Hens may be typed for production of:

- Table eggs (laying hens)
- Settable eggs (breeding hens)

Replacement pullets are generally reared in three phases:

- Starter (0-8 weeks of age)
- Grower (8-20 weeks of age)
- Layer (20 weeks or above).

For meeting the nutrient requirement, particularly that of calcium at onset of lay, pre-lay phase (17/18 – 20 weeks) is recommended.

Laying phase is often divided into

Phase I (20-30 weeks)

Phase II (>30 weeks).

In certain countries, a five-phase feeding system is followed viz. starter (0-6 weeks of age), grower I (6-12 weeks of age), grower II (12-18 weeks of age), grower III (18-to 1st egg) and layer (20 weeks or above).

Nutrition and feeding in early part of life influence subsequent laying performance

EXERCISE-1: NUTRIENT REQUIREMENT CALCULATION FOR POULTRY

Energy requirement

- Energy requirement of poultry depends on live weight, temperature in the poultry house, daily egg output, growth and physical activity.
  - Energy required = (170 - **2.2T**) W + **5 AW** + 2 **E** for Leghorn hens
  - W = mean live weight in kg
  - AW = mean daily gain, g/day
  - E = egg output, g/day
  - T = environmental temperature, C.

Energy requirement for maintenance layers from BMR studies

- NE m adult hen maintenance = 83 x BW kg $^{0.75}$ Kcal / day
- NE m 1.75 Kg adult hen = 83 x 1.75 kg $^{0.75}$ Kcal / day = 83 x 1.52 = 126 Kcal / day
- ME m requirement = 126 x 82% = 126/0.82 = 154 Kcal / day
- Activity allowance 50% of the basal metabolism in deep litter hens and 37 % of basal metabolism in hens in cages.
- Total ME Kcal / day for non laying hens = 154 + 57 = 211 Kcal / day

Energy requirement layers egg production

- Energy content of a large egg = 86 Kcal
- Energy requirement for 100 percent production = 211 + 86 = 297 Kcal / day

ICAR-2013

Table 4. Nutrient requirements (as fed basis) of starting and growing egg type pullets and cockerels

Nutrients	Laying pullets			Cockerels	
	0-8 wk	8-16wk	16-18wk	0-4wk	4-10wk
ME (kcal/kg)	2,600	2,600	2,700	2,600	2,600
Crude protein (%)	18.5	15.5	15.0	19	17.5
Lysine (%)	0.85	0.65	0.50	0.98	0.90
Methionine (%)	0.32	0.29	0.27	0.35	0.33
Methionine + Cysteine (%)	0.65	0.59	0.54	0.70	0.67
Threonine (%)	0.68	0.58	0.50	0.78	0.70
Linoleic acid (%)	1.0	0.8	0.8	1.0	0.8
Calcium, (%)	1.0	0.80	2.0	1.0	0.85
Available Phosphorus (%)	0.4	0.35	0.32	0.41	0.38
Sodium (%)	0.15	0.15	0.15	0.15	0.15
Chloride (%)	0.15	0.12	0.12	0.15	0.15
Copper (mg/kg)	8.0	5.0	5.0	8.0	8.0
Iodine (mg/kg)	0.35	0.35	0.35	0.35	0.35
Iron (mg/kg)	60	60	60	60	60
Manganese (mg/kg)	50	40	40	50	45
Selenium (mg/kg)	0.15	0.10	0.10	0.15	0.15
Zinc (mg/kg)	40	35	35	40	40

ICAR-2013 Cont…….

Vitamin A (IU/kg)	3,000	2,500	3,000	3,000	2,500
D_3, (IU/kg)	300	250	300	300	250
E (IU/kg)	10	10	10	10	10
K (mg/kg)	0.5	0.5	0.5	0.5	0.5
Thiamin (mg/kg)	1.0	1.0	1.0	1.0	1.0
Riboflavin (mg/kg)	3.6	1.8	1.8	3.6	3.0
Pyridoxine (mg/kg)	3.0	3.0	3.0	3.0	3.0
Vitamin B_{12} (mg/kg)	0.009	0.003	0.003	0.009	0.005
Biotin (mg/kg)	0.15	0.10	0.10	0.15	0.15
Folic acid (mg/kg)	0.55	0.25	0.25	0.55	0.55
Niacin (mg/kg)	25.0	11.0	11.0	25.0	25.0
Pantothenic acid (mg/kg)	10.0	10.0	10.0	10.0	10.0
Choline (mg)	1,300	900	500	1,300	1,000

ICAR-2013

Table 5. Nutrient requirements (as fed basis) of Leghorn type hens and breeder males

Description	Age (wk)		Age (wk)		Breeder male
	18-30	18-30	>30	>30	>20 wk
Live wt. (g)	1,300	1,400	1,400	1,500	-
Egg Mass (g)	42.5	45	45	50	-
Shed temp. (^{0}C)	25	25	25	25	-
Feed intake (g)	90	100	100	110	-
Nutrient					
ME (kcal/kg)	2,750	2,600	2,600	2,550	2,600
Crude protein (%)	20.0	18.0	16.5	15.0	16.5
Lysine (%)	0.90	0.82	0.76	0.68	0.76
Methionine (%)	0.40	0.36	0.34	0.32	0.34
Methionine+ Cysteine (%)	0.78	0.70	0.65	0.60	0.65
Threonine (%)	0.63	0.56	0.52	0.47	0.52
Arginine (%)	0.93	0.84	0.77	0.70	0.77
Tryptophan (%)	0.21	0.19	0.18	0.16	0.18
Linoleic acid (%)	1.10	1.00	1.0	0.85	1.0
Calcium, (%)	3.80	3.61	3.60	3.40	1.00
Available Phosphorus (%)	0.36	0.28	0.32	0.30	0.32
Sodium (%)	0.17	0.15	0.15	0.14	0.15
Iodine (mg/kg)	0.040	0.035	0.035	0.032	0.035
Iron (mg/kg)	55	50	50	45	50
Manganese (mg/kg)	50	45	45	40	45
Selenium (mg/kg)	0.08	0.06	0.06	0.05	0.06
Zinc (mg/kg)	50	45	45	40	45

ICAR-2013 Cont……

Vitamin A (IU/kg)	5,000	4,500	4,500	4,000	4,500
D_3 (IU/kg)	500	450	450	400	450
E (IU/kg)	15	10	10	10	10
K (mg/kg)	0.6	0.5	0.5	0.45	0.5
Thiamin (mg/kg)	0.85	0.70	0.70	0.65	0.70
Riboflavin (mg/kg)	3.5	3.0	3.0	2.8	3.0
Pyridoxine (mg/kg)	3.5	3.0	3.0	2.8	3.0
Vitamin B_{12} (mg/kg)	0.004	0.004	0.004	0.004	0.004
Biotin (mg/kg)	0.12	0.10	0.10	0.09	0.10
Folic acid (mg/kg)	0.30	0.28	0.28	0.25	0.28
Niacin (mg/kg)	12.0	10.0	10.0	9.0	10.0
Pantothenic acid (mg/kg)	2.5	2.0	2.0	1.80	2.0
Choline (mg/kg)	1,200	1,050	1,050	950	1,000

Notes: Add or subtract 80 kcal ME/kg diet for increase or decrease of each 100 g live weight. Add or subtract 30 kcal ME/kg diet for increase or decrease of each 1g of egg mass.

Add or subtract 20 kcal ME/kg diet for fall or increase of each ^{0}C of temperature. Add additional (25%) trace minerals and vitamins in the diet of layer breeders. The digestibility of lysine, methionine, Met + Cys, threonine and tryptophan is 88, 92, 89, 83 & 87% respectively.

BIS-2007

Broilers: **Pre-Starter: 1-7 d;** **Starter 8-21d;** **Finisher: 22d-market**
Layers: **Starter: 0-8 wks;** **Grower: 9-20 wks;** **Layer: Phase I: 21-45 wks;** **Phase I I: 46-72wks**

Sl No.	Characteristic	Requir						
		Broiler Feed			Layer Feed			
		Pre-starter	Starter	Finisher	Chick	Grower	Layer Phase I	Layer Phase II
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Moisture, percent by mass, *Max*	11.0	11.0	11.0	11.0	11.0	11.0	11.0
ii)	Crude protein (N × 6.25), percent by mass, *Min*	23.0	22.0	20.0	20.0	16.0	18.0	16.0
iii)	Ether extract, percent by mass, *Min*	3.0	3.5	4.0	2.0	2.0	2.0	2.0
iv)	Crude fibre, percent by mass, *Max*	5.0	5.0	5.0	7.0	9.0	9.0	10.0
v)	Acid insoluble ash, percent by mass, *Max*	2.5	2.5	2.5	4.0	4.0	4.0	4.5
vi)	Salt (as NaCl), percent by mass, *Max*	0.5	0.5	0.5	0.5	0.5	0.5	0.5

BIS-2007 cont….

Sl No.	Characteristic	Requir						
		Broiler Feed			Layer Feed			
		Pre-starter	Starter	Finisher	Chick	Grower	Layer Phase I	Layer Phase II
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
i)	Calcium (as Ca), percent by mass, *Min*	1.0	1.0	1.0	1.0	1.0	3.0	3.5
ii)	Total phosphorus, percent by mass, *Min*	0.7	0.7	0.7	0.7	0.65	0.65	0.65
iii)	Available phosphorus, percent by mass, *Min*	0.45	0.45	0.45	0.45	0.40	0.40	0.40
iv)	Lysine, percent by mass, *Min*	1.3	1.2	1.0	1.0	0.7	0.7	0.65
v)	Methionine, percent by mass, *Min*	0.5	0.5	0.45	0.40	0.35	0.35	0.30
vi)	Methionine + Cystine, percent by mass, *Min*	0.9	0.9	0.85	0.70	0.60	0.60	0.55
vii)	Metabolizable energy (Kcal/kg), *Min*	3 000	3 100	3 200	2 800	2 500	2 600	2 400
viii)	Aflatoxin B_1 (ppb), *Max*	20	20	20	20	20	20	20

NRC-1994

	0-6wks	6-12wks	12-18wks	18 wk to 1st egg lay	layer
					Feed intake=110g/d
CP%	18%	16%	15%	17%	13.64%
Ly%	0.85	0.60	0.45	0.52	0.63
Meth. %	0.30	0.25	0.20	0.22	0.27
Ca%	0.90	0.80	0.80	5%	2.96
PP%	0.40	0.35	0.30	0.32	0.23
Mn%	90	30	30	30	60
Fe%	80	60	60	60	40
Cu%	5	4	4	4	8
Zn%	40	35	35	35	60
Se%	0.15	0.1	0.1	0.1	0.1
Vit. A IU	1500	1500	1500	1500	8000
Vit. D IU	200	200	200	300	1200
ME Kcal/kg diet	2850	2850	2900	2850	2500 kcal

Fig 3. **Nutritional classification of amino acids**

Non-essential amino acids	Essential amino acids		
	Essential including critical and limiting	*Critical*	*Limiting*
1. Alanine	1. Lysine	1. Lysine	1. Lysine
2. Asparatic acid	2. Methionine	2. Methionine	2. Methionine
3. Glutamic acid	3. Methionine+cystine[1]	3. Methionine+cystine1	3. Threonine
4. Hydroxyproline	4. Tryptophan	4. Tryptophan	
5. Proline	5. Threonine	5. Threonine	
6. Glycine + 7. Serine	6. Arginine	6. Arginine	
	7. Isoleucine	7. Isoleucine	
	8. Leucine		
	9. Valine		
	10. Histidine		
	11. Phenylalanine		
	12. Phenylalanine + Tyrosine[2]		

[1]The requirement for cystine can be met by cystine or methionine.
[2]The requirement for tyrosine can be met by tyrosine or phenylalanine.

AA digestibility %

$= (\%AA_{diet} \times \text{Feed Intake (g)} - \%AA_{excreta} \times \text{Excreta(g)}) \times 100$

The urine AAs, present in excreta, are not of feed origin but of metabolic origin.

Apparent ileal AA dig % (g), (AID)

$= (\%AA_{diet} \times \text{Feed Intake(g)} - \%AA_{Ileal} \times \text{ileal contents(g)}) \times 100$

The ileal contents contain AA of endogenous origin. The endogenous amino acids may be non-specific (related to dry matter intake) and specific (related to the raw material).

True ileal AA dig % or Standardized ileal AA dig % (SID)

$= (\%AA_{diet} \times \text{Feed Intake(g)} - (\%AA_{Ileal} \times \text{ileal contents(g)}) - (\%AA_{\text{endogenous non-specific}} \times \text{Ileal contents(g)}) \times 100$

- The critical nutrients required for optimum laying performance are energy and protein (amino acids).
- Birds satisfy energy intake by adjusting their daily feed intake; unable to meet their AA needs by adjusting FI.
- The daily requirement for all the AAS changes as the amount of egg mass changes.
- It also increases from 25 to 40 weeks of age, and then gradually decreases as egg mass decreases.
- As the laying house temperature and energy content of the diet influence the feed intake, the AA content in the feed must be adjusted to compensate those changes.
- The prediction formula developed by Harms (2001): Critical amino acids requirements are 13.42, 5.45, 8.54, 2.91, 11.82 and 12.73 mg/g of egg mass for lysine, methionine, threonine, tryptophan, isoleucine and valine, respectively.

Amino acids can be calculated from the equation:

$$\textbf{\% of amino acid in diet} = \frac{\text{mg of AA / g egg mass X kcal ME consumed per day}}{\text{kcal ME / g egg mass X Feed consumption in mg}}$$

- NRC (1994) recommendations provide much energy (2,800-2,900 kcal ME/kg).
- It becomes difficult to provide such an amount of energy under Indian conditions.
- The dietary energy level is kept in between 2,500 and 2,750 kcal ME/kg during growth period.
- Moreover, being tropical country, the maintenance requirement is also slightly lower.
- Lower energy level is associated with higher feed conversion ratio, higher gut volume and subsequent higher feed intake.
- In laying hens the dietary energy concentration ranges from 2,550 to 2,700 kcal ME/kg.
- On an average one laying hen showing 90% egg production requires 16-18 g of protein and 285 to 290 kcal ME per day.

- Meeting calcium requirement is important during overall growth (0.9 to 0.7%), but most crucial during laying phase.
- Just prior to initiation of egg production, huge amount of calcium is stored in bones, which is sufficient for 6 to 30 eggs.
- Therefore, calcium concentration is increased to about 2% of diet a week before onset of egg production.
- Once egg laying starts birds meet their calcium requirements from dietary intake and body reserve.
- The specific gravity of egg-hell increases with increased calcium concentration in diets.
- White Leghorn hens producing 90% eggs require daily about 3.8 to 4.2 g of calcium.
- Half of the calcium in diet should be supplied through LSP and remaining half as grit so that the needy hens may select and consume calcium as per need and palatability of feed is maintained.

- Therefore, in addition to dietary calcium (3 to 3.5%), there should be continuous access to shell grit.
- Shell grits improve digestion and utilization of other nutrients by helping in the grinding of feed materials in the gizzard.
- Addition of grit of appropriate sizes in mash at an interval of every two to four weeks may be beneficial.
- Retention of calcium during the first 40 weeks is about 55% and decreases thereafter with age.
- Thus, requirement of calcium increases with age.
- Heavy birds consume more feed, hence dietary concentration of calcium should be less.
- Any factor that affects feed intake like ME content of diet, and environmental temperature, will affect calcium concentration in the diets.

- The available P requirements are 0.4% in starting, 0.35% during growing and 0.25 to 0.3% in laying phase.

- Egg content can be manipulated by nutrition. The major changes that can be brought through nutritional manipulation are egg size, egg shell quality, yolk pigmentation, egg cholesterol content, and concentration of certain vitamins, minerals and desired fatty acids (enrichment of eggs).

Chick Mash

Chick mash should be fed to the birds from its arrival until the average body weight of the birds reaches 580 gms. This is a feed-to-weight program rather than feed-to-age program. Body weight gains are better with pelleted/ crumbled feed compared to mash feed. Therefore it is recommended to use pelleted/crumbled chick feed.

Grower Mash

The grower feed should be fed till flock reaches an average body weight of 1100 gms. Do not administer prelay feed to the birds weighing below 1100 gms.

Prelay Feed

Care should be taken to ensure prelay feed is introduced after the flock attains an average body weight of 1100 gms and usually for 2 to 3 weeks

Layer Feed

Layer feed offered to the laying birds should be formulated according to the age of the birds and egg production. Accordingly, layer feed can be divided into three groups i.e. Phase I , Phase II and Phase III. Phase I feed should be given upto the age of 40 weeks and later Phase II ration may be given. Phase III feed should be given after the age of 60 weeks.

Feed Consumption and Body Weight Targets of BV-300 (Growing Phase)

Type of Feed	Age		Grams of Feed per Bird		Body Weight
	Weeks	*Days*	*Per Day*	*Cumulative*	*in gms*
1	1	0-7	11	77	70
1	2	8-14	16	189	120
1	3	15-21	18	315	170
1	4	22-28	25	490	230
1	5	29-35	35	735	310
1	6	36-42	40	1015	410
1	7	43-49	44	1323	490
1/2	8	50-56	48	1659	580
1/2	9	57-63	49	2002	660
2	10	64-70	50	2352	740
2	11	71-77	51	2709	820
2	12	78-84	54	3087	900
2	13	85-91	56	3479	970
2	14	92-98	58	3885	1030
2	15	99-105	60	4305	1070
3	16	106-112	62	4739	1110
3	17	113-119	63	5180	1160
3/4	18	120-126	66	5642	1200
4	19	127-133	75	6167	1280
4	20	134-140	82	6741	1360

Standards for Commercial Layer Flocks

Age in Weeks	Livability	Prod. %	Egg/HH/ Weeks	Cummu. Egg H.H.	Recommended Daily Feed
19	100	5	0.35	0.35	75
20	100	15	1.05	1.40	82
21	100	38	2.66	4.06	90
22	99.9	64	4.48	8.54	93
23	99.9	83	5.80	14.34	96
24	99.9	89	6.22	20.56	102
25	99.8	92	6.43	26.99	104
26	99.8	94	6.57	33.56	106
27	99.7	94	6.56	40.12	108
28	99.7	95	6.63	46.75	108
29	99.6	96	6.69	53.44	109
30	99.6	97	6.76	60.20	111
31	99.6	97	6.76	66.96	111
32	99.5	97	6.76	73.72	115
33	99.4	96	6.68	80.40	115
34	99.3	96	6.67	87.07	115
35	99.2	96	6.67	93.73	115
36	99.1	96	6.66	100.39	115
37	99.0	95	6.58	106.98	114
38	98.9	95	6.58	113.55	114
39	98.8	95	6.57	120.13	114
40	98.7	95	6.56	126.69	113
41	98.6	94	6.49	133.18	113
42	98.5	94	6.48	139.66	113
43	98.4	94	6.47	146.13	113
44	98.3	93	6.40	152.53	113
45	98.2	93	6.39	158.92	113
46	98.1	93	6.39	165.31	113

Age in Weeks	Livability	Prod. %	Egg/HH/ Weeks	Cummu. Egg H.H.	Recommended Daily Feed
47	98.0	93	6.38	171.69	113
48	97.9	93	6.37	178.06	113
49	97.8	92	6.30	184.36	113
50	97.7	92	6.29	190.65	112
51	97.6	91	6.22	196.87	112
52	97.5	90	6.14	203.01	112
53	97.5	89	6.07	209.08	112
54	97.4	89	6.07	215.15	112
55	97.3	89	6.06	221.21	112
56	97.2	89	6.06	227.27	112
57	97.2	89	6.06	233.33	112
58	97.1	88	5.98	239.31	112
59	97.0	88	5.98	245.29	112
60	96.9	88	5.97	251.26	112
61	96.9	88	5.97	257.22	110
62	96.8	87	5.90	263.12	110
63	96.7	87	5.89	269.02	110
64	96.6	86	5.82	274.84	110
65	96.5	86	5.81	280.65	110
66	96.5	86	5.81	286.46	110
67	96.4	85	5.74	292.20	110
68	96.3	84	5.66	297.86	110
69	96.3	84	5.66	303.52	110
70	96.2	83	5.59	309.11	110
71	96.1	82	5.52	314.63	110
72	96.0	81	5.44	320.07	110
			320.00		**41.25**

Standards for Commercial Layer Flocks

Performance Goals

The following performance goals are expected to be achieved during the 52 weeks of laying circle:

1. Livability	96%
2. Egg yield	320 eggs cumulative hen housed
3. Feed consumption	41.25 kg/bird during laying
4. Peak production	(above 90%) 25 weeks to 52 weeks of age

JAPANESE QUAILS

➢**Japanese quails** (Coturnix coturnix japonica) are reared intensively for commercial meat and egg production.

Quails are also important laboratory birds because of their small size and short life span.

➢**Quail possess characteristics of fast growth, early sexual maturity and high rate of egg production.**

➢**They are prolific breeders and have the ability to produce 4 generations in a year.**

➢**Quails are immunologically more potent than chicken ,need no vaccination, little or no medication ,tough to environmental constraints due to inherent ability to grow under natural conditions**

➢**Quils meat and eggs contain less fat and cholesterol and thus are more healthy and friendly to cardiac patients.**

Broiler quail chicks

- Biphasic rearing system (0-3 and 3-5 weeks)

- Quail broilers achieve body weight of about 180-240 g at 35 days.

- The growth rate is very high during the first three weeks of age and decreases thereafter at 4th and 5th weeks of age.

Layer quail chicks

- Females grow faster than males and at 5th week of age, the difference is about 10-20 g.

- They start to lay at about 6th week of age and about 50% egg production is achieved at 42 to 49 days of age; 9-30 weeks =80% egg production

- Their live weight at hatch is about 6-8 g
- Egg mass output as per the body weight is more than of chicken, thus, the requirements of energy, protein and amino acids in layer/breeder ration are higher.
- Egg weight of egg line quails is about 10 g.
- The 10 g egg contains 7.46 g water, 1.31 g protein, 1.12 g fat and 0.11 g of total ash.
- The average daily feed intake is about 25 g.
- The minimum daily protein requirement is less than 4.7 g and energy is 60 kcal ME per layer.

ICAR 2013

Table 11. Nutrient requirements (as fed basis) of Japanese quails

	Growing		Breeder/layer (5-30wk)	
	0-3 wk	3-5wk	Meat line	Egg line
ME (kcal/kg)	2,900	2,950	2,950	2,850
Protein (%)	25.0	21.5	20.0	18.6
Lysine (%)	1.45	1.20	1.10	1.00
Methionine (%)	0.55	0.50	0.45	0.40
Methionine +Cysteine (%)	0.90	0.80	0.80	0.70
Arginine (%)	1.80	1.50	1.25	1.15
Threonine (%)	1.12	0.92	0.80	0.70
Linoleic acid (%)	1.00	1.00	1.00	0.90
Calcium (%)	0.85	0.85	3.00	3.00
Non phytate P (%)	0.45	0.35	0.35	0.32
Sodium (%)	0.15	0.15	0.15	0.14
Copper (mg)	5.0	5.0	5.0	4.5
Iron (mg)	80	60	60	55
Manganese (mg)	50	60	60	54
Zinc (mg)	60	50	50	45
Vitamin A (IU)	2500	2500	3300	2970
D_3 (ICU)	400	400	900	810

DUCKS

They are raised for both meat and eggs.

Duck rearing is more common in entire coastal belt in India.

White Pekin is the most preferred meat type duck breed.

Among egg-laying breeds, Khaki Campbell is the best: 300 eggs per year and egg weight 65 to 75 g.

They thrive well in scavenging conditions.

Ducks supplement their feed intake by foraging.

They eat fallen grains in paddy fields, insects, snails, earthworms, small fishes and other aquatic materials.

They do not require any elaborate houses like chicken.

Ducks are quite hardy, more easily brooded and more resistant to common avian diseases.

Marshy river side, wet land and barren moors are excellent quarters for duck farming.

	Poultry	Duck
Egg Production	60-80 eggs Year/B Back yard	130-140/D/Year So 40-50 eggs more
Duration of egg production	1 year Commercially viable	2-3 years Commercially viable
Egg wt.	50-60 g	65-70 g Protein content more
Egg shell	Thin	Thick Less transportation loss
Management	More	Less
	Immunity poor	Immunity higher
	Mortality high	Less mortality

Eggs	Poultry	Duck
Av. wt	52.0 g	67.0 g
Albumin %	55.8 g	52.6 g
York %	31.9	35.4
Shell thickness	0.31 mm	0.33 mm
CP %	12.9 %	13. 5%
Energy kcal /100g	148	150
Colesterol mg/g	12.0	6.50
Ca mg/g	0.60	0.70
P mg/g	2.0	2.60

Ducks are suitable for integrated farming systems such as duck-cum-fish farming and duck farming with rice cultivation.

In duck-cum-fish farming droppings of ducks serve as feed for fishes and no other feed or manuring of the pond is necessary for fishes (200-300 ducks per hectare of waste area).

Under integrated duck farming with rice cultivation, ducks perform four essential functions viz. inter tillage as they search for food, their bills loosen up the soil around the rice plants, weeding, insect control and manuring.

Ducks also reduce the incidences of schistosomiasis, amphistomiasis and fascioliasis.

Though duck is a water fowl and very fond of water, water for swimming is not essential at any stage of duck rearing.

Nutrient requirements of Broiler Duck (NRC, 1994)

Nutrients	Starter	Grower
	0-2 weeks	3-7weeks
ME(Kcal/kg)	2900	2900
CP%	22	16
Ly%	1.1	0.9
Meth.%	0.4	0.3
Ca%	0.65	0.60
P%	0.40	0.35

Production performance of White pecking duck (Straight run)

Age	B.wt kg	Feed Consumption kg	FCR
1wk	0.19	0.21	1.14
2wk	0.60	0.97	1.61
3wk	1.11	2.25	2.02
4wk	1.68	3.79	2.26
5wk	2.18	5.42	2.48
6wk	2.58	7.17	2.78
7wk	2.95	9.09	3.08
8wk	3.29	11.11	3.38

Nutrient Requirement of Layer duck (ICAR 2013)

Table 13. Nutrient requirements (as fed basis) of Ducks

Nutrients	Starter	Grower	Rearer	Layer
Age, weeks	**0-8**	**8-16**	**16-20**	**>20**
Protein (%)	20.5	16.5	15	16.5
ME (kcal/kg)	2,800	2,650	2,500	2,650
Linoleic acid (%)	1.0	1.0	0.8	1.0
Lysine (%)	1.0	0.75	0. 60	0.75
Methionine (%)	0.45	0.35	0.30	0.3
Methionine + Cysteine (%)	0.85	0.65	0.60	0.75
Calcium (%)	1	1		3
Available Phosphorus (%)	0.42	0.35	0.35	0.35
Manganese (mg/kg)	60.	50	40	50
Sodium (%)	0.17	0.15	0.15	0.17
Chlorine (%)	0.12	0.12	0.12	0.12
Vitamin A (IU/kg)	3,200	2,250	2,250	4,000
Vitamin D3 (IU/kg)	400	350	350	650

GUINEA FOWL

- It is superior as free range bird.
- Three major varieties of guinea fowl: Pearl, Lavender and White.
- Guinea fowls are reared primarily for meat purpose.
- The CARI has developed improved guinea fowl: Kadambari, Chitambari and Swetambari.
- They are resistant to many common diseases of chicken, do not need elaborate and expensive housing, have excellent foraging capabilities, are more tolerant to mycotoxins and have meat low in cholesterol.
- They weigh 500-550 g at 8 weeks and 900-1000 g at 12 weeks of age
- They start laying when 230-250 days of age.
- Average egg weight ranges from 38 to 40 g.

.

ICAR-2013

Table 14. Recommended dietary density of nutrients in the diets of guinea keets for hot seasons in tropics.

Nutrients	Starter (0-4 wk)	Grower (5-8 wk)	Finisher (9-12 wk)
Crude protein (%)	22	20	18
ME (kcal/kg)	2,700	2,900	2,900
ME (kcal)/g CP	123	145	161
Lysine (%)	1.11	0.80	0.80
Methionine (%)	0.43	0.40	0.35
Cysteine (%)	0.28	0.25	0.22
Calcium (%)	1.00	0.90	0.80
Phosphorus (%)	0.65	0.60	0.55

TURKEY

- Turkeys are native of the North America.
- They were first domesticated in Europe.
- They are now important source of meat in many parts of the world.
- The bird is suitable for free range, semi-intensive and intensive systems of rearing.
- Turkey birds are less sensitive to dietary energy level but they require more protein (28% CP) and amino acids during earlier part of life (NRC, 1994).
- They have special requirements for lysine and methionine.
- Lysine has special role in feathering, as lysine-deficient Bronze poults show a characteristic white barring of the primary and secondary feathers of the wings.

Nutritional Requirements of turkey:

Items	Male	0-4	4-8	8-12	12-16	16-20	20-24	Adult/ Breeder
	Female	0-4	4-8	8-11	11-14	14-17	17-20	17-20
ME/kg diet		2800	2900	3000	3100	3200	3300	2900
Protein (%)		28	26	22	19	16	14	14
Lysine (%)		1.6	1.5	1.3	1.0	0.8	0.65	0.6
Methinine(%)		0.5	0.45	0.38	0.33	0.28	0.23	0.2
Calcium (%)		1.2	1.0	0.85	0.75	0.65	0.5	2.25
Phosphorous(%)		0.7	0.6	0.5	0.5	0.4	0.4	0.6
Vitamin A(IU)		4000	4000	4000	4000	4000	4000	4000
Vitamin D3(IU)		900	900	900	900	900	900	900
Choline (mg)		1900	1800	1300	1100	950	800	1800
Niacin (mg)		70	70	50	50	40	40	30

Green feeding:

In intensive system, greens can be fed upto 50% of the total diet on dry mash basis. Fresh Lucerne is first class green feed for turkeys of all ages. Apart from the Desmanthus and Stylo can be chopped and fed turkeys to reduce the feed cost.

Body weight and feed consumption:

Age in weeks	Average Body Weight (Kg)		Total feed consumption (Kg)		Cumulative feed efficiency	
	Male	Female	Male	Female	Male	Female
Upto 4th week	0.72	0.63	0.95	0.81	1.3	1.3
Upto 8th week	2.36	1.90	3.99	3.49	1.8	1.7
Upto 12th week	4.72	3.85	11.34	9.25	2.4	2.4
Upto 16th week	7.26	5.53	19.86	15.69	2.8	2.7
Upto 20th week	9.62	6.75	28.26	23.13	3.4	2.9

Note: FCR of 2.13 with feed consumption of 140gm/day on feed with 4,400 k.cal/kg. ME (Thayee et.al, 1985)

Turkey meat and egg

Turkey egg

- The turkey will start lay from the 30th week of age and its production period is 24 weeks from the point of lay.
- Under proper feeding and artificial lightening management turkey hens lay as much as 60-100 eggs annually.
- Nearly 70 percent of the eggs will be laid in the afternoon.
- The turkey eggs are tinted and weigh about 85 gms.
- Egg is noticeably pointed at one end with strong shell.
- The protein, lipid carbohydrate and mineral content of turkey egg are 13.1%, 11.8%, 1.7% and 0.8% respectively. The cholesterol is 15.67-23.97 mg/gm of yolk.

Turkey meat

People prefer turkey meat because of its leanest nature. The protein, fat, energy value of turkey meat are 24%,6.6%, 162 Calories per 100 gm of meat. Mineral like potassium, calcium, magnesium, iron, selenium, zinc and sodium are present. It is also rich in essential amino acids and vitamins like niacin, vitamin B6 and B12. It is rich in unsaturated fatty acids and essential fatty acids and low in cholesterol.

A market study shows that a male turkey sold at 24 weeks of age weighing 10 to 20 kg with expenditure of Rs.300 to 450 will give a profit of Rs. 500 to 600. Likewise a female will give a profit of Rs.300 to 400 in a span of 24 weeks of time. Besides, the turkey can be reared in scavenging and semi-scavenging conditions also.

Economic Parameters in Turkey Farming

Male – Female ratio	1:5
Average egg weight	65gms
Average day old poult weight	50gms
Age at sexual maturity	30weeks
Average egg number	80 -100
Incubation Period	28 days
Average body weight at 20 weeks	4.5 – 5 (f) 7-8(m)
Egg production period	24 weeks
Marketable age Male Female	 14 -15 weeks 17 – 18 weeks
Marketable weight Male Female	 7.5 kg 5.5 kg
Food efficiency	2.7 -2.8
Average feed consumption upto marketable age Male Female	 24 -26 kg 17 – 19 kg
Mortality during brooding period	3-4%