

**PRACTICAL MANUAL
FOR
ANIMAL NUTRITION
PAPER II
(UNIT- III & IV)**



Complied by-

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FOREWORD

I am glad to see the Laboratory Manual PRINCIPLES OF ANIMAL NUTRITION & FEED TECHNOLOGY, APPLIED RUMINANT NUTRITION-is prepared by Dr.M.A. Akbar Prof. & Head, Dr. A.R.Nazki Associate Professor, and Dr. Alok Ranjan Assistant Professor, Dept. of Animal Nutrition. It is appreciable to note that the manual covers the practical syllabus (MSVE-2016) of B.V.Sc.&A.H. course as per the standards laid down by Veterinary Council of India.

Dr.M.A. Akbar, Dr. A.R. Nazki and Dr. Alok Ranjan have devoted keenly to prepare this manual with their excellent knowledge and expertise in the field of Animal Nutrition. They have covered all the aspects like objectives, outline and description, material and methods and observation to be taken care off.

Definitely this manual will be helpful for smooth and effective conduction of practicals and ensure a handbook for students for entire life in the profession.

I congratulate Dr.M.A. Akbar, Dr. A.R. Nazki and Dr. Alok Ranjan for their strenuous efforts and excellent presentation of this manual.

**Dean
Mahatma Jyotiba Fule College of
Veterinary & Animal Science, Chomu, Jaipur**

PREFACE

This Manual has been prepared for the undergraduate students of B.V.Sc. & A.H. in accordance with the syllabus (MSVE-2016) designed by the Veterinary Council of India. The efforts have been made to make the manuscript worthy, realistic and easily understandable for the students, teachers and personnel of feed industry, Extension workers of department of Animal Nutrition for applied use at field condition. We hope this manual will serve very useful tool to the undergraduate and graduate students of Veterinary Science who are undergoing courses in Animal Nutrition.

It's our pleasure to thank Dean Sir, M.J.F College of veterinary and Animal Sciences, Chomu, Jaipur for providing necessary facilities, cheerful environment and rendering all helps in preparing this course manual.

Computer operator and typist Mr. Mukesh Kumar Saini and Mr. Ashutosh Sharma worked hard for very existence of this manual so I acknowledge his efforts.

Course Incharge

Dept. of Animal Nutrition

PRACTICAL MANUAL
ANIMAL NUTRITION

CERTIFICATE

This is to certify that this manual contains bonafide practical work of
Mr./Ms. bearing Roll No.
..... Student of the Mahatma JyotibaFule College of Veterinary &
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Signature of course teacher
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Exercise-1

Calculation of nutrient requirements in terms of DCP, TDN and ME for maintenance, growth and production

The term requirement is defined as the amount of the nutrient that must be supplied in the ration to meet the needs of normal healthy animal. The nutrient requirement vary with the size of animal and to the level of production.

Nutrient requirements for maintenance:

Nutrient requirement for maintenance in non-producing animals is defined as the amount of nutrient sufficient to maintain the body weight besides maintaining normal physiological function under resting condition.

Nutrient requirements for milk production:

In case of lactating animal requirements are indicated separately for body maintenance based on body weight and milk production based on daily milk yield and content of butter fat in milk. Composition of milk depends upon the breed, age and stage of lactation. Milk yield of cow increases from parturition to the end of 3rd month and then falls gradually up to the end of lactation. Total requirement of animals in such case is determined after adding the two kinds of requirements. Requirements for milk production are calculated by factorial method and different feeding trials. Generally the energy requirements increase with fat content of milk.

Nutrient requirements for wool production:

There are no separate standards for wool growth but maintenance requirements are higher enough to take care of wool production in sheep.

Nutrient requirements for growth:

In feeding standards for growing animals, requirements of both protein and energy for maintenance are combined and presented alone against body weight. Requirement for growth varies due to different breed and different rates of growth. Calculations of requirements are based on N- balance studies, factorial methods and feeding trials.

Nutrient requirements for reproduction:

Requirements for reproduction are divided into 2 phases (i) requirement of female animal bringing them up to conception (ii) requirement for gestation for pregnant animals. During last trimester of pregnancy extra requirement in terms of energy and protein are given for foetal growth over maintenance. Higher plane of nutrition brings early puberty in animals.

Digestible energy and Metabolisable energy:

The values of TDN can be converted to digestible energy (DE) and Metabolisable energy (ME) by following formulas.

$$1 \text{ kg TDN} = 4.4 \text{ Mcal DE}$$

$$\text{kg TDN} = 3.6 \text{ Mcal ME}$$

Calculation of nutrient requirement based on metabolic body weight: $\text{DCP} = 2.84 \text{ g/}$

$$w^{0.75} \text{ kg b. wt.}$$

$$\text{TDN} = 33.74 \text{ g/ } w^{0.75} \text{ kg b. wt.}$$

Q. Calculate the DCP and TDN requirement for maintenance of a cow weighing 625 kg.

Exercise- 2

Formulation of ration for different categories of livestock under Different conditions

Principle: Computation of ration includes translating the recommendation contained in feeding standards into actual formulation of feed mixture and feeding practices.

Objective:

1. To provide balance ration to farm animals in view of production.
2. Scientific approach for feeding of farm animals.
3. To make economically use of locally available feed.

Computation of Ration for cattle and Buffalo:

The ration of animal may be divided into two parts, one for maintenance and other for production. The maintenance ration is that portion of the diet which just enables the animals at rest to carry on essential process of life or physiological function of the body without gain or loss in body weight. Whereas the production ration is the quantity of ration supplied in addition to maintenance for production e.g. growth, milk, pregnancy, wool and work in case of draft animals. For the formulation of balanced ration for dairy cattle and buffalo following steps are to be followed.

Steps for ration formulation:

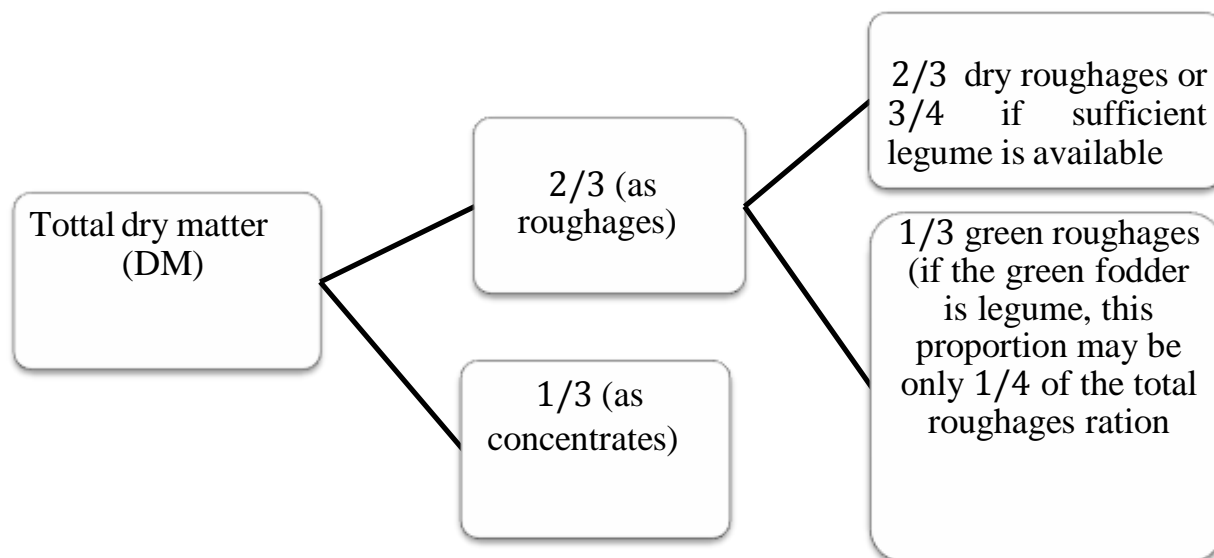
Step 1: To determine the total dry matter requirement-

The DM requirement of an animal depends on its body weight and its status of productivity.

For Indian cattle total DM requirement = 2-2.5 kg DM/100 kg b. wt.

For Buffalo and crossbreds DM requirement = 2.5-3 kg DM/100 kg b. wt.

Step 2: To determine the roughage: concentrate ratio-



Step 3: To determine the nutrient requirement of animals-

For the nutrient requirement the standard prescribed by Sen and Rey (1964) should be followed. For the purpose of calculation of nutrient requirement the most convenient system is DCP and TDN system.

Maintenance requirement:

Body weight (kg)	DCP (kg)	TDN (kg)	ME (Mcal)
200	0.15	1.66	6.0
300	0.20	2.36	8.4
400	0.25	3.00	10.8
450	0.28	3.40	12.4
500	0.30	3.69	13.2
550	0.33	4.00	14.4

Production requirement: The requirement for milk production to be added per litre of milk production according to fat% in milk.

% Butter fat	DCP (kg)	TDN (kg)	ME (Mcal)
3	0.040	0.27	0.97
4	0.045	0.32	1.13
5	0.051	0.37	1.28
6	0.057	0.41	1.36
7	0.063	0.46	1.54
8	0.069	0.51	1.80
9	0.075	0.55	2.06
10	0.081	0.60	2.16
11	0.850	0.65	2.34

Gestation requirement: If the animal is in condition of advanced pregnancy it should be given 0.14 kg DCP and 0.70 kg TDN in addition to maintenance requirement.

Requirement for breeding bull (Maintenance and production):

Body weight (kg)	DCP (kg)	TDN (kg)	ME (Mcal)
400	0.38	3.6	13.0
500	0.45	4.5	16.2
600	0.53	5.4	19.4

Requirement for growing cattle (Maintenance and production):

Body weight (kg)	DCP (kg)	TDN (kg)	ME (Mcal)
45	0.17	0.9	3.29
70	0.22	1.3	4.68
100	0.28	1.9	6.90
150	0.35	2.6	9.36
200	0.40	3.2	11.50
300	0.47	4.1	14.80

Requirement for working bullock (Maintenance and production): The nutrient requirements of the working animal depends upon the labour performed. Work can be divided into two types one is normal work and another is heavy work. Normal work includes 6 hours of carting or 4 hours of ploughing while heavy work includes 8 hours of carting or 6 hours of ploughing.

1. For normal work:

Body weight (kg)	DCP (kg)	TDN (kg)	ME (Mcal)
200	0.24	2.0	7.2
300	0.33	3.1	11.4
400	0.45	4.0	14.4
500	0.56	4.9	18.0
600	0.66	5.8	20.8

2. For heavy work:

Body weight (kg)	DCP (kg)	TDN (kg)	ME (Mcal)
200	0.25	2.7	9.5
300	0.42	4.0	14.4
400	0.57	4.8	17.3
500	0.71	6.4	23.0
600	0.82	8.0	28.8

Step 4: To determine the nutritive value of available feed ingredients-

There are two types of animal feeds roughage and concentrate. Roughage feed ingredients contains high level of crude fiber (more than 18%) and concentrate feeds have low levels of crude fiber (less than 18%) Roughage can be further classified as dry roughage and green roughage on the basis of moisture content. The nutritive value of some important animal feed ingredients available in Rajasthan are as follows.

(a) Dry roughages

Feed	DM (%)	DCP (%)	TDN (%)
Rice straw	90	0.0	35
Wheat straw	90	0.0	42
Bajra straw	90	0.8	48
Jowar straw	90	1.0	50
Sewan hay	90	2.5	55
Lucerne hay	90	9.0	60
Berseem hay	90	14.0	50
Beri leaves	90	5.7	49
Khejri leaves	90	8.9	49

(b) Green succulent roughage

Feed	DM (%)	DCP (%)	TDN (%)
Green bajra	30	1.0	15
Green jowar	30	0.8	16
Green maize	30	1.2	17
Green berseem	30	2.8	13
Green lucerne	30	3.0	12

(c) Concentrate

Feed	DM (%)	DCP (%)	TDN (%)
Barley	90	8	78
Maize	90	7	87
Guar	90	29	71
Wheat bran	90	10	62
Guar churi	90	38	74
Gram churi	90	14	87
Cotton seed cake	90	17	72
Ground nut cake	90	42	72

Step 5: Preparation of balanced concentrate mixture-

Balanced concentrate mixture should contain 12-15% DCP and 70-75% TDN from available feeds.

Example 1:

Ingredients	Quantity	DM (%)	DCP (%)	TDN (%)
Wheat bran	100	90	10	62
Barley	100	90	8	78
Guar churi	50	45	19	37
Cotton seed cake	100	90	17	42
Total	350	315	54	249
%	100	90	15.00	71.00

Example 2:

Ingredients	Quantity	DM (%)	DCP (%)	TDN (%)
Barley	50	45	4.0	39.00
Wheat bran	30	27	3.0	18.60
Ground nut cake	20	18	8.4	14.40
Total	100	90	15.4	72.00

Step 6: Balancing of nutrients-

In this step the ration is computed from available roughage and concentrate on keeping view of quantity of total dry matter requirement and balancing of nutrients is done according to total requirement.

Exercise-3

Formulation of ration for cattle and buffalo

Q. Compute a balance ration for a cow weighing 450 kg b. wt. producing 5 litres milk per day of 5% butter fat content. The available feed stuffs are sewan hay, wheat straw, cotton seed cake, wheat bran, barley and guar churi.

Exercise-4

Formulation of ration for sheep and goat under different conditions

Sheep:

Pastures and ranges are natural habitat of sheep they thrive on them under and extremely wide variety of climate conditions and utilize most adverse types of vegetation. Sheep can utilize grasses, legumes, weeds herbs and shrubs that grow on cultivated and uncultivated land in India or other countries. When fed in the stall, they can easily consume 2.5 to 3.0kg dry matter per head per day from good quality roughages.

Nutrient requirements for maintenance of adult sheep:

Live weight (kg)	DM (g)	DCP (g)	TDN (g)
20	575	28	258
25	678	33	305
30	775	38	350
35	873	43	393
40	964	48	434
45	1055	53	475
50	1140	56	513
55	1225	60	551
60	1310	65	588

Nutrient requirements of growing lambs:

A pre-ruminant lamb is to be fed creep feed of high quality according to appetite from its age of 2 week to 13 weeks to promote growth during early age through optimum rumen development. Creep feeding is the practice of providing supplemental feed to nursing lambs.

Live weight (kg)	Rate of gain (g/d)	DM (g)	DCP (g)	TDN (g)
10	50	300	32	195
	100	340	37	220
	150	385	42	250
15	50	450	48	290
	100	510	55	330
	150	580	60	375
	200	690	75	450
20	50	600	55	360
	100	680	63	410
	150	830	77	500
	200	1000	92	600
25	50	750	65	450
	100	850	73	510
	150	1040	89	625
	200	1250	107	750
30	50	900	74	520
	100	1035	86	600
	150	1290	107	750
	200	1550	128	900

Examples of creep mixtures for young lamb:

Ingredients	%
Maize/barley	50
Ground nut cake/linseed cake	20
Wheat bran/rice bran	22
Fish meal	5
Mineral mixture	2.5
Common salt	0.5

Ingredients	%
Maize	30
Bajra	10
Ground nut cake	22
Ground Lucerne/berseem	10
Wheat bran/rice bran	20
Fish meal	5
Mineral mixture	2.5
Common salt	0.5

Nutrient requirements of pregnant ewes:

Body weight (kg)	DM (g)	DCP (g)	TDN (g)
25	1120	80	580
30	1280	90	665
35	1440	105	750
40	1590	115	827
45	1740	135	903
50	1880	135	978
55	2020	145	1050
60	2160	155	1121

Nutrient requirements of lactating ewes:

Body weight (kg)	DM (g)	DCP (g)	TDN (g)
25	1230	95	665
30	1410	108	760
35	1580	120	855
40	1750	135	945
45	1910	150	1030
50	2070	160	1120
55	2220	170	1200
60	2372	185	1280

Nutrient requirements for reproduction:

Breeding rams should be provided 50% more nutrients than what is recommended for maintenance. Similarly, pregnant ewes during last 6 weeks of gestation should be provided with 50% more nutrients than the maintenance needs. The practice of increasing the nutrient intake of ewes and condition prior to and during breeding is called flushing. It's purpose is to increase the ovulation rate and consequently the lambing rate. This special feeding of providing 25% more nutrients above the maintenance needs has to be given 2-3 weeks prior to breeding and continues into the breeding season.

Nutrient requirements for wool production:

No specific recommendations are given for wool production as it has been observed that if sheep are provided all the essential nutrients required for maintenance, growth and production, they should also meet the requirements for wool production.

Feeding schedule:

Body weight (kg)	Concentrate (g/d)	Roughage (g/d)
12-15	200	400
16-25	250	600
26-35	300	700

** 8 hours grazing can be substituted in place of roughage.

Goat:

Goats prefer browsing rather than grazing or nibbling as far as feeding habit is concerned. They always like to pluck the tender leafy twigs of herbs, shrubs and small trees. Stall feeding is practiced in urban areas. They are considered to be better converter of fibrous feeds into food like chevon and milk of high biological value. The DM intake of goats is higher in comparison to large farm animals.

Meat goats have a DM intake of 3% of their body weight whereas dairy goats have a higher DM intake (4-6% of body weight).

Nutrient requirements for maintenance of adult goats:

Live weight (kg)	DM (g)	DCP (g)	TDN (g)
15	500	23	240
20	615	29	295
25	730	34	350
30	830	39	400
35	940	44	450
40	1040	48	500
45	1125	53	540
50	1230	57	590
55	1315	62	630
60	1410	66	675

Nutrient requirements of growing kids:

The kids should be allowed to suck its dam for the first 3-4 days so that they can get good amount of colostrum. The kids start nibbling the grasses from 15 days of age. Creep feed is also introduced at the same time. These help rapid growth of the kids and hasten the development of the rumen. Two types of creep mixtures can be offered depending on the type of the roughage available. If grasses and cereal fodders are available, a creep feed with 18% DCP and 75% TDN has to be offered. If leguminous fodders are available, a creep feed with 12% DCP and 70% TDN has to be offered.

Live weight (kg)	Rate of gain (g/d)	DM (g)	DCP (g)	TDN (g)
10	50	380	27	265
	100	510	37	355
	150	635	47	445
15	50	510	33	330
	100	645	43	420
	150	785	53	510
20	50	640	39	385
	100	790	49	475
	150	985	59	590
25	50	760	44	440
	100	915	54	530
	150	1070	64	620

Nutrient requirements of pregnant does:

Body weight (kg)	DM (g)	DCP (g)	TDN (g)
15	700	42	385
20	865	52	475
25	1025	62	564
30	1170	71	645
35	1320	80	725
40	1460	88	802
45	1590	96	875
50	1725	104	984
55	1850	112	1018
60	1975	120	1086

Nutrient requirements for reproduction:

For meeting the demands of the growing foetus in advanced pregnancy and spermatogenesis in males during breeding season an extra allowance of 55g DCP, 400g TDN, 2g calcium and 1.4g phosphorus should be provided over and above maintenance requirement.

Nutrient requirements of lactating does:

For each litre of milk produced the dairy goats should be provided with 70g DCP, 350g TDN, 3.0g calcium and 2.1g phosphorus. The recommended requirements have been given as follows.

Body weight (kg)	Milk yield (kg)	DM (g)	DCP (g)	TDN (g)
20	0.5	865	51	468
	1.0	1185	74	640
25	0.5	968	56	523
	1.0	1290	79	695
30	0.5	1060	61	573
	1.0	1380	84	745
35	0.5	1155	66	623
	1.0	1470	89	795
40	0.5	1245	70	673
	1.0	1565	93	845
45	0.5	1320	75	713
	1.0	1640	98	885
50	0.5	1410	79	763
	1.0	1730	102	935
55	0.5	1490	84	803
	1.0	1805	107	975
60	0.5	1570	88	848
	1.0	1890	111	1020

Exercise-5

Formulation of rations for feeding of livestock during scarcity

The states of M. P., Rajasthan, Gujarat and Maharashtra are fully dependent upon rains for cultivation of crops. If monsoon fails, the watershortage results in scarcity of feeds and fodders. The scarcity of animal feed caused by floods is of temporary nature. During the draught, however, severe shortage of animal feed especially roughage is encountered. During such natural calamities animals are sometimes collected and fed in common places in groups.

The use of non conventional feed resources and agro industrial by products as well as draught resistant vegetation in combination with urea and molasses can be used for meeting the immediate nutritional requirement under condition of scarcity. Crop residues, dry grasses from forests, fallen tree leaves are to be collected from the place of their availability and transported to the place of scarcity. Large scale feeding off bagasses, molasses in combination with urea and mineral supplements can be adopted.

Cost of harvesting and collection in case of forest grasses and tree leaves is also considerable in addition to transportation cost. Hence it is suggested that the crop residue, grasses and tree leaves are chaffed, densified with the addition of brans, molasses, minerals and compressed by machine at the place of their availability. Such compressed feedblocks are to be transported to needy place to tide over the feed scarcity. These complete feed blocks meet the nutrient requirement for moderate growth and milk production.

In case of drought or during floods, straw, kadbi, can be utilized for feeding animals fortified with concentrate mixture and urea.

Concentrate mixture could be formulated using locally available feed ingredients and should contain 12-15% DCP and 70-75% TDN.

Ration for feeding during scarcity:

Ration for adult non producing cattle (150-300 kg body weight)

Bagasse	2.0 kg
Molasses	0.4 kg
Sugarcane tops	8.0 kg
Urea	22 gm
Common salt	30 gm
Sterilized bone meal	20 gm
Trace element mixture	0.5gm/ animal twice a week

Ration of growing animals (50-150 kg body weight)

Bagasse	2 kg
Molasses	0.8 kg
Sugarcane tops chopped	3.0 kg
Urea	40 gm
Common salt	20 gm
Sterilized bone meal	20 gm
Trace element mixture	0.5gm/ animal twice a week

Some ration scale for draught or flood affected regions:

Ingredients	Quantity		
	Milch animals	Bullocks	Calves
Straw (kg)	Up to 10	9	2-8
Local tree/green leaves (kg)	1.5	1.5	1.0
Concentrate mixture (kg)	1.5	1.0	0.75
Mineral mixture (gm)	40	40	30
Urea (gm)	25	20	5

Urea molasses liquid feed:

Liquid molasses containing 2-3% uniformly mixed urea, fortified with minerals and vitamins has been named as liquid feed and is fed to the animal along with roughage.

Composition:

Urea	2.5%
Water	2.5%
Mineral mixture	2%
Common salt	1%
Molasses	92%
Vitablend AD3	25gm/100 kg of liquid feed

Urea molasses mineral block (UMMB):

NDDDB has developed a feed supplement UMMB which is kept before the animal for licking as it provides a continuous intake of nitrogen. This increases the feed intake of the straws and improves the digestibility of DM. Therefore it has become a regular supplement not only during scarcity period but also during normal feeding practices. One block may last 7-10 days for one animal.

Composition:

Molasses	40-45%
Urea	15%
Mineral mixture	15%
Common salt	8%
Cotton seed cake	10%
Calcite powder	4%
Bentonite	3%

Exercise-6

Visit to Animal farm and Feed Mill

Exercise- 7

CALCULATION OF REQUIREMENT OF NUTRIENT FOR GROWTH, REPRODUCTION, EGG AND MEAT PRODUCTION

Composition of various feedstuffs commonly used in poultry feed:

Sr. No.	Ingredient	ME Kcal/kg	CP (%)	Ca (g%)	P (g%.)	Lysine (%)	Meth. (%)	EE (%)	CF (%)
1	Maize	3340	9	0.02	0.28	0.22	0.18	3.8	2.2
2	Rice Polish	3300	12	0.08	1.3	0.5	0.22	15.1	8
3	Jowar	3000	9.5	0.04	0.09	0.3	0.15	2.5	2
4	DORB	880	14	0.08	0.2	0.34	0.24	1	12
5	Oil	8800	0	0	0	0	0	99	0
6	Molasses	1962	2.5	0.5	0.03	0	0	0	0
7	Maize Gluten	3100	35	0.22	0.13	0.8	1	2.01	5
8	Soybean DOC	2486	45	0.25	0.26	2.8	0.62	0.5	7
9	Full fat soya	2800	44	0.25	0.57 (Total)	2.5	0.55	20	5.5
10	Groundnut Doc	2300	40	0.22	0.2	1.55	0.4	1	10
11	SFE	2000	29	0.37	0.22	1.5	0.8	1.5	22
12	Meat meal	3800	54	2.64	1.19	2.54	0.92	23	2.45
13	Fish whole	2000	47	6.2	3.5	3.4	0.68	2	1
14	Fish Jawala	2200	50	5	4.2	3.5	.75	0	0
15	Fish meal	1935	42	7	3.1	1.65	0.5	0	0
16	Tallow	8800	0	0	0	0	0	100	0

Calculation of Requirement of ME for Maintenance, Growth and Production for Poultry

Energy requirement of chicken

Experimental studies have shown that the ME requirements are approximately 18% higher than the NE requirements. This is due to the specific dynamic action of the nutrients; consumption of protein causes about 30% increase in heat production while consumption of carbohydrates and fat yield 15 and 10% heat increment, respectively. In a well balanced diet containing 20% protein, 5% fat and 65% carbohydrate, the average heat increment is 18%. Thus the NEm requirements are approximately 82% of the MEm requirements. Since the chicken has a higher body temperature than mammals, its energy expenditure for maintenance is greater.

1. Energy requirement for maintenance of layers

The basal metabolism studies indicate that the

$$\text{NEm requirement of adult hen} = 83 \times \text{BW kg}^{0.75} \text{ kcal/day}$$

$$\text{NEm requirement of 1.75 kg adult hen} = 83 \times 1.75 \text{ kg}^{0.75} \text{ kcal/day}$$

$$= 83 \times 1.56 = 126 \text{ kcal/day}$$

$$\text{MEm requirement} = 126 \times 82\% = \frac{126}{0.82} = 154 \text{ kcal/ day}$$

Activity allowance is 50% of the energy needed for basal metabolism and 37% for caged hens.

Therefore, total ME requirements for non-laying hens (kept in cages)

$$= 154 + 57 = 211 \text{ Kcal/ day}$$

The energy content of a large egg = 86 Kcal

Then the total ME requirement of laying hen (W Leghorn) (in 100% egg production at 21 °C) = 297 Kcal/day

2. Energy for growth:

The energy for growth ranges from approximately 1.5 to 3.0 Kcal per gram of body gain. This depends upon the amount of fat in relation to protein in the body gains. The requirements of growing cockerels are higher than that of pullets.

Calculate ME requirement of cockerels weighing 1 kg and growing at the rate of 100 g per day.

The basal metabolism studies indicate that the

$$\text{NEm requirement of adult hen} = 83 \times \text{BW kg}^{0.75} \text{ kcal/day}$$

$$\begin{aligned} \text{NEm requirement of 1.75 kg adult hen} &= 83 \times 1 \text{ kg}^{0.75} \text{ kcal/day} \\ &= 83 \times 1 = 83 \text{ kcal/day} \end{aligned}$$

$$\text{MEm requirement} = 83 \times 82\% = \frac{83}{0.82} = 101.22 \text{ Kcal/ day}$$

Activity allowance is 50% of the energy needed for basal metabolism and 37% for caged hens.

Therefore, total ME requirements for Cockerel (kept in cages)

$$= 101.22 + 37.45 = 138.67 \text{ Kcal/ day}$$

3. Calculation of energy requirement of broilers:

The energy requirement for growth ranges from approximately 1.5 to 3.0 Kcal per gram of body weight gain. This depends upon the amount of fat in relation to protein in the body gains. The requirements of growing cockerels are higher than that of pullets.

Growth rates, basal metabolism, type of tissue deposited, and efficiency of feed utilization all to some extent are determined by the levels of various hormones secretions, particularly growth hormones.

Calculation of energy requirements of broilers:

Weight of broiler breeder : 2.5 kg
Age : 25 weeks

$$\text{NEm} : 83 \times 2.5^{0.75} = 83 \times 1.99 = 165 \text{ Kcal/day}$$

$$\text{MEm} : 165/0.82 = 201 \text{ Kcal/day}$$

$$\text{Activity} : 50\% \text{ of MEm} = 101 \text{ Kcal/day}$$

$$\text{MEm} + \text{Activity} : 302 \text{ Kcal/day}$$

Egg production is 85%

MEm egg= 86 Kcal X 0.85 = 73 Kcal/day. (The energy content of a large egg = 86 Kcal)

These pullets are still growing and body gain approximately 500 g over 10 week period.
i.e. = 7.14 g gain/day.

Energy requirement for gain: 18% protein and 15% fat are present.

1.285 g Protein X 4.0 Kcal = 5.14

1.05 g X 9.0 Kcal = 9.45

14.60 say 15 Kcal.

Total ME required = MEm + ME activity + ME egg + ME gain
(for the period 25-30 weeks of age)

= 201 + 101 + 73 + 15

= 390 Kcal/hen /day.

Problems

1. Calculation of ME requirement of layer weighing 2 kg with 80% egg production.
2. Calculate ME requirements of cockerel weighing 1.2 kg and growing at the rate of 80 g per day.
3. Calculate ME requirements of 27 weeks old broiler breeder weighing 2.6 kg having 80% egg production.

Calculation of Requirement of Crude Protein For Maintenance, Growth and Production for Poultry

Protein requirement of Chicken

1. The protein requirements of growing chicken may be calculated as follows:

Growth : White Leghorn chicken has 61% of efficiency in utilization of protein. That is of the daily protein consumed about 61 % is only retained in the body.

- a. Maintenance requirement = 250 mg N/ kg BW/ day
= 16000 mg Protein/ kg BW/ day.(Since 250X 6.25)
- b. Tissue growth (Tissue contain 18% protein)
Daily gain in g X 0.18.
- c. Feather growth: Feathers contain 82% protein and feather comprises 7% body weight at 4 weeks of age.

Daily protein requirement for a growing chicken

$$= \frac{(\text{BW in g} \times 1.6/1000) + (\text{Daily gain in g} \times 0.18) + (\text{Daily gain in g} \times 0.07 \times 0.82)}{\% \text{ efficiency of protein utilization.}}$$

2. Calculation of protein requirement for egg production:
Maintenance requirement of White Leg Horn hen = 3 g/ day
Protein content in one egg = 6 g /day
Total requirement = 9 g /day.

Efficiency of protein utilization for maintenance and egg production = 55%

$$\text{Therefore, the protein requirement of the hen} = 9 \times \frac{100}{55} = 16.36 \text{ g/ day}$$

If hen eats 120 g diet per day, then the protein content of the diet should be 13.6%. If hens eat 100 g diet only, then the protein content of the diet should be 16.4%.

Problems:

1. Calculate crude protein requirement of broiler weighing 1.2 kg and growing at the rate of 50g per day.
2. Calculate crude protein requirement of layer weighing 2.5 kg having 90% egg production.

Exercise - 8

FORMULATION OF RATION FOR BROILER WITH CONVENTIONAL AND UNCONVENTIONAL FEED INGREDIENTS

Formulation of concentrate rations for poultry

Poultry is divided into three groups:

Broiler

- I. Broiler group is divided into 3 categories on the basis of the age.
 1. Pre-starter 0-7 days
 2. Starter 8-21 days
 3. Finisher 22-42 days

Principles of feeding poultry

1. As birds have no teeth, hence more concentrate ration should be supplied.
2. They have high basal metabolic rate and hence need high energy ration.
3. They must get all major and minor essential nutrients in balanced form.
4. As they have no sweat glands, they are sensitive to environmental factors.
5. Birds are fed better collectively rather than individually.
6. They cannot digest (being simple stomach) crude fibre more than 6-7 %.
7. Feed compounded must be palatable and free from any kind of fungal or microbial infestation.
8. Optimum protein and energy ratio must be maintained for the purpose, it is intended.

Modern feeding systems of poultry

Mash form feeding

Pellet form feeding

Crumble form feeding

Classification of poultry feed

1. Energy source

Cereals contribute as a major supply for energy. It includes maize, bajra, jowar, sorghum, rice polish, molasses, wheat bran, etc.

2. Fat source

Vegetable oil, soybean oil meal, sesame meal, etc.

3. Protein sources

Are of two types.

1. Vegetable origin
2. Animal origin

1. Vegetable origin

e.g. Soybean meal, GNC, cotton seed cake, sunflower cake, mustard cake, etc

2. Animal origin

e.g. Fish meal, meat meal, hatchery waste, etc.

3. Minerals

Supply of different kinds of minerals can be made through mineral mixtures.

3. Vitamins

Supply of different kinds of vitamins is made through the vitamin mixture.

4. Additives

It includes antibiotics coccidiostate, probiotics, hormones, enzymes, etc.

6. Unconventional feeds:

In pig and poultry, the conventional feed sources can be replaced by unconventional feeds and fodder.

Unconventional feeds are those which are not commonly used for the livestock feeding but are used during the scarcity. Following unconventional feeds are used in feeding of swine.

1. Salseed cake

It is rich in oil as well as energy and therefore it is used for pig and poultry very conveniently.

2. Tapioca

It has got highest energy content same as that of cereals.

3. Mango seed kernel cake/meal

Kernel is the outer covering of mango seed inside which the seed is present. This can be used as unconventional source of feeds and fodder.

4. Damaged wheat grains

These can be also a useful unconventional source to be included in the formation of diet of poultry and pig.

5. Silk worm pupae meal

This can be used in poultry feeds as animal protein source.

Important points to be considered in formulation of poultry feed.

1. Availability of feed ingredients
2. Adaptability
3. Cost of ingredients
4. Nutritive value of ingredients and effect of feed on growth, production and reproduction.

FEED FORMULATION

The following information is required for feed formulation:

1. Requirements of nutrients for poultry and composition of a formulae in terms of nutrients :

For poultry, the energy content of mashes and the body requirements of energy is considered in terms of metabolizable energy.

The total protein requirement of poultry can be met easily. However, it is difficult to meet the requirements of essential amino acid. The ones that are critical in diet are arginine, threonine, lysine, methionine + cystine and tryptophan. Arginine deficiency is usually not a problem in Indian diets because groundnut cake is a rich source of arginine amino acids. Therefore the amino acid requirement can be restricted in practical feed formulation to the requirement of lysine and methionine + cystine in chick and methionine + lysine in layer diet.

Minerals and vitamins contribute only to 10% of the total cost of the feed. Economization on these neglecting or reducing safety margins may restrict the performance of birds sometimes with heavy economic losses. The energy, protein, amino acid, mineral and vitamins requirements are given in Table 1.

2. Feed analytical values :

The most efficient way to provide nutrients for the birds is to analyze the feed ingredients for various nutrients and formulating the diets utilizing the analyzed values. The average nutrients content of the feed ingredient based on the analyses done is available in the form of published tables called feed composition tables.

3. Maximum level of inclusion of feed ingredients :

Each ingredient has its maximum level of inclusion in the diet. Inclusion of an ingredient beyond the maximum level may induce imbalance of nutrients, difficulty in feed formulation, and may reduce the performance of the bird due to the presence of anti-nutritional factors beyond level. Cost is alone one of the factors imposing an upper limit on the inclusion of feed ingredients. Following table indicates maximum inclusion of common feed ingredients in poultry diets.

Sr. No.		Ingredients	Level of inclusion (%)
I		Energy source	
	1	Maize	60
	2	Wheat	50
	3	Barley	20 - 40
	4	Oats	10 - 20
	5	Sorghum (<i>dark variety</i>)	10 - 20
	6	Sorghum (<i>white variety</i>)	25 - 40
	7	Pearl millet	50
	8	Rice	40
	9	Til cake	40
	10	Rice polish	25 - 40
	11	Rice polish (deoiled)	10 - 20
	12	Wheat bran	10 -15
	13	Maize bran	10
	14	Hominy feed	10
	15	Maize grit	10
	16	Salseed meal (deoiled)	3 - 5
	17	Molasses	5 -10
	18	Animal and vegetable fat	10
	19	Poultry manure meal	10
	20	Tapioca flour	10 - 20
	21	Gram chuni	10 - 15
II		Leaf meals	
	1	Alfalfa leaf meal	5
	2	Ground nut leaf meal	5
	3	Grass meal	5
III		Protein sources	
	1	Groundnut meal	40
	2	Groundnut meal (deoiled)	20
	3	Soybean meal	40
	4	Sesame meal	20
	5	Safflower meal	20
	6	Sunflower meal	20
	7	Linseed meal	4
	8	Linseed meal (water treated)	20

	9	Coconut meal	5
	10	Cotton seed meal (degossypolized)	5
	11	Mustard meal	10
	12	Maize gluten feed	15
	13	Maize gluten meal	15
	14	Maize germ meal	15
	15	Niger meal	10
	16	Fish meal	10
	17	Fish scrap	5
	18	Fish soluble	3
	19	Meat meal	10
	20	Meat-cum bone meal	5
	21	Blood meal	3
	22	Poultry by - product meal	5
	23	Poultry hatchery by-product meal	3
	24	Silk worm pupae meal	6
	25	Feather meal	2
	26	Skim meal dried	3
	27	Penicillin - mycelium waste	15
IV		Fermentation by-products	
	1	Distillers dried soluble	10
	2	Distillers dried grains	10
	3	Distiller dried grains with soluble	10
	4	Yeast dried	5
	5	Yeas sludge dried	10
	6	Mahua cake (treated with water)	8
Where, the values are given in range, lower level of range for chicks and higher levels of range are for layers.			

4. Availability and cost of feed ingredients:

In computing the feed formulation, many nutrients can be taken into consideration at a time. However, by calculation, only a few nutrients can be considered. These included the following, based on practical consideration.

Steps in formulation of ration

1. Fix/ leave slack space: 5 kg

The minor ingredients are fixed and or slack space may be left to include them later. These are added in limited quantities because of cost or to provide a specific nutrient or non- nutrients feed additives or to balance a nutrient usually deficient. Trace minerals, vitamins and feed additives can be fixed because the contribution of major feed ingredients for these nutrients are little. Slack space may be left for addition of salt, calcium and phosphorus sources, supplemental amino acids and fats at a later stage to balance the diet.

Fixed minor ingredients- Trace minerals, vitamins, coccidiostates, arsenicals, antibiotic.

Slack space for - Fat phosphorus, calcium source, common salt and amino acids.
Fixed minor ingredient and slack space = 5.00 kg.

2. **Fix level of Animal Protein (fish meal/meat meal etc.): 10 kg** (for broiler starter, broiler finisher and Chick feeds). Its level may be reduced to 7 kg in the ration of grower and layer). These are added at fixed levels because of cost. These provide the limiting amino acids (*Lysine and methionine + cysteine*) at higher level than other feed ingredients.
3. **Fix level of cereal by-products: 8 kg** (for broiler starter, broiler finisher and Chick feeds). Its levels may be increased up to 15-20% in the ration of grower and layer)
4. **Calculate proportion of Energy feed and Vegetable protein through Pearson square method**
5. **Balance ME content: First calculate ME supply from above ingredients (already worked out from above steps), if there is shortage it can be meet out by addition of animal fat, vegetable oil or maize grain depending on the cost availability.**
6. **Balance Available phosphorus:** Available P is considered as 30 % of the total P content present in vegetable sources i.e. grains, grain byproducts, oil seed cake/meal. Total P present in animal sources and inorganic mineral supplements is considered as 100 % available P. Calculate available P supply from the above feed ingredients, total it. If there is shortage can be meet out by addition of desired quantity of DCP (Di calcium phosphate).
7. **Balance Calcium Content:** First calculate Ca supply through above feed ingredients and DCP and total it. If there is any shortage it can be meet out by addition of desired

quantity of lime stone powder/other calcium supplement (**In layer ration about 4 % Oyster shell grit/calcite grit is essentially added as a source of Ca**).

- 8. Balance Sodium content:** Usually Na supply from feed ingredients is not calculated and common salt is incorporated @ 0.5 %. However, if animal sources like fishmeal/meat meal contains higher level of salt then accordingly you adjust the addition of common salt.
- 9. Balance Limiting amino acids (Lysine & Methionine):** Calculate supply of both amino acids from above all feed ingredients, total it and compare with requirements, if there is any deficit, it can be meet out by addition of synthetic L-Lysine and DL-Methionine available in the market.
- 10. Check Crude fiber level:** calculate CF contributed by different feed ingredients, total it and compare with recommended Max. CF levels given in the feeding standard, it should not be higher than that level.
- 11.** Finally total, quantities of feed ingredients and each nutrients it should match with the recommended nutrient levels given in the feeding standards.
- 12. Vit A, D₃, K, E, Choline etc. are necessarily added. In addition to this toxin binder, Antibiotic growth promoters/probiotics, preservatives are also added.**

Problem 1: Formulate 100 kg broiler starter (as per BIS 1992) ration using following feed ingredients/ supplements: Maize, soybean meal, Deoiled Rice Bran (DORB), Fishmeal, Di-calcium phosphate (DCP), Lime Stone Powder (LSP), Synthetic Lysine, Methionine, Trace mineral & vitamin mixture.

Nutrient Requirement Broiler starter (BIS,2007)	CP %	ME Kcal/Kg	Ca %	Available P %	Lysine %	Methionine %	CF %
	23	3000	1.0	0.7	1.3	0.5	5.0

Chemical composition of feed ingredients/ supplements

Feed ingredient/ supplement	DM %	CP %	EE %	CF %	ME Kcal/kg	Ca %	P %	Lysine %	Methio- nine %
Maize	89	9.0	3.8	2.2	3340	0.02	0.28	0.22	0.18
SBM	89	45	0.8	6.6	2300	0.29	0.65	2.7	0.65
DORB	91	13.5	0.6	14.0	2200	0.07	1.50	0.6	0.25
Fish meal	91	42	5.0	1.0	2400	3.73	2.43	3.2	1.10
Meat meal	92	45	7.1	8.7	2400	8.27	4.1	2.5	0.65
DCP	-	-	-	-	-	21.0	18.5	-	-
LSP	-	-	-	-	-	36.0	-	-	-
Lysine	-	-	-	-	-	-	-	100	--
Methionine	-	-	-	-	-	-	-	-	100

Step 1: leave slack space: **05 kg**

Step 2: Fix level of Animal Protein (fish meal): **10 kg**

Step 3: Fix level of cereal by-products i.e. DORB: **08 kg**

Total Quantity fixed	23 kg
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Now calculate CP supply from above quantity **CP (kg)**

Slack space: 05 kg0.00

Fish meal (if CP content is 42 %) 10 kg – 42/100x10 = 4.20

DORB (if CP value is 13.50 %) 08 kg – 13.50/100x8 = 1.08

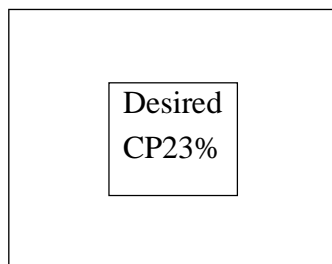
5.28

CP required to be supplemented through 77 kg [(100 (qty. to be prepared) - 23 kg (qty. already fixed))] is 17.72 kg [23 (required CP) – 5.28 (CP supplied by qty. of ingredients fixed)]

Therefore CP desired in percentage will be $17.72/77 \times 100 = 23.01\%$

Step 4: Calculate proportion of Energy feed and Vegetable protein through Pearson square method

Maize CP 9 % 22



SBM	
CP 45%	14
Total	36

In Pearson square method is used to get the proportion of two feeds, in our case, maize and SBM. Desired level of CP in the mixture is kept in middle of the square while at left upper corner CP value of maize and at left lower corner CP content of SBM is kept. All three values should be in %. First minus values of left upper and left lower corners from the middle value. Always minus lower value from higher one diagonally as shown in the

above square, viz. $45 - 23 = 22$ keep on right upper corner (indicate proportion of SBM), similarly $23 - 9 = 14$ (indicate proportion of maize), keep this value at right lower corner. Now, make total of values at right corners. Then work out the proportion of two feeds as shown below

Proportion of maize in the remaining quantity (77 kg) = $\frac{22}{36} \times 77 = 47.05$ kg
 Proportion of SBM in the remaining quantity (77 kg) = $\frac{14}{36} \times 77 = 29.94$ kg

By Algebraic Equation

Total of ingredients = 77 kg

Protein = 17.72 kg

Let x represent the maize and y represent SBM.

$$x + y = 77.00 \quad \text{--- I}$$

$$0.09x + 0.45 y = 17.72 \quad \text{--- II}$$

$$0.45x + 0.45 y = 34.65 \quad \text{---III (Equation I X 0.45)}$$

Subtract the equation II from III

$$0.36x = 16.93$$

$$16.93$$

$$x = \frac{16.93}{0.36} = 47.05 \text{ kg}$$

$$y = 77.00 - 47.02 = 29.94 \text{ kg.}$$

Step 5. ME is balanced by addition of 2 kg maize grain (within the slack place provided in step 1)

Step 6. Available P is balanced by addition of 0.690 kg DCP (within the slack place provided in step 1)

Step 7. Ca is balanced by addition of 0.315 kg LSP (within the slack place provided in step 1) because 0.145 kg Ca is also available through DCP

Step 8. Na may be balance by addition of 0.50% common salt.

Step 9 Lysine and methionine are balanced by addition of same quantity i.e. 0.217Kg and 0.148 kg synthetic lysine & methionine, respectively (within the slack place provided in step 1)

Step 10. CF level is higher by 0.67 %, this is because of higher level of CF in DORB (14 %), therefore DORB should checked before use for CF level, it should not be higher.

Step 11. Finally total, quantities of feed ingredients and each nutrients it should match with the recommended nutrient levels given in the feeding standards.

Step 12. Vit A, D₃, K, E, Choline etc. are necessarily added. In addition to this toxin binder, Antibiotic growth promoters/probiotics, preservatives are also added.

BIS SPECIFICATIONS FOR BROILER FEEDS (2007) :

Stage of poultry □	Broiler			Broiler breeder			
	Pre-starter	Starter	Finisher	Chick	Grower	Layer	Male
Age group □ (days)	1 – 7	8 – 21	22 - 42	0 - 56	57-140	140-560	-----
Moisture (max. %)	11	11	11	11	11	11	11
ME (kcal/kg)	3,000	3,100	3,200	2,800	2,750	2,800	2,750
Crude Protein (min. %)	23	22	20	20	16	18	15
Crude fibre (max. %)	5	5	5	7	9	9	9
AIA (max. %)	2.5	2.5	2.5	4	4	4	4
Salt as NaCl (max. %)	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Calcium (min. %)	1.0	1.0	1.0	1.0	1.0	3.5	1.0
Total P (min. %)	0.7	0.7	0.7	0.7	0.7	0.7	0.4
Available P (min. %)	0.45	0.45	0.45	0.45	0.45	0.40	0.40
Lysine (min. %)	1.3	1.2	1.0	1.0	0.80	0.85	0.80
Methionine (min. %)	0.5	0.5	0.45	0.45	0.40	0.45	0.40
Linoleic acid(min g/100g)	1.1	1.1	1.1	1.0	1.0	1.0	1.0
Vitamin A (IU/kg)	11,000	11,000	10,000	12,000	12,000	15,000	12,000
Vitamin D ₃ (IU/kg)	3000	3000	3000	2500	2500	3000	2500
Vitamin E (mg/kg)	30	30	30	20	20	50	20
Vitamin K (mg/kg)	1.5	1.5	1.5	2.0	2.0	3.0	2.0
Riboflavin (mg/kg)	6	6	6	5	5	6	5
Biotin (mg/kg)	0.15	0.15	0.15	0.20	0.20	0.20	0.20
Choline (mg/kg)	500	500	500	850	850	700	500
Pyridoxine (mg/kg)	5	5	5	5	5	6	5
Aflatoxin (max. ppb)	20	20	20	20	20	20	20

Problem:

Example 1. Prepare 100 kg ration for broiler finisher using same above feed ingredients and Supplements.

Note: You can fix quantity of fish meal, DORB at same levels as in case of broiler starter.

Example 2. Prepare 100 kg ration for chick using same above feed ingredients and Supplements..

Note: You can fix quantity of fish meal, DORB at same levels as in case of broiler starter.

Example 3. Prepare 100 kg ration for growing chicken using same above feed ingredients and Supplements.

Note: in this case, animal protein feed (fish meal) may be fixed at 8 kg instead of 10kg and DORB may be fixed at 25 kg in place of 08 kg..

Exercise - 9

FORMULATION OF RATION FOR LAYERS WITH CONVENTIONAL AND UNCONVENTIONAL FEED INGREDIENTS

Formulation of concentrate rations for poultry

Layer is divided into three groups:

I. Layer

On the basis of growth rate and the nutrient requirement of growing period of layers is divided into three phases.

- | | |
|---------------------|-------------|
| 1. Chick Starter | 0- 8 weeks |
| 2. Grower / Pullets | 9-20 weeks |
| 3. Layer - Phase I | 21-45 weeks |
| - Phase II | 46-72 weeks |

II. Breeder

FEED FORMULATION

The following information is required for feed formulation:

1. Requirements of nutrients for poultry and composition of formulae in terms of nutrients:
2. Feed analytical values:
3. Maximum level of inclusion of feed ingredients
4. Availability and cost of feed ingredients:

Steps in feed formulation :

In practical diet formulation by calculation, the essential steps are as follows:
Chick Starter feed formulation

Step 1.

Fixed minor ingredients - Trace minerals, vitamins, coccidiostates, arsenicals, antibiotic.

Slack space for Fat phosphorus, calcium source, common salt and amino acids.
Fixed minor ingredient and slack space = 5.00 kg.

Step 2.

The levels of animal protein sources fixed. These are added at fixed levels because of cost. These provide the limiting amino acids (*Lysine and methionine + cystine*) at higher level than other feed ingredients.

Animal protein sources

	CP	ME Kcal	CP	ME Kcal
Fish meal (42 % protein,		2400 Kcal ME/kg) = 7.00 kg	2.94	16800 Kcal
Meat meal (45 % protein,		2400 Kcal ME/kg) = 3.00 kg	1.35	7200 Kcal
<hr/>			4.29 kg	24000 Kcal

Step 3.

The level of cereal by - products if to be added may be fixed. Alternatively, the cereal by-products and cereals can be mixed in certain ration and can be added. In this example, rice polish (cereal by-product is fixed at 8 per cent).

Cereal by-products

Deoiled rice bran = 8 kg (13.5 CP, 2200 Kcal/ kg)

CP contribution = 1.08 kg and ME Kcal contribution 17600 Kcal

Step 4.

Vegetable protein sources and energy sources are added to provide the required amount of protein. Till now 23.00 kg of ingredients, were added (including the slack space) and these contributed 5.37 kg protein. Still 73.00 kg of ingredients are to be added and 14.63 (20 -5.37) kg protein is to be made up.

Soybean meal as vegetable protein source and maize as an energy source are considered. The required protein level can be calculated by algebraic equation or by Pearson's formula.

Algebraic Equation

6. Total of ingredients = 77 kg

Protein = 14.63 kg

Let x represent the protein source soybean meal and y represent maize.

$$x + y = 77.00 \quad \text{--- I}$$

$$0.45x + 0.09y = 14.63 \quad \text{--- II}$$

$$0.09x + 0.09y = 6.93 \quad \text{---III (Equation I X 0.09)}$$

$$0.31x = 7.7$$

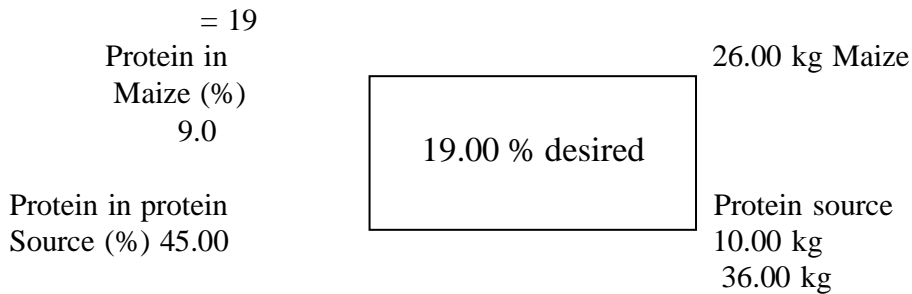
$$x = \frac{7.7}{0.31} = 24.84 \text{ kg}$$

$$y = 77.00 - 28.84 = 52.16 \text{ kg.}$$

Pearson's formula

7. Total of ingredients = 77.00 kg
 Protein = 14.63 kg

$$\text{Protein as per cent in} = \frac{14.63}{77} \times 100$$



For desired protein level as per cent is entered at the centre of square. The protein per cent of vegetable protein source and maize is entered in the corners. The difference between the protein per cent of ingredients and desired protein per cent is the ratio of different ingredients to be mixed.

$$\begin{aligned} \text{For } 73.00 \text{ kg} &= \frac{26.00}{36.00} \times 77 = 55.61 \text{ kg maize} \\ &= \frac{10}{36.00} \times 77 \\ &= 30.4 \text{ kg Soybean meal .} \end{aligned}$$

Step 5.

The metabolizable energy of the diet has to be balanced. The shortfall of 1066Kcal (260000 - 258934) can be met by supplementation of 0.125 kg animal fat (ME content of animal fat= 8000 Kcal/kg) or 320 g more of grain depending on the cost

Step 6.

The phosphorus content of the diet is calculated in forms of available phosphorus. Phosphorus from animal and inorganic sources is considered completely available, whereas that from plant source is considered to be 30 per cent available.

In this example, the deficiency of available phosphorus can be met by inclusion of 2.29 kg bone-meal.

Ingredients	% Kg	Ca	P
Maize	55.61	$55.61 \times 0.02/100 = 0.011$	$55.61 \times 0.28/100 = 0.156$
Soybean	21.39	$21.39 \times 0.29/100 = 0.062$	$21.39 \times 0.65/100 = 0.139$
Deoiled rice bran	8.00	$8.00 \times 0.07/100 = 0.0056$	$8 \times 1.50/100 = 0.12$
Fish meal	7.00	$7.00 \times 3.73/100 = 0.261$	$7.00 \times 2.43/100 = 0.1701$
Meat meal	3.00	$3.00 \times 8.27/100 = 0.248$	$3.00 \times 4.1/100 = 0.123$
		$= 0.582$	$= 0.7081$
			P from vegetarian sources = 0.415
			Available P (30% only) = 0.1245
			P from Non-vegetarian sources = 0.2931
		Ca from veg and non-veg sources = 0.582	Available P from veg and non-veg sources = 0.418
		Ca required = $1 - 0.582 = 0.418$	P required = $0.5 - 0.418 = 0.082$
		Addition of 0.630 kg Bone meal will provide $0.630 \times 24/100 = 0.151$ Therefore, Ca required = $1 - (0.582 + 0.151) = 0.267$	Addition of 2.29 kg bone meal fulfill P requirement also ($0.630 \times 14/100 = 0.0882$)
		Addition of 0.742 kg Lime stone powder fulfill Ca requirement ($0.742 \times 36/100 = 0.267$)	

Step 7.

The calcium content of the diet is calculated at 0.582 %. The remaining (0.418%) calcium content to meet the requirement can be met by supplementation of 0.630 kg bone meal and 0.267kg lime stone powder.

Step 8.

The sodium content is not usually calculated and 0.5 per cent addition of common salt meets the requirements. However, when feed ingredients high in sodium content such as meat meal and fish meal are used, the sodium content of the diet has to be calculated and only the deficiency has to be made up by supplementation of common salt.

In the example take, 0.5 per cent of salt has been included to meet the requirement.

Step 9.

The limiting amino acids (Methionine and lysine) in synthetic form are not required since requirements are already met.

Ingredients	% Kg	Lysine	Methionine
Maize	55.61	$55.61 \times 0.22/100 = 0.122$	$55.61 \times 0.18/100 = 0.10$
Soybean	21.39	$21.39 \times 2.7/100 = 0.577$	$21.39 \times 0.65/100 = 0.139$
Deoiled rice bran	8.00	$8.00 \times 0.6/100 = 0.048$	$8 \times 0.25/100 = 0.02$
Fish meal	7.00	$7.00 \times 3.2/100 = 0.224$	$7.00 \times 1.1/100 = 0.077$
Meat meal	3.00	$3.00 \times 2.5/100 = 0.075$	$3.00 \times 0.65/100 = 0.0195$
Animal Fat	0.125	----	----
Bone meal	0.630	----	----
Limestone powder	0.742	----	----
Common Salt	0.50	----	----
Total	96.997	=1.046	= 0.3555

Step 10.

The trace mineral mixture is required to be added at the rate of 0.400 kg and vitamin mixture at the rate of 0.200 kg to fulfill requirement of trace minerals and vitamins.

Step 11.

A check is made for the totals of ingredients and for all the nutrients if desired. If the total of ingredient are not 100, cereal or cereal by-products can be added to make it 100. Therefore 2.403 kg cereal by-products like wheat bran can be added to make it 100.

Ingredients	% (Kg)
Maize	55.61
Soybean	21.39
Deoiled rice bran	8.00
Fish meal	7.00
Meat meal	3.00
Common salt	0.5
Animal fat	0.125
Bone meal	0.630
Limestone powder	0.742
Trace mineral mixture	0.4
Vitamin mix.	0.2
cereal by-products	2.403
Total	97.597

The diet may be modified by incorporating higher levels of cereals to meet the protein of specific amino acid requirements, if necessary. After modification, again a check is made for all the nutrients.

2. NUTRIENT RECOMMENDATION FOR LAYERS

	Chicks (0-8 wk)	Grower (9-20wk)	Layer Phase I (21-45 wk)	Layer Phase II (46-72 wk)
Moisture, max %	11	11	11	11
Metabolizable energy ME (kcal/kg)	2,800	2,500	2,600	2,400
Crude Protein, min %	20	16	18	16
Crude fibre, max %	7	9	9	10
Acid insoluble ash, max %	4	4	4	4.5
Salt as (Nacl), Max %	0.5	0.5	0.5	0.5
Calcium, min %	1.0	1.0	3.0	3.5
Available Phosphorus, min %	0.45	0.4	0.4	0.4
Lysine, min %	1.0	0.7	0.7	0.65
Methionine, min %	0.4	0.35	0.35	0.30
Manganese, mg/kg	70	60	60	60
Vitamin A, IU/kg	9000	8000	8000	8000
Vitamin D3, IU/kg	1800	1600	1600	1600
Vitamin E, mg/kg	15	10	10	10
Vitamin K, mg/kg	1.5	1.5	1.5	1.5
Thiamine, mg/Kg	2	1.5	1	1
Riboflavin, mg/Kg	6.0	5.0	5.0	5.0
Pyridoxine, mg/Kg	3.0	3.0	3.0	3.0
Pantothenic, mg/Kg	10	9	7	7
Niacin, mg/Kg	40	20	20	20
Biotin, mg/kg	0.1	0.1	0.1	0.1
Choline, mg/Kg	500	200	400	400
Folic acid, mg/Kg	1	0.5	0.5	0.5
Aflatoxin B ₁ , max ppb	20	20	20	20

BIS Specification (2007)

Problem :

Formulate ration for Chick grower and layer bird as per BIS.

Exercise - 10

FORMULATION OF RATION FOR SWINE – CREEP RATION, GROWER AND FINISHER RATION (WITH CONVENTIONAL AND UNCONVENTIONAL FEED INGREDIENTS)

SWINE FEEDING: There are different categories of swine feeds (As per BIS)

- | | |
|------------------------------|--------------|
| 1. Pre-starter | - 1-5 kg |
| 2. Starter | - 5-20 kg |
| 3. Grower | - 20-50 kg |
| 4. finisher (upto slaughter) | - 50-90 kg |
| 5. Breeder | - Upto 90 kg |

Requirements of pig feeds (IS 7472:1986 (Clause 3.3) i.e. BIS standards:

Sr. No.	Characteristics (%)	Pig starter/ Creep feed (7 th day of age to 56 days)	Pig growth meal (15-45 kg)	Pig Finisher/ Breeding meal (45-70 kg)
1.	Moisture, Max.	11.0	11.0	11.0
2.	Crude protein, Min.	20.0	18.0	16.0
3.	Crude fat, Min	2.0	2.0	2.0
4.	Crude fibre, Max.	5.0	6.0	8.0
5.	Total Ash, max	8.0	8.0	8.0
6.	Acid insol. Ash, Max.	4.0	4.0	4.0
7.	Ca, Min.	0.6	0.6	0.6
8.	Available P, Min.	0.6	0.4	0.5
9.	Iron (As Fe) , mg/kg, Min	100.0	90.0	80.0
10.	Co , mg/kg, Min	8	6	6
11.	Mn, mg/kg, Min	30.0	30.0	20.0
12.	Zn, mg/kg, min	50.0	50.0	50.0
13.	Common Salt (as NaCl) mg/kg, Max	0.5	0.5	0.5
14.	Metabolizable Energy (kcal/kg), Min.	3360	3170	3170

Note : The values specified for requirements (2) to (17) are on moisture free basis

Nutrient requirements of Swine allowed feed *ad libitum*. (90% DM) (Adopted from NRC, 1988)

Intake and performance levels	Swine Live weight (kg)				
	1-5	5-10	10-20	20-50	50-110
Expected Wt. gain g/ day	200	250	450	700	820
Expected feed intake, g/day	250	460	950	1900	3110
Expected efficiency, feed/gain	1.25	1.84	2.11	2.71	3.79
Metabolizable Energy, Kcal/kg	3220	3240	3250	3260	3275
Protein %	24	20	18	15	13
Indispensable amino acids (Important only)					
Lysine %	1.40	1.15	0.95	0.75	0.60
Methionine + Cystine %	0.68	0.58	0.48	0.41	0.34
Threonine%	0.80	0.68	0.56	0.48	0.40
Tryptophan %	0.20	0.17	0.14	0.12	0.10
Linoleic acid (%)	0.1	0.1	0.1	0.1	0.1
Requirements (% or amount/kg diet) a					
Mineral elements					
Ca%	0.90	0.80	0.70	0.60	0.50
P, total%	0.70	0.65	0.60	0.50	0.40
Available P%	0.55	0.40	0.32	0.23	0.15
Fe, mg	100	100	80	60	40
Co, mg	6	6	5	4	2
Mn, mg	4	4	3	2	2
Zn, mg	100	100	80	60	50
Se,mg	0.3	0.3	0.25	0.15	0.10
Vitamins					
Vit.A, IU	2200	2200	1750	1300	1300
Vit. D, IU	220	220	220	150	150
Vit E, IU	16	16	11	11	11
Vit K, mg	0.5	0.5	0.5	0.5	0.5
Niacin, available, mg	20	15	12.5	10	7
Pantothenic acid, mg	12	10	9	8	7
Riboflavin, mg	4	3.5	3	2.5	2
Vit. B 12, µg	20	17.5	15	10	5

a-The amino acids, minerals and vitamins requirements are based upon the types of ingredients.

Nutrient requirements of breeding swine (adopted from NRC 1988)

Intake levels	Bred gilts, sows and adult boars	Lactation gilts and sows
DE Kcal/kg diet	3340	3340
ME Kcal/kg diet	3210	3210
CP%	12	13

Nutrient requirements for pig ration are like poultry feeds with somewhat slight changes which are as follows.

1. It should be supplied with Fe, Cu and vitamin B6 as sow's milk is deficient in all these vitamins and minerals.
2. Pig prefers coarsely ground semi-solid feed instead of fine mixture.
3. Excess protein may be detrimental to the animal which may lead to scouring and enlargement of some vital organs like liver, kidney, spleen, etc.

In order to formulate ration for different livestock, many kinds of raw materials are required. Some of them are as follows.

1. **Cereals :** Cereals are rich in energy. They are used upto 35-55 %. Most valuable and precious is maize on the basis of nutrient it contains, nutritive value and its availability and cost effective factor. Others are jowar, millet, wheat, rice, damaged food grains, etc.
2. **Cereal by-products:** They are medium in CP and energy content. They are good source of calcium and phosphorus e.g. wheat bran, rice bran. They are added at the rate of 15-20% due to high fibre content. They have laxative action.
3. **Chunies:** These are the byproducts of dal industries. They are good source of protein e.g. gram, tur, musoor, udid, chunies. They are added at the rate of 15-20 %.
4. **Protein supplements:** They are very useful and used very judiciously. They are of two types.
 - A) **Vegetable protein supplements:** Groundnut cake, cotton seed cake, sunflower cake, soya DOC (deoiled cake), etc.
 - B) **Animal protein supplements:** Fish meal, meat meal, feather meal, bone + meat meal.

Vegetable proteins are used as low as possible when availability of good animal protein supplement is available is the proportion of 25-30%.

5. **Minerals:** Minerals are supplied in the form of mineral mixtures. Mineral mixture is added in the ration at the rate of 1-2%.

6. **Vitamins:**

Vitamins are supplied through green and fermented feeds. Supply of different kinds of vitamins is made through the vitamin mixture.

7. **Common salt:** The dose of salt is fixed i.e. 05%

8. **Additives:**

It includes antibiotics coccidiostat, probiotics, hormones, enzymes, etc.

9. **Sugarcane molasses:**

They are added at the rate of 1-5 % , besides cheaper source of energy, they are added as binding agent so that it can reduce dustiness of feed; also losses of vitamins and minerals through dust can be minimized. It does have sweet flavour, hence increases the palatability of feed by acting as appetizer.

9. **Unconventional feeds:**

In pig and poultry, the conventional feed sources can be replaced by unconventional feeds and fodder. Unconventional feeds are those which are not commonly used for the livestock feeding but are used during the scarcity.

Following unconventional feeds are used in feeding of swine.

1. **Salseed cake**

It is rich in oil as well as energy and therefore it is used for pig and poultry very conveniently.

2. **Tapioca**

It has got highest energy content same as that of cereals.

3. **Mango seed kernel cake/meal**

Kernel is the outer covering of mango seed inside which the seed is present. This can be used as unconventional source of feeds and fodder.

4. **Damaged wheat grains**

These can be also a useful unconventional source to be included in the formation of diet of poultry and pig.

5. **Silk worm pupae meal**

This can be used in poultry feeds as animal protein source.

Important points to be considered in formulation of poultry feed.

1. Availability of feed ingredients
2. Adaptability
3. Cost of ingredients
4. Nutritive value of ingredients and effect of feed on growth, production and reproduction.

Composition of various feedstuffs commonly used in pig feed:

Sr. No.	Ingredient	ME Kcal/kg	CP (%)	EE (%)	CF (%)	Lysine (%)	Methionine. (%)	Ca (g%)	P (Av.) (g%)
1	Maize	3340	9	3.8	2.5	0.21	0.18	0.02	0.13
2	Rice Polish	3300	12	14	6	0.4	0.2	0.04	0.125
3	Jowar	3000	9.5	2.5	2	0.3	0.15	0.04	0.09
4	DORB	2200	14	1	12	0.34	0.24	0.08	0.2
5	Oil	8000	0	99	0	0	0	0	0
6	Molasses	2300	2.5	0	0	0	0	0.5	0.03
7	Maize Gluten	3100	35	2.01	5	0.8	1	0.22	0.13
8	Soybean DOC	2400	45	0.5	7	2.8	0.62	0.25	0.26
9	Full fat soya	2800	44	20	5.5	2.5	0.55	0.25	0.57 (Total)
10	Groundnut DOC	2400	40	1	10	1.55	0.4	0.22	0.2
11	Sunflower extract	2000	29	1.5	22	1.5	0.8	0.37	0.22
12	Meat meal	2400	54	23	2.45	2.54	0.92	2.64	1.19
13	Fish whole	2400	47	2	1	3.4	0.68	6.2	3.5
14	Fish Jawala	2200	50	0	0	3.5	.75	5	4.2
15	Fish meal	2400	45	0	0	1.65	0.5	3.73	2.43
16	Tallow	8000	0	100	0	0	0	0	0

Creep and starter ration

Creep feed is a feed given to suckling pigs behind a barrier (or creep) which allows only piglets to have access to the feed. This kind of arrangement avoids the risk of injury to the piglets from overlaying by sows and essential for faster growth of suckling piglets. It should contain 20% CP and should be low in fibre. It is given to the piglet from 7 -10 days after birth and continued up to 56 days of age at which piglets are weaned from their dam. Piglets grow 300 g/day in pre-starter stage and 600 g/day in starter stage. Iron Dextran injection (I/M) is to be given on 4th and 14th day of age to prevent piglet anemia.

Formulation of creep mixture

Sr. No.	Ingredients	Percentage
1.	Ground yellow maize	40
2.	Skimmed milk	15
3.	GNC	10
4.	Til cake	10
5.	Molasses	05
6.	Wheat bran	10
7.	Fish meal	06
8.	Brewer's yeast	02
9.	Mineral mixture	02
10.	Vitamins	15-25 g

Steps in feed formulation

- 1. Slack space for:** Energy sources like animal fat, vegetable oil, phosphorus, calcium source, common salt and amino acids.
For minor ingredients: Trace minerals, vitamins, arsenicals , antibiotic etc.
Fixed minor ingredient and slack space = 10.00 kg.
- 2. Fix level of cereal by-products i.e. DORB :** 07 kg, 20 kg and 25 kg for pigstarter, pig growth meal and pig finisher feeds, respectively.
- 3. Fix level of animal protein source i.e. Fish meal:** 10 kg, 7 kg and 5 kg for Pig starter, Grower and Finisher meals, respectively.
- 4. Calculate proportion of Energy feed and Vegetable protein through Pearson square method**
- 5. Balance ME content:** Same as you have done in case of poultry
- 6. Balance Available phosphorus:** Same as you have done in case of poultry
- 7. Balance Calcium Content:** Same as you have done in case of poultry
- 8. Check Crude fiber level:** calculate CF contributed by different feed ingredients, total it and compare with recommended Max. CF levels given in the feeding standard, it should not be higher than that level. This can be maintained by using good quality DORB (CF, Max. 12 %) and GNC (CF, Max. 11 %), or even then if, CF level is slightly

higher, supplementation of fiber digesting enzyme preparations may be recommended.

9. Finally total, quantities of feed ingredients and each nutrients, it should match with the recommended nutrient levels given in the feeding standards.

10 .Vit AB₂D₃ and B-complex are necessarily added @ 25 g/100 kg each.

Requirements of Pig Feeds [IS 7472: 1986(Clause 3.3)] BIS 1986

Nutrients	Pig starter/ Creep feed	Pig growth meal	Pig finishing/ Breeding meal
CP (%)	20 (17.80)	18 (16.00)	16 (14.20)
ME (Kcal/kg)	3360 (2990)	3170 (2821)	3170 (2821)
Ca (%)	0.6 (0.53)	0.6 (0.53)	0.6 (0.53)
Available P (%)	0.6 (0.53)	0.4 (0.36)	0.5 (0.45)
CF (%)	5.0 (4.45)	6.0 (5.34)	8.0 (7.12)

Note: All values are based on moisture free basis (100 % DMB), while values in Parenthesis are converted to 89 % DMB (as fed basis)

Chemical composition of feed ingredients

Feed ingredient/ supplement	DM %	CP %	EE %	CF %	ME Kcal/kg	Ca %	P %
Maize	89	9.0	3.8	2.20	3340	0.02	0.28
GNC (Expeller)	90	40	7.3	13.0	2600	0.16	0.56
DORB	91	13.5	0.6	12.0- 14.0	2200	0.07	1.50
Fish meal	91	42	5.0	1.00	2400	3.73	2.43

Problem 1: Formulate 100 kg pig starter ration as per BIS (1986) using Maize, DORB, GNC (expeller), Fish meal, Mineral mixture, Salt, Vit. AB₂D₃ and B-complex.

Step 1: leave slack space: **02 kg**
Step 2: Fix level of cereal by-products i.e. DORB **07 kg**
Step 3: Fix level of fish meal **10 kg**

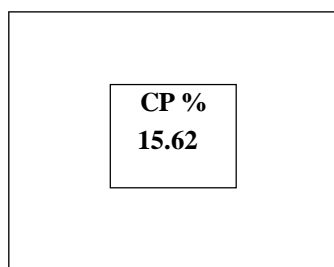
Total Quantity fixed 19 kg

Now calculate CP supply from above quantity **CP (kg)**
 Slack space 02 kg..... **0.00**
 Fish meal 10 kg = **4.20**
 DORB 07 kg – 13.50/100x07 = **0.95**
5.15

CP required to be supplemented through 81 kg [(100 (qty. to be prepared) - 19 kg (qty. already fixed))] is 12.65 kg [17.8 (required CP) – 5.15 kg (CP supplied by qty. of ingredients fixed)] Therefore, CP desired in percentage will be 12.65/81x100 = 15.62 %.

Step 4: Calculate proportion of Energy feed and Vegetable protein through Pearson square method

Maize CP 9 % 24.38



GNC
CP 40% 6.62

Total 31.00

Proportion of maize in the remaining quantity (81 kg) = $24.38/31 \times 81 = 63.70$ kg

Proportion of SBM in the remaining quantity (81 kg) = $06.62/31 \times 81 = 17.30$ kg

Ingredients	Qty (kg)	CP %	ME Kcal/kg	Av. P %	Ca %	CF %
NR, Pig starter (BIS 1986)	-	17.80	2990	0.530	0.530	4.45
DORB (CF 12 %)	07.00	0.95	154	0.105	0.005	0.84
Fish meal	10.00	4.20	240	0.243	0.373	0.10
Maize	63.70	5.73	2178	0.178	0.013	1.40
GNC (expeller)	17.30	6.92	450	0.097	0.028	2.25
Av.P. and Ca thr. ingredients	--	--	--	0.357	0.420	--
MM + salt + other additives	02.00	--	--	MM *	MM*	--
Total	100.0	17.80	3022	Fulfilled	Fulfilled	4.59

Note:1. Available P = $0.105+0.178+0.097= 0.380 \times 0.3 = 0.114$ (30 % of 0.380) + 0.243 = 0.357

2. MM* (mineral mixture normally contains Ca 20-22 % and P, 9-12 %, in addition to this it also contains essential trace minerals, therefore addition of 2 % will take care of Ca & Av. P and TM); Vit. AB2D3 and B- complex are added @ 25 g/100 kg.

Note: Similarly, by following above steps, you can formulate rations for Growing and Finisher pigs. Final results are given below:-

Ingredients	Qty (kg)	CP %	ME Kcal/kg	Av. P %	Ca %	CF %
NR, Pig grower (BIS 1986)	-	16.00	2831	0.360	0.530	5.34
DORB (CF 12 %)	20.00	02.70	440	0.300	0.014	2.40
Fish meal	07.00	02.94	168	0.170	0.261	0.07
Maize	58.29	05.25	1947	0.163	0.015	1.28
GNC (expeller)	12.71	05.08	330	0.071	0.020	1.65
Av. P & Ca thr. ingredients	--	--	--	0.330	0.310	--
MM + salt + other additives	02.00	--	--	MM *	MM*	--

Total	100.0	15.97	2885	Fulfilled	Fulfilled	5.40
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Note 1: Available P = 0.300+0.163+0.071= 0.534 x 0.3 = 0.160 (30 % of 0.534) + 0.170 = 0.330

2. MM* (mineral mixture normally contains Ca 20-22 % and P, 9-12 %, in addition to this it also contains essential trace minerals, therefore addition of 2 % will take care of Ca & Av. P and TM); Vit. AB2D3 and B- complex are added @ 25 g/100 kg.

Ingredients	Qty (kg)	CP %	ME Kcal/kg	Av. P %	Ca %	CF %
NR, Pig finisher (BIS 1986)	-	14.20	2821	0.450	0.530	7.12
DORB (CF 12 %)	25.00	03.38	550	0.375	0.018	3.00
Fish meal	05.00	02.10	120	0.122	0.187	0.05
Maize	59.50	05.36	1987	0.167	0.012	1.31
GNC (expeller)	08.50	03.40	221	0.048	0.014	1.44
Av. P & Ca thr. ingredients	--	--	--	0.299	0.231	--
MM + salt + other additives	02.00	--	--	MM *	MM*	--
Total	100.0	14.24	2878	Fulfilled	Fulfilled	5.80

Note 1: Available P = 0.375+0.167+0.048= 0.590 x 0.3 = 0.177 (30 % of 0.590) + 0.122 = 0.299

2. MM* (mineral mixture normally contains Ca 20-22 % and P, 9-12 %, in addition to this it also contains essential trace minerals, therefore addition of 2 % will take care of Ca & Av. P and TM); Vit. AB2D3 and B- complex are added @ 25 g/100 kg.

Final formula

Ingredients	% Kg
Maize	59.50
GNC	8.50
Fish meal	5.00
Common Salt	2.00
Trace mineral Mix	
Vit. Mix.	
Feed additives	
Cereal by-products	25.00
Total	100

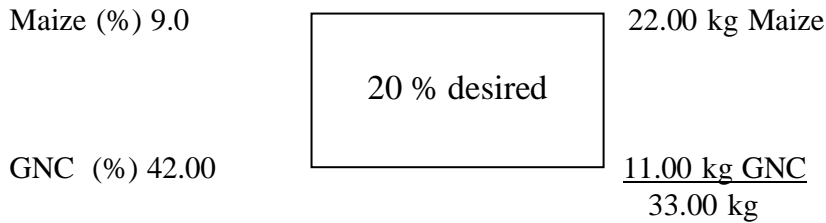
The diet may be modified by incorporating higher levels of cereals to meet the protein of specific amino acid requirements, if necessary. After modification, again a check is made for all the nutrients.

Problem

Formulate concentrate mixture of 20% CP with the help of Pearson Square method from the following feed ingredients.

Ingredients	% CP
Maize	9
Groundnut cake	42

Pearson square method:



i. e. 33 kg concentrate mixture should contain 22kg maize
100 kg concentrate mixture should contain 66.66

33 kg concentrate mixture should contain 11 kg GNC
100 kg concentrate mixture should contain 33.33

Therefore, concentrate mixture formula should be as follows

Ingredients	% kg	%CP
Maize	66.66	5.99
GNC	33.33	13.99

Total	100	19.98 i.e. 20

Simultaneous equation method

Compute a concentrate mixture of 20% CP with help of simultaneous equation method from the following feed ingredients; also calculate the TDN value of the same.

Ingredients	CP %	TDN %
Crushed maize	9	85
Mustard cake	31	75

Solution : Suppose maize is A and Mustard cake is B

A+ B =100 -----equation (1)

And 0.09A+0.31B =20 -----equation (2)

Now multiply Equation (1) by 0.31

$$0.31A + 0.31B = 31 \text{----- equation (3)}$$

Subtract equation (2) from equation (3)

$$0.22A + 0 = 11$$

$$A = 11/0.22 = 50$$

$$\text{Since } A + B = 100$$

$$50 + B = 100$$

$$\text{Therefore, } B = 100 - 50 = 50$$

Thus, the concentrate mixture formula should be as follows

Ingredients	% kg	%DCP	% TDN
Crushed maize	50	$50 \times 9/100 = 4.5$	$50 \times 85/100 = 42.5$
Mustard cake	50	$50 \times 31/100 = 15.5$	$50 \times 75/100 = 37.5$
<hr/>			
Total	100	20%	80 %

Exercise:

Formulate concentrate mixture as NRC standards for various classes of pigs.

Exercise - 11

PRINCIPLES OF COMPOUNDING AND MIXING OF FEEDS

Objectives:

1. To formulate the feed mixture of desired protein and energy content
2. To know how the different feed ingredients are balanced and how to mix them well.

Compound feed is essentially nutritionally balanced one. These are prepared by using raw feed ingredients for feeding of dairy animals and poultry by the farmers. The raw feed ingredients are carefully and scientifically analyzed to find out any anti-nutritional factor present in them and to know the nutritional content of feed. The raw feed ingredients are mixed in certain proportion or following specific standards so that the final product has desired level of nutrients or nutritive value. The ingredients are mixed in such a way that the final product meets all the essential nutrient requirements of the livestock, maintained for specific purpose.

Raw ingredients are categorized as:

1. Cereals and their byproducts
2. Oilseeds and their byproducts
3. Legumes and their byproducts
4. Animal protein supplements
5. Minerals
6. Vitamins
7. Additives

Extractions thus indicate that the product or the feed ingredient is less in oil content (up to 1 % or less than 1 %). They are brought from the market and stored in godowns and used as and when required for production of feed mixtures with the help of formula. The unnecessary and unwanted ingredients used for production of feed mixtures should be removed. The nutritionist must check all kinds of ingredients that are used for production of feed by visual examination and carrying out the different types of tests in order to reject or accept the raw material or feed ingredients on economical basis. Then the feed ingredient or raw material sample is taken out for proximate analysis by chemical method. The raw material or feed ingredient is also checked or tested for any kind of anti-nutritional factor like tannin content. After confirming the quality of the feed with the help of visual and laboratory examination, the raw material is purchased for production of feed mixtures.

Processes in manufacture of feed

1. Batch making
2. Feeding to grinder
3. Grinding
4. Mixing
5. Addition of molasses (optional)
6. Pelleting
7. Crumble formation
8. Bagging and storage

1. Batch making- It is of two types;

1. Cereals, oil cakes

Have big particle size therefore they need grinding before use.

2. The other raw materials including milling products which are already in powdered form require no grinding. Vitamins, minerals are always in powdered form and because of less quantity and to avoid the losses through dust during the process, they are added directly into mixer.

2. Feeding to grinder

All raw materials and feed ingredients, as per the formulation in a particular batch is forwarded for production after batch making

3. Grinding

The grinding is done with the objective to obtain a uniform particle size and to avoid the segregation of feed particle which may result due to unequal particle size.

4. Mixing

Mixing is such that one part is mixed with one million parts so as to have homogenized feed. The main aim of mixing is to mix all the feed ingredients homogeneously to have a balanced form of feed.

5. Addition of molasses

After getting the mash form of feed, molasses is being added. It minimizes the dustiness of feed and makes the feed more palatable. The maximum limit of addition of molasses in different kinds of feeds for different categories of animals must be strictly followed.

6. Pelleting

Mash is converted to pellet with the help of steam and dyes. Prepared mash is passed through elevator which contains the electromagnet helping to remove any iron particle that is going for bagging.

7. Bagging

The bagging is done with different weights like 60, 70, 75 kg etc.

8. Storage

The bags are stored in a godown on raised platform in row. There must be minimum 1-0 m space between rows and from the walls of the godown. The godown must be well ventilated, rat, birds and water proof.

Exercise - 12

VISIT TO FARMS

A- COMMERCIAL BROILER FARMS

Objectives:

1. To collect the information about management of farm
2. Feed offered to the birds and feeding practices followed
3. Feed conversion ratio/ efficiency

Information to be collected from poultry farm

1. Breed
2. Type of birds: Broiler
3. Feed offered to the birds
4. Consumption of feed per day per bird
5. Ingredients used
6. Nutritional borne diseases/problems in past and present
7. Feeding schedule
8. Daily feed required
9. Feed conversion ration/ efficiency
10. Remark/conclusion

B- COMMERCIAL LAYER FARMS

Objectives

1. To collect the information about management of farm
2. Feed offered to the birds and feeding practices followed
3. Hen house egg production, total egg production on farm

Information to be collected from poultry farm

1. Breed
2. Type of birds : Layer
3. Feed offered to the birds
4. Consumption of feed per day per bird
5. Ingredients used
6. Nutritional borne diseases/problems in past and present
7. Feeding schedule
8. Daily feed required
9. Feed required per egg.
10. Remark/conclusion

C- VISIT TO DAIRY FARM

Objectives

- a. To collect the information about management of farm
- b. Feed and fodder offered to the cattle/ buffalo and feeding practices followed
3. Milk production and feed efficiency

Information to be collected from Dairy farm

- a. Breed of Cattle/ Buffalo
- b. Green and dry roughages offered
- c. Ingredients used for preparation of concentrate mixture
- d. Feeding schedule
- e. Daily feed required
- f. Feed efficiency
- g. Metabolic diseases in past and present
- h. Remark/conclusion

D- VISIT TO GOAT/ SHEEP FARM

Objectives

1. To collect the information about management of farm
2. Feed and fodder offered to the goats / sheep and feeding practices followed
3. Market weight of goats and sheep/ Wool production of sheep and feed efficiency

Information to be collected from goat farm

1. Breed of Goat/ Sheep
2. Feed offered to Goat/ Sheep
3. Green and dry roughages offered
4. Ingredients used for preparation of concentrate mixture
5. Feeding schedule
6. Daily feed required
7. Market weight of goats/ sheep
8. Wool production of sheep
9. Feed efficiency
10. Metabolic diseases in past and present
11. Remark/conclusion

E- VISIT TO PIG FARM

Objectives

1. To collect the information about management of farm
2. Feed offered to the pigs and feeding practices followed
3. Market weight of pigs and feed efficiency

Information to be collected from pig farm

1. Breed of Pigs
2. Feed offered to Pigs
3. Ingredients used for preparation of concentrate mixture
4. Hotel waste or other unconventional feedstuffs used for feeding
5. Feeding schedule
6. Daily feed required
7. Market weight of Pigs
8. Feed efficiency
9. Remark/conclusion

Exercise -13

FORMULATION OF BALANCED DIETS FOR HORSES

Formulation for ration for Horses

In computation of ration for Horses, most important things are to meet the requirement of DM, DCP, DE/TDN in 24 hours for the particular animal. There are different steps with the help of which we can formulate the ration. Before formulation of ration for Horses one should know the nutrient requirements of animals for various physiological stage, feed/ Dry matter requirement of animal, roughage to concentrate ratio in the ration

Nutrient requirement of Horses as per body weight for various physiological stages and type of work perform (NRC, 1989)

Daily nutrient requirements of Horses (400 kg Mature Weight)

Animal	BW (kg)	ADG (kg)	DE Mcal	CP (g)	Ca (g)	P (g)
Mature Horse						
Maintenance	400		13.4	536	16	11
Stallion breeding season	400		16.8	670	20	15
Pregnant mare	400					
9 months			14.9	654	28	21
10 months			15.1	666	29	21
11 months			16.1	708	31	23
Lactating mare	400					
Foaling to 3 months			22.9	1141	45	29
3 months to weaning			19.7	839	29	18
Working horses	400					
Light			16.8	670	20	15
Moderate			20.1	804	25	17
Intense			26.8	1072	33	23
Growing horse						
Weanling, 4 months	145	0.85	13.5	675	33	18
Weanling, 6 months	180					
Moderate growth		0.55	12.9	643	25	14
Rapid growth		0.70	14.5	725	30	16
Yearling, 12 months	265					
Moderate growth		0.4	15.6	700	23	13
Rapid growth		0.5	17.1	770	27	15

Daily nutrient requirements of Horses (500 kg Mature Weight)

Animal	BW (kg)	ADG (kg)	DE Mcal	CP (g)	Ca (g)	P (g)
Mature Horse						
Maintenance	500		16.4	656	20	14
Stallion breeding season	500		20.5	820	25	18
Pregnant mare	500					
9 months			18.2	801	35	26
10 months			18.5	815	35	26
11 months			19.7	866	37	28
Lactating mare	500					
Foaling to 3 months			28.3	1427	56	36
3 months to weaning			24.3	1048	36	22
Working horses	500					
Light			20.5	820	25	18
Moderate			24.6	984	30	21
Intense			32.8	1312	40	29
Growing horse						
Weanling, 4 months	175	0.4	14.4	720	34	19
Weanling, 6 months	215					
Moderate growth		0.3	15.0	750	29	16
Rapid growth		0.4	17.2	860	36	20
Yearling, 12 months	325					
Moderate growth		0.2	18.9	851	29	16
Rapid growth		0.3	21.3	956	34	19

Daily nutrient requirements of Horses (600 kg Mature Weight)

Animal	BW (kg)	ADG (kg)	DE Mcal	CP (g)	Ca (g)	P (g)
Mature Horse						
Maintenance	600		19.4	776	27	17
Stallion breeding season	600		24.3	970	30	21
Pregnant mare	600					
9 months			21.5	947	41	30
10 months			21.9	965	42	31
11 months			23.3	1024	44	33
Lactating mare	600					
Foaling to 3 months			33.7	1711	67	43
3 months to weaning			28.9	1258	43	27
Working horses	600					
Light			24.3	970	30	21
Moderate			29.1	1164	36	25
Intense			38.8	1552	47	34
Growing horse						
Weanling, 4 months	200	1.0	16.5	825	40	22
Weanling, 6 months	245					
Moderate growth		0.75	17.0	850	34	19
Rapid growth		0.95	19.2	960	40	22
Yearling, 12 months	375					
Moderate growth		0.65	22.7	1023	36	20
Rapid growth		0.8	25.1	1127	41	22

NUTRIENT REQUIREMENTS OF EQUINE AS PER INDIAN STANDARD

Nutrient Requirements of Horses (% of ration)

Class	TDN (Kg/day)	Crude Protein %	Calcium %	Phosphorus %	Feed intake %, Body weight
Adult horses at rest	3.7	8.0	0.30	0.2	1.5
Pregnant mare (last 3 months of pregnancy)	4.2	10.0	0.45	0.35	1.75
Lactation (First 3 months)	6.4	12.5	0.45	0.35	2.75
Nursing Foal (3-5 months) Requirements in addition to milk	1.6	16	0.8	0.55	0.75
18-24 months	3.9	10.0	0.40	0.35	2.0
12-18 months	3.8	12.0	0.50	0.35	2.5
2 year old to maturity	3.7	9.0	0.40	0.35	1.75

DM requirement and forage concentrate ratio for different categories of horses of the animal which depends upon live body weights of the animal and various physiological stages

Factor	Feed Intake		
	% of body weight	Forage : concentrate ratio	
		Forage	Concentrate
Maintenance	1.5-2.0	80-100	0-20
Mare, late gestation	1.5-2.0	65	35
Mare, early lactation	2.0-3.0	45	55
Mare, late lactation	2.0-2.5	60	40
Working horses			
Light work	1.5-2.5	65	35
Moderate work	1.75-2.5	40	60
Intense work	2.0-2.5	30	70
Young horse			
Nursing foal, 3 months	2.5-3.5	20	80
Weanling foal, 6 months	2.0-3.5	30	70
Yearling foals 12 months	2.0-3.0	45	55
Long yearling, 18 months	2.0-2.5	60	40
2 year old, 24 months	2.0-2.5	40	60

In addition to these following are the points to be considered while formulating ration for Horse

1. Availability of feeds and fodder
2. Nutrient content and nutritive value of feedstuffs
3. Cost of available raw material in that particular geographical area
4. Number of animals to be fed and duration of feeding
5. Cost of feeds and fodder available in the farm

Exercise:**1. Formulate ration for early lactating mare weighing 500 kg body weight****Nutrient requirements**

Animal	BW (kg)	DE Mcal	CP (g)	Ca (g)	P (g)
Lactating mare- Foaling to 3 months	500	28.3	1427	56	36

Available feedstuffs

Feed stuff	DM	CP	DCP	TDN	DE (Mcal/kg)	Ca	P
Oats fodder	20	10	4.5	60	2.64	0.33	0.17
Maize	90	9	7.5	80	3.52	0.02	0.29
Gram	90	22.8	20	74	3.26	0.27	0.28

For lactating mare DM requirement is 2.5% of body weight

Therefore, total DM requirement will be

100=2.5 kg

500= 12.5 kg

Total DM i.e 12.5 kg may be divided into Roughages 60% and Concentrates 40%
i.e. 7.5 kg DM from Oat hay and 5.00 kg DM from concentrates

Nutrients obtained from Oat hay

Roughages	DM	DE (Mcal)	CP (g)
Oat hay	7.5	19.8	750

Nutrients required from concentrates

Roughages	DM	DE (Mcal)	CP (kg)
Nutrients required	12.5	28.3	1.427
Nutrient form Oat hay	7.5	19.8	0.750
		8.5	0.677

From, 5 kg concentrate DM we required 0.677 kg CP

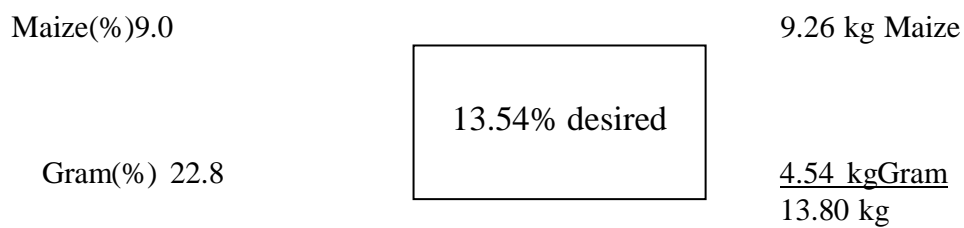
Therefore, we have to use mixture of Maize and gram 5 kg and it should provide 0.677 kg CP

By using Pearson square

5.0 kg concentrate DM= 0.677 kg

100 kg concentrate DM= 13.54 kg

$$\begin{aligned} \text{Protein} & \quad \text{Total of ingredients} & = & \quad 5.00 \text{ kg} \\ & = & \frac{0.677 \text{ kg}}{0.677} \\ \text{Protein as per cent in} & = \frac{\text{-----}}{5} \times 100 \\ & = & 13.54 \end{aligned}$$



For desired protein level as per cent in entered in the centre of square. The protein per cent of Maize and Gram is entered in the corners. The difference between the protein per cent of ingredients and desired protein per cent is the ratio of different ingredients to be mixed.

$$\text{For} \quad 5.0 \text{ kg} = \frac{9.26}{13.80} \times 5.0 = 3.36 \text{ kg Maize}$$

$$5.0 \text{ kg} = \frac{4.54}{13.80} \times 5.0 = 1.64 \text{ Kg Gram}$$

Algebraic Equation

$$\begin{aligned} \text{Total of ingredients} & = 5 \text{ kg} \\ \text{Protein} & = 0.677 \text{ kg} \\ \text{Let } x & \text{ represent the Maize and } y \text{ represent Gram} \\ x + y & = 5.0 \text{-----I} \\ 0.09x + 0.228y & = 0.677 \text{-----II} \\ 0.09x + 0.09y & = 0.45 \text{-----III (Equation I X 0.09)} \\ \text{Deduct eqn III from eqn II} \\ 0.09x + 0.228y & = 0.677 \text{-----II} \\ \text{---} & \\ 0.09x + 0.09y & = 0.45 \text{-----III} \\ \text{-----} & \\ 0.138Y & = 0.227 \\ Y & = 1.64 \\ X & = 5 - 1.64 = 3.36 \end{aligned}$$

Protein and energy contributed through roughages and concentrates:

Ingredients	% ingredients	CP contributed	Energy Contributed
Oat hay	7.5	$7.5 \times 10/100 = 0.75$	$7.5 \times 2.64 = 19.8$
Maize	3.36	$3.36 \times 9/100 = 0.302$	$3.36 \times 3.52 = 11.83$
Gram	1.64	$1.64 \times 22.8/100 = 0.374$	$1.64 \times 3.26 = 5.35$
Total		1.426	36.98

Thus, we have fulfilled CP requirement, however, energy exceeds requirement
i.e $36.98 - 28.3 = 8.68$ Mcal

Actual quantity of each ingredient required

Ingredients	% DM from ingredients	DM% of ingredient	Actual quantity
Oat fodder/ hay	7.5	80%	$7.5 \times 100/80 = 9.375$
Maize	3.36	90%	$3.36 \times 100/90 = 3.73$
Gram	1.64	90%	$1.64 \times 100/90 = 1.82$

Exercise N0.2:

Formulate ration for intense working horse weighing 500 kg body weight
Nutrient requirements

Animal	BW (kg)	ADG (kg)	DE Mcal	CP (g)	Ca (g)	P (g)
Intense working	500		32.8	1312	40	29

Available feedstuffs

Feed stuff	DM	CP	DCP	TDN	DE (Mcal/kg)	Ca	P
Oats fodder/hay	20	10	4.5	60	2.64	0.33	0.17
Bajra	90	8.0	4.5	80	3.52	0.01	0.44
Gram	90	22.8	20	74	3.26	0.27	0.28

For intense working horse, DM requirement is 2.5-3% of body weight

Therefore, total DM requirement will be

$100 = 2.5$ kg

$500 = 12.5$ kg

Total DM i.e 12.5 kg may be divided into Roughages 50% and Concentrates 50%

i.e 6.25 kg DM from Oat hay and 6.25 kg DM from concentrates

Nutrients obtained from Oat fodder/ hay

Roughages	DM (kg)	DE (Mcal)	CP (kg)
Oat fodder/ hay	6.25	16.5	0.625

Nutrients required from concentrates

Roughages	DM (kg)	DE (Mcal)	CP (g)
Nutrients required	6.25	32.8	1312
Nutrient form Oat fodder hay	6.25	16.5	625
		16.3	687

From,6.25 kg concentrate DM we required 0.687 kg CP

Therefore, we have to use mixture of Bajra and gram 6.25 kg and it should provide 0.687 kg CP

By using Pearson square

6.25 kg concentrate DM= 0.687 kg CP

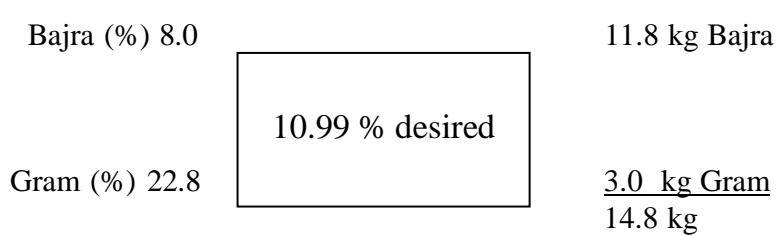
100 kg concentrate DM= 10.99

Pearson’s formula

Total of ingredients = 6.25 kg

Protein = 0.687 kg

$$\text{Protein as per cent} = \frac{0.687}{6.25} \times 100 = 10.99$$



For desired protein level as per cent is entered in the centre of square. The protein per cent of Bajra and Gram is entered in the corners. The difference between the protein per cent of ingredients and desired protein per cent is the ratio of different ingredients to be mixed.

$$\text{For } 6.25 \text{ kg} = \frac{11.8}{14.8} \times 6.25 = 4.98 \text{ kg Bajra}$$

$$6.25 = \frac{3.0}{14.8} \times 6.25 = 1.27 \text{ Kg Gram}$$

Algebraic Equation

Total of ingredients = 6.25 kg

$$\text{Protein} = 0.687 \text{ kg}$$

Let x represent the wheat bran and y represent rice husk.

$$\begin{aligned} x + y &= 6.25 && \text{--- I} \\ 0.08x + 0.228y &= 0.687 && \text{--- II} \\ 0.08x + 0.08y &= 0.5 && \text{---III (Equation I X 0.09)} \end{aligned}$$

Deduct eqn III from eqn II

$$\begin{array}{r} 0.08x + 0.228y = 0.687 \quad \text{--- II} \\ \text{---} \\ 0.08x + 0.08y = 0.5 \quad \text{---III} \\ \hline 0.148Y = 0.287 \\ Y = 1.26 \text{ kg} \\ X = 6.25 - 1.26 = 4.98 \text{ kg} \end{array}$$

Protein and energy contributed through roughages and concentrates

Ingredients	% ingredients	CP contributed	Energy Contributed
Oat hay	6.25	$6.25 \times 10/100 = 0.625$	$6.25 \times 2.64 = 16.5$
Bajra	4.98	$4.98 \times 8/100 = 0.398$	$4.98 \times 3.52 = 17.53$
Gram	1.27	$1.27 \times 22.8/100 = 0.289$	$1.27 \times 3.56 = 4.14$
Total		1.312	38.17

Thus, we have fulfilled CP requirement, however, energy exceeds requirement
i.e $38.17 - 32.8 = 5.37\text{Mcal}$

Actual quantity of each ingredient required

Ingredients	% DM ingredients	DM from	DM% of ingredient	Actual quantity
Oat hay	6.25		80%	$6.25 \times 100/80 = 7.81$
Bajra	4.98		90%	$4.98 \times 100/90 = 5.53$
Gram	1.27		90%	$1.27 \times 100/90 = 1.41$

Exercise -14

FORMULATION OF BALANCED DIETS FOR DOGS

Foodstuffs commonly used for feeding pet animals

Foods of animal origin

Meat and meat by-products
Milk, milk products and by-products
Fish, marine by- products and fish meal
Poultry and poultry products
Edible fatty tissues and fats

Foods of plant origin

Cereals
Cereal by- products
Pulses and by-products
Fruits and vegetables

Food supplements

Common salt
Minerals
Vitamins
Phytobiotics

Orphaned pups can be fed as follows:

Cow Milk = 800 ml.
Cream (12%fat) = 200ml.
Egg yolk = 1.
Vit.A = 6gm
Vit.D = 3000 I.U.
Citric Acid = 500 I.U.
Steamed bone meal = 4 gm.

Feed Formulae for Young Pups.

Ingredients (g)	Diet 1	Diet2	Diet 3
Dried milk powder	200	-	-
Cow milk	-	700	-
Buffalo milk	-	-	800
Cream (30%fat)	200	200	100
Egg-Yolk	-	50	50
Boiling water	400	-	-
Rice gruel\flour gruel (30% dry -matter)	200	50	50

Feeding Schedule of Mature Dogs.

Daily food requirement (g)

Body Weight

(Kg)	Cooked Cereals	Meat	Green vegetables of legume pods	Milk.
5	100	50	50-60	100
10	150	50	60-80	100
15	200	100	80-100	100
20	300	100	100-150	-
25	400	100	100-150	-
30	450	150	100-150	-
40	500	150	150-200	-
50	600	200	200-300	-
60	700	200	200-300	-
70 & above.	800	200	200-300	-

Balanced Diet Charts

Standard balanced dog food (On dry Matter Basis)

CP : 20-22%

EE : 4-5 %

CF : 5-10%

TA : 4-5%

Energy : 3300-4000 ME Kcal/Kg of food

Energy requirement during various physiological stages of dogs

<u>Category of Animal</u>	<u>Energy required</u> (ME kcal/W ^{0.75} kg)
----------------------------------	--

ME requirements per day

Mature Idle dog	132
Terminal Trimester of pregnancy	188
Lactation	470
Growing puppies	274
Adolescent puppies	200

Fat requirements per day

Maintenance	1.0 g/kg BW
Growth	2.7 g/kg BW

Protein requirement per day

Maintenance	4.8 g/kg BW
Growth	9.6 g/kg BW

Composition of commonly used foodstuff in pet animals (per 100g) on as such basis

Ingredient	Energy (Kcal)	Protein (g)
Rice	345	6.8
Wheat	346	11.8
Ragi	345	6.8
Pulses	350	22.5
Soybean meal	230	45
Groundnut cake	260	40.9
Milk	67	3.3
Egg	143	11.3
Green leafy vegetables (GLV)	30	4.25

Examples on formulation of Balanced diets

1. Calculate the nutrient requirements of 3 kg growing dog and formulate a balanced diet

Requirements per day	
Energy, Kcal NE	600
Fat, g	8.1
Protein, g	28.8
Balanced Diet I	

Energy Kcal/100g	Protein g/100g	Ingredient	Quantity (g)	Nutrient Content	
				Energy (Kcal)	Protein (g)
67	3.2	Milk	100	67.0	5.2
100	11.3	Egg	50	71.5	5.65
50	4.25	GLV	50	25.0	2.13
345	6.8	Rice	75	259.0	5.1
346	11.8	Wheat	50	173.0	5.9
350	22.5	Pulses	25	88	5.6
				683	27.6

Balanced diet II

Ingredients	Quantity (g)	Nutrient Obtained	
		Energy (Kcal)	Protein (g)
Rice	100	345	6.8
Meat	100	194	18.5
Milk	100	67.0	3.2
		806	28.5

2. Calculate the nutrient requirements of 10 kg actively growing dog and formulate a balanced diet

Requirements per day

DM requirement	50 g X 10	= 500
ME requirement @264 Kcal/kg W ^{0.75}	264 X 5.62	=1484 Kcal
Protein requirement, g	9.6 X 10	= 96 g

Diet suggested

Rice/ Wheat	=150 g
Ragi	= 150 g
Soybean meal	=100 g
Groundnut cake (exp)	= 50 g
Water	= 1 lit.

Cook well and cool

Add, 1-2 hard boiled eggs, ¼ tsp salt, 1 tsp vitamin-mineral mixture and 2 tsp bone meal

Energy Kcal/100g	Protein g/100g	Ingredient Quantity (g)	Nutrient Content	
			Energy (Kcal)	Protein (g)
345 10.2	6.8	Rice 150	517.5	
328 10.95	7.3	Ragi 150	492	
230	45	Soybean meal 100	220	45
260 20.5	40.9	GNC 50	130	
143 11.3	11.3	Eggs (2 Nos.) 100	143.0	

Add ¼ tsp salt, 1 tsp vitamin-mineral mixture and 2 tsp bone meal

				1512	98.0

346 17.7	11.8	Wheat 150	519		
328 10.95	7.3	Ragi 150	150		492
230	45	Soybean meal 100	220		45
260 20.5	40.9	GNC 50	130		
143 11.3	11.3	Eggs (2 Nos.) 100	143		

Add ¼ tsp salt, 1 tsp vitamin-mineral mixture and 2 tsp bone meal

1514 105.0

Dog food categories

Food Category

Nutrients (%)

	CP	Fat
Growth foods/All life stages	21	8
Adult foods/ Maintenance type	21-26	8-18
Reduced Calorie/ Maintenance type	14-25	7-8
Performance foods/ all life stages	27	9

Exercise - 15

FORMULATION OF BALANCED DIETS FOR CATS

FEEDING OF CATS

Opportunist feeders eating as and when they catch and kill prey. Adapted to large meals at irregular intervals. Domestic cats on palatable foods prefer to eat many small meals (12-20 meals per 24 hours) rather than one or two large ones. Many pet cats are fed on demand with food made available whenever the animal asks for it throughout the day. The average pet can weigh about 4 kg. This would be provided in 90 g dry matter (100 g dry food). Kittens are entirely dependent on the milk of queen for about 4 weeks. From this age onwards, the process of weaning or gradual replacement of queen's milk by other foods can begin.

By fifth week they begin to eat the queen's food and will start to eat finely minced or chopped moist food. By the time the kittens are 7-8 weeks old the proportion of their total nutrient intake coming from supplementary food should be at least 70-80 % and they can be finally separated from their mother and fed independently thereafter.

Kittens grow very rapidly if fed generously and will achieve adult weight of around 3.5 kg by 6 months of age. It is good to introduce different varieties of flavors while they are still growing so that they will readily accept a variety of foods as adults.

Feeding cats in pregnancy

There is no need to provide any special feeding for cats that are pregnant, if a regime of feeding to appetite with a variety of foods is being followed. The extra nutritional needs of pregnancy are small and will be adequately catered by normal prepared foods.

Feeding cats lactation

Depending on the number of kittens, this demand for food reaches 3 to 4 times her normal maintenance needs. The queen should be encouraged to increase her nutrient intake by the provision of frequent meals and by offering more concentrated foods. It is good practice to offer milk as well as water at least twice a day, to provide free access to dry or semi-moist food and to give four or more meals of canned food daily.

Ration for cats.

1. Dried milk powder	= 100 g
2. Skimmed milk power	= 300 g
3. Cream (30 % fat)	= 50 g
4. Rice gruel	= 150 g
5. Boiling water	= 400 g

Total = 1000 g

Special Feeding Characteristics of Cats

Essential Fatty Acid Nutrition

In most of the mammals, the EFA Linoleic acid can be converted into longer chain fatty acid like Arachidonic acid. Cats have only limited ability to convert linoleic acid into arachidonic acid, therefore cats required dietary source of arachidonic acid, which can be provided through animal origin sources.

NRC, recommended 1% Linoleic and 0.1% Arachidonic acid in food (On DMB)

Amino Acids

The adult cat is different to dog in that it requires a dietary source of the amino acid arginine. Arginine is required for the metabolism of nitrogenous compounds. Deficiency of Arginine may lead to hyper-ammonaemia. Since arginine is important component of urea cycle, which is required for the formation of Ornithine.

Taurine Synthesis/ Taurine :

Not an amino acid but an amino sulfonic acid and it is an end product of sulfur amino acid (Methionine and Cysteine) metabolism and produce from sulfur containing amino acids. It is present all over the body and mainly concentrated in retina and lens. Taurine is also required for the formation of bile salt. Other mammals including dogs can synthesize enough taurine from sulfur containing amino acids. In cats enzyme required for the conversion is present but activity of enzyme is low therefore cannot synthesize. Deficiency leads to degeneration retina and lens, therefore blindness. Taurine is present in high amount in animal derived raw material and little is found in plant tissues.

Conversion of B-carotene to Vit-A

All the mammals including dogs can convert B-carotene to Vit-A. Cats lacks this capacity and hence need preformed Vit.A which occurs only in foods of animal origin.

Synthesis of Niacin from tryptophan

Vitamin Niacin can be synthesized from the EAA tryptophan by most of the mammals but cats cannot. Enzymes required for conversion are present but activity of the enzyme Picolinate carboxylase is very high, which channelizes tryptophan towards glutamic acid synthesis rather than nicotinic acid.

Vit. C

Unlike man, dogs and cats can synthesized Vit.C from glucose hence not required through the diet

Daily ME intakes observed for cats

Kitten age weeks	Body weight (kg)		Kcal/kg BW	Expected BW gain g/d		Adults (50 wks of age or old)	Kcal/Kg BW
	Male	Female		Male	Female		
10	1.1	0.9	250	20	14	Inactive	70
20	2.5	1.9	130	14	11	Active	80
30	3.5	2.7	100	7	4	Gestation	100
40	4.0	3.0	80	-	-		
Lactation (kcal/kg BW)							
Litter size	1	2	3	4	5	6	
Lactation week							
1	60	76	92	108	124	124	
2	66	83	100	117	134	134	
3	72	94	116	138	160	190	
4	78	106	134	162	190	190	
5	84	117	150	183	217	250	
6	90	136	182	228	274	320	

Essential daily food allowance for cats

Cat	Weight of cat (kg)	Food intake (DM 90%, CP 25.2% and Fat 8.1%, ME 3.2 Kcal/g)	
Kitten		g/kgBW	g/cat
10 weeks	0.9-1.1	78	70-86
20 weeks	1.9-2.5	41	78-103
30 weeks	2.5-3.8	31	78-118
40 weeks	2.9-3.8	25	73-95
Adult (50 weeks of age or older)			
Inactive	2.2-4.5	22	48-90
Active	2.2-4.5	25	55-113
Gestation	2.5-4.0	31	78-124
lactation	2.2-4.0	78	172-312

Queens nursing 4-5 kittens in week 6 of lactation. Nutrient requirement of cats, revised edition, 1986

Exercise - 16

FEEDS AND FEEDING SCHEDULE OF ZOO ANIMALS- BIRDS DIET CHARTS

Carnivores

Strict carnivores are the large cats (lions, tiger and leopard etc.) and like to eat their kill prey rather than left over but in captivity conditions these animals have been adapted on the feeding of raw meat supplemented with some micro nutrients like mineral mixture and also some uncommon feeds like succulent leaves, fruits and roots. Requirement of protein taurine, arachidonic acid, niacin and vitamin A is much higher in the diets of feline than canines

Carnivores are the meat eating animals and require highly digestible and high quality food resources with nearly all the types of nutrients. The various species of this group require most of the times unique type of nutrition.

Feeding habits

- The feeding habit varies from species to species.
- Chewing bones is a preferred activity among lions, tigers and jaguars and the activity is less in panthers.
- These carnivores prefer larger pieces of meat to alleviate hunger more readily than the smaller meat pieces.
- Lions and tigers carry the beef pieces to one side of the cage before it sits for feeding.
- In lion, tiger and jaguar the posture of consumption was of extending the fore legs and holding the meat while the hind legs are tucked up within the body, whereas in panthers all the four legs tucked up within the body.
- During the act of drinking the large cats curl tongue backward and then flick it forward, rolling it up slightly into a spoon shape, as they do so and they swallow after every 4 or 5 laps.
- Tigers, Jaguars and Panthers show a preference for chicken meat when offered than beef.
- Almost all species of the carnivores like panther, lion, wild dog and tiger eat quickly in winter than in summer.
- In panther, lion and tiger, smelling and licking of the meat were noticed. Tigers and lions show a greater degree of smelling and licking than the other species.

Feeds of Carnivores includes

- Meat eating
- May consume plant material
- Captivity: Commercially prepared diets. Based on meat, meat by-products of various animals, fish meal, soybean meal, ground maize, beet pulp, minerals and vitamins.
- Requirement depends on physiological stage

Tiger (Avg. weight 200 - 230 kg)

Feed items	Quantity of food given
Beef	14-16 kg
Liver	0.2 kg
Rock salt	Always avail
Eggs	2 No.
Multivitamin Tablet	2 No.
Ca-bolus	1 No.

Lion(Avg. weight 180-200 kg)

Feed items	Quantity of food given
Beef	12-14 kg
Liver	0.2 kg
Rock salt	Always avail
Eggs	2 No.
Multivitamin Tablet	2 No.
Ca-bolus	1 No.

Cubs (Up to 9 month of age)

Feed items	Quantity of food given
Milk	½ to 1 lit.
Eggs	1-.2 Nos.
Chicken	½ to 1 kg

Hyena (Avg. weight 30-35 kg)

Feed items	Quantity of food given
Beef	4 kg
Liver	0.2 kg
Rock salt	Always avail
Multivitamin Tablet	2 No.
Ca-bolus	½ No.

Leopard (Avg. weight 60-70 kg)

Feed items	Quantity of food given
Beef	4-6 kg
Rock salt	Always avail
Eggs	1 No.
Multivitamin Tablet	1 No.
Ca-bolus	½ No.

Wolves and Jackal (Avg. weight 10-15 kg)

Feed items	Quantity of food given
Beef	2-4 kg
Liver	0.1 kg
Multivitamin Tablet	1 No.
Ca-bolus	½ No.

Crocodile and gharial (Avg. weight 100-1504 kg)

Feed items	Quantity of food given
Fish	3 kg

Snakes

Feed items	Quantity of food given
White mice or rat	1 No.

Palm Civet (Avg. weight 2-4 kg)

Feed items	Quantity of food given
Beef	150 g
Liver	50 g
Papaya+ Sweet potato + apple	150 g
Banana and Carrots	100 g
Boiled egg	1 No.

**Feeds and feeding schedule of zoo animals- Herbivores
Herbivores**

- They constitute the wide spectrum of different species of wild animals with anatomical adaptations comprising of symbiotic microbial population of bacteria, protozoa etc.
- Feed resources: Low nutritional values but are bulky in nature.
- Among herbivores: Ruminant are the most efficient ones in utilization of roughages and forages.
- Microbial fermentation is the mode of digestion in these species.

- Example: Gaur, deer, giraffe, antelopes like blackbuck, buffaloes etc.
- Pregastric fermenters: Kangaroo, wild pig, hippopotamus etc. Similarly, hind gut fermenters like rabbits, guinea pigs, capybara (caecal fermentation) and zebra and wild asses (colon fermentation) are also existing under captive conditions.
- Caecotrophs are the ones that are produced in the morning and are the soft materials that are often consumed directly from the anal region.
- Animals like rabbit and hares produce these soft faecal pellets that have high protein, fibre and water contents with increased amounts of vitamin B complex.
- Bulk eaters like elephants or rhinos have poor digestive efficiency but meet their nutritional requirements by consumption of high levels of feed intake and fast rate of food transit without digesting fibre (as the case with giant panda)

Elephant (Avg. weight 3000 -3500 kg)

Feed items	Quantity of food given (kg)
Hay	20
Rice straw	10
Lucerne grass	55
Bread	1.5
Carrots	15
Sugarcane	25
Pony pellets	5
Wheat bran	5
Oil cake	1

Rhinoceros (Avg. weight 2500 kg)

Feed items	Quantity of food given (kg)
Soaked gram	5
Maize	1
Wheat bran	10
Protein pellets/ Pony pellets	5
Sugarcane	20
Lucerne grass	30
Carrots or sweet potato	3

Hippopotamus (Avg. weight 1800 -2000 kg)

Feed items	Quantity of food given (kg)
Soaked gram	5
Maize	1
Wheat bran	10
Lucerne grass	30

Sambar, Blue bull (Avg. weight 150 and 200 kg, respectively)

Feed items	Quantity of food given (kg)
Soaked gram	0.25
Maize	0.25
Wheat bran	0.5
Oil cakes	0.1
Carrots	0.25
Lucerne grass	2
Hay	1
Cattle feed	0.5

Nilgai (Avg. weight 150 and 300 kg, respectively)

Feed items	Quantity of food given (kg)
Concentrate mixture	2
Green fodder	8-12
Dry grass	5-10
Soaked gram	1
Wheat bran	0.8
Carrot	0.5
Lucerne	2-3
Hay grass	3-8
Green grass	2-3

Four Horned Antelope (25 kg), Black buck (30 kg), spotted deer (75-90 kg), Barking deer (25-30 kg)

Feed items	Quantity of food given (kg)
Soaked gram	0.25
Maize	0.25
Wheat bran	0.5
Carrots	0.25
Lucerne grass	1
Hay	1
Cattle feed	0.25

Zebra

Feed items	Quantity of food given (kg)
Concentrate mixture	2 kg
Lucerne	3 kg
Hay	<i>Ad lib</i>

Starred tortoise

Feed items	Quantity of food given
Banana with skin and Carrots	Quantity vary according to size
Vegetables leafy	

Giraffe and Camels

Feed items	Quantity of food given (kg)
Alfalfa hay	10 kg
Pelleted concentrates	5 kg
Rolled oat mixed with carrots, potatoes, cabbage, apples, bread and banana	2.5 kg

Camels

Feed items	Quantity of food given (kg)
Tree fodder	20-25 kg
Barley crushed	2 kg
Maize crushed	2 kg
Pelleted concentrates	5 kg

Feeds and feeding schedule of zoo animals- Omnivores

Large group of wild animals belong to this in general. Most of the rodents, flying fox, sloth, bears, non-human primates, pigs many species of birds etc. belong to this group. Carbohydrates become the major nutrient received from the plants, while moderate amount of protein and fat are received from meat sources.

There is great variation in food preference, voluntary intake capacity and nutrient digestibility and requirement of the omnivore's mammals. Standard diet use by human may be considered most suitable for the non-human primates, but there is great variation in the food preference of free ranging non-human primates. Nutritional management of captive non-human primates has significantly improved during the recent years; still it is difficult job to provide good nutrition to captive primates

Diet of Giant panda

Ingredients	Quantity of food given
Boiled rice	1.6 kg
Canned feline diet	210 g
Soybean oil	15 ml
Honey	30 ml
Cottage cheese	100g
Water	1 lit.
Minerals	50g
Vitamins	20g
Mixed above ingredients in gruel along with	Carrots-430 g and apples-340 g
Sufficient amount of bamboo leaves and shoots	<i>Ad lib.</i>

Diet for red panda

Ingredients	Quantity of food given
Bamboo leaves	500g
Vegetables and fruits	100 g
Milk	500 ml
Oat powder	250 g
Wheat flour	250 g

Diet for rat and mice:

Feed items	Quantity /100 kg feed
Ground maize	31.0
Ground nut cake	15.0
Ground wheat	30.0
Wheat bran	8.5
Fish meal	8.0
Edible oil	5.0
Mineral mixture	2.0
Salt	0.5

Bears (Brown bear, black bear, Himalayan sun bear)

Feed items	Quantity of food given
Bread	3 kg
Beef	1-2 kg
Banana	6-10 Nos
Milk	1 lit.
Tomato, Sweet potato, carrots etc.	1-2 kg

Chimpanzee, Gibbon, Macaque, Langur, Old and new monkeys:

Primates in captivity: Commercially prepared diets blended with natural foods like, green vegetables, banana, apples, carrots, sweet potatoes, cabbage, eggs, tomato, honey and sunflower seeds etc. Primates spend up to 60% time in feeding. Food can be divided in 3-4 small portions and feed at different times of the day. Tree branches with leaves may also be provided

Feed items	Quantity of food given
Eggs	2 Nos.
Banana	6-12 Nos.
Milk	½ -1 lit.
Apple	½ to 1 kg
Carrot	100 -250 g
Cabbage	100-250 g
Tomato	100-250 g
Green leaves	500-2000 g

Diet chart for Birds

COMMON DIET FOR DIFFERENT CATEGORIES OF PET BIRDS

Seed eaters

- Largest and most popular cage and aviary birds are seed eaters.
- These birds live mainly on seeds, but also eat fruit, insects, egg food and green food.
- Fruit and green food contain a lot of important nutrient, but too much of these will give rise to problem such as diarrhea.
- Green feed is good during breeding season.
- During breeding season, seed eaters should be introduced with insects and worms so that they will recognize the feed and feed their young with insects and worms.
- Egg food, is an important dietary supplement for most seed eaters.
- This food has proven to be very valuable especially in the period leading up the breeding time as well as during and after the breeding time too.
- The bird's main diet should consist of its seed mix supplemented with some green food, insects, and egg food to avoid deficiency.

Fruit, vegetable, berries and weeds

- Most birds eat some form of green food. For some them it is an essential ingredient of their diet and for others it is a supplement.
- The main problem with this is contamination with dust, fumes and pesticides.
- Example of suitable fruits and vegetables are apple, pears, bananas, grapes, orange segments, mandarins, papays, dates, apricots, pineapples, carrots, tomatoes, corncobs.
- Never feed the birds avocados as these are poisonous for a lot of birds. Black berries, raspberries, rose hips and fire thorn berries and also suitable to feed them.

Insects and worms

- Not all live food is suitable for all the insect eating species of birds.
- The weaker species of insects are more suitable for small and younger birds.
- Example of suitable insects and other animal proteins for aviary birds are : crickets, grasshoppers, bugs, spiders, meal worms, buffalo worms, maggots, fruit flies, aphids, Nealy bugs, earthworms, mosquito larvae, water fleas.

DIET FOR FINCHES AND CANARIES

White millet	2 part
Red millet	1 part
Canary seed	2 part
Oat groats	1 part
Rape or thistle seed	1 part

- A good mineralized grit should always be available and cuttlebone is desirable.
- Many finches require animal protein in their diets, especially when feeding young.
- Finches enjoy green seeding grasses, such as winter grass, chickweed and most other types found in the garden.

FOR SMALL PARROTS

For small parrots (Budgerigar or Red rumped parrots)

White millet	1 part
Canary seed	2 part
Red or yellow millet	1 part
Oats groats	1 part
Wheat	1 part
Mineralized grit and shell grit, cuttlebone when available	

FOR MEDIUM PARROT

White millet	1 part
Canary seed	1 part
Oats groats	1 part
Wheat	1 part
Sunflower seed	1 part
Milo	1 part

- Green food, fruit (apple, pear, orange and whole meal bread)
- Mineralized grit and shell grit, cuttlebone when available
- Many birds enjoy chewing on the leaves and bark of native trees.
- Branches placed in the cage provide a bird with something to do and may add minerals to their diet.

FOR LARGER PARROTS

For larger parrots (cockatoos, macaws and African gray parrot)

Sunflower seed	1 part
Wheat	2 part
Milo	1 part
Oat groats	1 part
Whole or cooked corn	1 part
Peanut (raw)	1 part
Mineralized grit and shell grit	

- It is essential that these species have a wide variety of fruit, vegetables, bread and green branches of non-poisonous tree.
- Feather problem are common in larger parrots, as they are prone to boredom; this situation can be partially alleviated by something to chew on.

FOR LORIES AND LORIKEETS

- Lories and lorikeets feed on nectar and pollen
- Nectar foods are usually powders that need to be mixed with water and provided to the birds in special feeders.
- Lories and lorikeets also eat fruit.

1 cup dry baby food cereal
1 cup warm water
2 table spoon condensed milk
2 table spoon honey, raw sugar or glucose
6 drops liquid vitamins for babies

- The food should be changed twice daily.
- In a separate pan offer mixed fruit, apple, pear, grapes, papaya, soaked raisins, tomato etc.
- Seed should be available (medium parrot mix).
- These species also like to chew on bark, leaves and blossoms of most of the trees.

PIGEONS AND DOVES

- Some species of rain forest pigeons feed on fruit and must be given an appropriate diet.
- The Major of the species are seed eaters. They require variety of seeds of appropriate size and a good mineralized grit.
- Grit is especially important, because pigeons swallow their food whole and grind it in the gizzard.

For small pigeon and doves

White millet	1 part
Canary seed	1 part
Wheat	1 part
Milo	1 part
Yellow millet	1 part
Oat groats	1 part
Mineralized grit and shell grit	

For large breeds

Wheat	2 part
Milo	2 part
Pigeon peas	1 part
Whole corn	1 part
White millet	1 part
Mineralized grit and shell grit	