PRACTICAL MANUAL

APPLIED RUMINANT AND NON-RUMINANT NUTRITION

ANN (Unit – II, III and IV)

Name of student …….

Roll No. …….

Batch No. ……..

DEPARTMENT OF ANIMAL NUTRITION

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FOREWORD

I am very happy to see the practical manual of Applied Animal Nutrition (Ruminant and Non-Ruminant, Poultry and Laboratory Animals) prepared by Dr. G. N. Mathur, Professor and Dr. Vijay Prakash Saini, Associate Professor (Dept. of Animal Nutrition) Mahatma Jyotiba Fule College of Veterinary & Animal Sciences, Chomu, Jaipur. This manual is well prepared with point wise comparative information on the important practical aspects of ruminant and non-ruminant nutrition in the course which is offered in the 2nd year of B. V. Sc. & A. H. degree programme. The exhaustive text has been concisely presented in a quite lucid form.

The manual written by the authors is a good attempt which is based on their knowledge and experience of teaching undergraduate courses. The language used in the manual is simple and the outline and description of practical exercises have been nicely presented which will be very useful to the students, teachers and also the practitioners of veterinary science who need to know well with wildlife practices.

I congratulate the authors for their efforts put in bringing out this practical manual in student friendly language with covering all important information required.

Dean
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PREFACE

The Veterinary Council of India has laid down a policy and guidelines for uniform education in veterinary colleges all over the country. Accordingly, it has drafted a common syllabus, course curriculum for administering the instructional material in each course of B.V.Sc. & A.H. programme. Alongside that, the council has put special emphasis on practical-oriented training.

The course curriculum about nutrition of non-ruminants, poultry and lab has been revised and separated recently. Therefore it was felt necessary to prepare practical manual covering the course of discipline *viz.* Applied Animal Nutrition (Ruminant and Non-Ruminant, Poultry and Laboratory Animals) offered in the 2nd year of B. V. Sc. & A. H. the manual is prepared in such a way that the students can understand the complex subject in a very simple way. This manual is covering all the topics included in the revised syllabus. It is hoped that the manual will help motivate the habit of studying the course from text books.

The author would like to thank Dr. R. K. Chandolia, Dean, Mahatma Jyotiba Fule College of Veterinary and Animal Science, Chomu,(Jaipur) for providing his constant inspiration and encouragement in developing this manual.

Authors

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 Jyotiba Fule College of Veterinary & Animal Sciences Chomu, Jaipur, studying in the Second Year B.V.Sc. and A.H. degree course no. ANN (Unit – II, III and IV) during the academic session 2025-26.

Date:

Signature of course teacher
(Assistant Professor)

Signature of Head of Department

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Exercise-1

Calculation of nutritive value of different feed stuffs in terms of DCP, TDN, NR and SE

Principle: The quality of feed and fodder are based on the presence of nutrients and their nutritional worth in terms of digestible crude protein (DCP), total digestible nutrients (TDN), nutritive ratio (NR) and starch equivalent (SE).

Objective:

1. To evaluate nutritional value of feed and fodder.
2. The value to be used for formulation of ration for various categories of animal performing different type of work.

Procedure:

In general the most common practice of evaluation of food nutrients is firstly find out the digestive coefficient through digestion trials in terms of protein (DCP) and energy (TDN, SE).

Calculation of digestible nutrients:

$$\%\text{Digestible Nutrient} = \frac{\%\text{ nutrient in feed x }\%\text{ digestibility coefficient of nutrient}}{100}$$

$$\%\text{DCP} = \frac{\%\text{ CP in feed x }\%\text{ digestibility coefficient of CP}}{100}$$

$$\%\text{DCF} = \frac{\%\text{ CF in feed x }\%\text{ digestibility coefficient of CF}}{100}$$

$$\%\text{DEE} = \frac{\%\text{ EE in feed x }\%\text{ digestibility coefficient of EE}}{100}$$

$$\%\text{DNFE} = \frac{\%\text{ NFE in feed x }\%\text{ digestibility coefficient of NFE}}{100}$$

Calculation of Total Digestible Nutrient (TDN):

TDN = %DCP + %DCF + %DNFE + (%DEE × 2.25)

Digestible fat is multiplied by the factor 2.25 because of its higher energy value than carbohydrate and protein.

Calculation of Nutritive Ratio (NR):

It is the ratio of digestible protein to the sum of digestible carbohydrate and fat, the later being multiplied by 2.25.

$$\text{Nutritive ratio} = \frac{\text{DCF} + \text{DNFE} + \text{DEE} \times 2.25}{\text{DCP}}$$

$$\text{Nutritive ratio} = \frac{\text{TDN} - \text{DCP}}{\text{DCP}}$$

Calculation of Starch Equivalent (SE):

Starch equivalent of a feed means that the amount of feed require to produce as much animal fat as is being produced by a unit of starch when fed in addition to maintenance. Fat producing power of each of digestible nutrient is calculated by using appropriate factors and upon addition the total producing power *i.e*. starch equivalent is known. Fat producing power of each nutrient as given by Kellner's is as follows.

% SE = %DCP × 0.94 + %DCF × 1 + %DNFE × 1 + %DEE × (1.90 to 2.40)

Nutrient	**Kellner's value (SE factor)**
Digestible protein	0.94
Fat from roughages	1.90
Fat from cereal grains	2.10
Fat from oil cakes	2.40
Digestible carbohydrate and fibre	1

When Kellner tested feedstuffs instead of pure nutrients, he found that fat producing power was less than calculated from their content of digestible nutrients therefore Kellner instituted two types of correction factors:

1. Correction factor for concentrates (The value number): The digestible nutrients are multiplied by number ranges from 95 to 100.

   Corrected SE = Calculated SE x Value number/100

2. The fibre correction for roughages:- Following correction factors are deducted from digestible nutrients for every 1% CF present in the original feed.

Feed stuff	**Correction factor**
Dry roughages unchopped	0.58
Dry roughages chopped	0.29
Green roughages with 4 to 16% CF	0.29-0.58

Exercise-2

Calculation of nutritive value of different feed stuffs in terms of DCP, TDN, NR and SE

Q. Calculate the DCP, TDN, NR and SE from following observations.

Chemical composition of green maize		Digestible coefficient
Nutrient	%	%
CP	1.5	82.22
CF	8.0	58.33
EE	0.5	53.33
NFE	13.0	59.00

(Fibre correction factor= 0.34)

Exercise-3

Calculation of nutritive value of different feed stuffs in terms of DCP, TDN, NR and SE

Q. Calculate the DCP, TDN, NR and SE from following observations.

Nutrient	% composition of feed	% composition of faeces
DM	87.0	27.0
CP	6.9	4.2
EE	1.9	0.9
CF	19.8	16.8
NFE	59.4	38.0
Feed Intake- 11 kg	Faeces voided- 13 kg	

(Fibre correction factor= 0.58)

Exercise-4

Calculation of nutritive value of different feed stuffs in terms of DCP, TDN, NR and SE

Q. Calculate the DCP, TDN, NR and SE from following observations.

Nutrient	% composition of feed	% composition of faeces
DM	90.0	25.0
CP	10.0	5.8
EE	2.5	1.5
CF	19.0	15.7
NFE	61.2	70.51
Feed Intake- 10 kg	Faeces voided- 13 kg	

(Fibre correction factor= 0.34)

Excerxise-5

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 increases 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 Metabolizable energy:

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

1 kg TDN = 4.4 Mcal DE

1 kg TDN = 3.6 Mcal ME

Calculation of nutrient requirement based on metabolic body weight:

DCP = 2.84 g/ $w^{0.75}$ kg b. wt.

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

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

Exercise-6

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.

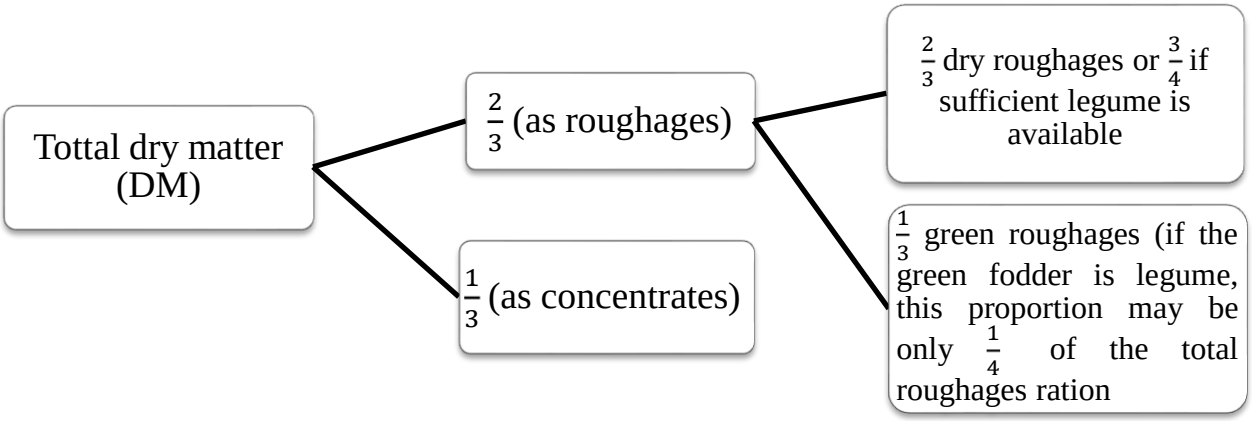
Steps for ration formulation:

Step 1: To determine the total dry matter requirement-

The DM requirement of an animal depends on its body weight and it's 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 and 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 Normal 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-7

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-8

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 3.0 kg 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:
Example 1:

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

Example 2:

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

Nutrients requirement 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

Nutrients 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-9

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 water shortage 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 feed blocks 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	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):

NDDB 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-10

Nutrient requirement for poultry birds

Table: Nutrients requirement for birds

	Duck	Pheasants	Turkey	Quail	Geese
ME Kcal/kg	2900	2800	3200	3000	2900
Protein%	15-22	Starter = 30 Other = 16-18	Starter = 20 Other = 12-20	20	15-22
Lysine%	0.7-1	1-1.5	0.5-1.5	1.15	0.6-0.9
Methionine + Cystine%	0.5-0.8	1.1	0.5-1	0.76	0.75

Nutrient requirement for poultry, NRC, USA, 1991

CALORIE:PROTEIN RATIO

There is a close association between the numbers of calories of metabolisable energy in the ration and the percent of protein necessary to balance the energy. The calorie/protein ratio is defined as the metabolisable energy kcal energy per kilogram divided by the percentage of crude protein in the ration. The ratio varies with the age of the bird.

A ratio of energy to protein exerts an influence on feed intake and feed efficiency. The calorie/protein ratio influences over consumption of feed and body composition. Broiler starter rations having a calorie/protein ratio of 135 and a finisher ration with a calorie/protein ratio of 155 gives best results. If the calorie/protein ratio is wide, problem of feathering may be noticed. There are also inter-relationship of energy with other nutrients. High energy rations need to have increased concentration of nutrients to avoid nutrient deficiencies since feed intake will be low on much diets. Similarly on low energy diets the nutrients density may be diluted because of higher intake of feed on such diet.

Suggested calorie : protein ratio (Kcal ME/protein%) in poultry rations

Broiler starter (0-5 weeks)	132-142
Broiler finisher (after 5 weeks)	152-165
Chick starter (0-8 weeks)	140-145
Chick grower (8-18 weeks)	170-190
Layer 70% production	185-190
Layer 90% production	175-183

Energy requirement of chicken

Experimental studies have shown that the metabolizable energy (ME) requirements are approximately 18% higher than the net energy (NE) requirements. This due to the specific dynamic action of nutrients; consumption of protein causes about 30% increase in heat production while consumption of carbohydrate 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 NE_m requirements are approximately 82%of the ME_m requirements. Since the chicken has a higher body temperature than mammals, its energy expenditure for maintenance is greater.

1. **Energy requirement for maintenance**

The basal metabolism studies indicate that the
NE_m requirement of adult he = 83 X BW $kg^{0.75}$ Kcal/day
e.g. NE_m requirement of 1.75 kg adult hen = 83 X $1.75^{0.75}$
= 83 X 1.52 = 126 kcal/day
ME_m requirement = 126 X100/82 = 154 kcal/day
Activity allowance is 50% of the energy for hens kept in deep litter needed for basal metabolism and 37% for caged hens.
Therefore, total ME requirement for non-laying hens = 154+57 = 211 kcal/day
The energy content of large egg = 86 kcal
Then the total ME requirement of laying hen (White leghorn with 100% production at 21˚C) = 86+211 = 297 kcal/day.

2. **Energy for growth**

The energy requirement 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 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 hormons secretions, particularly growth hormone, thyroxin and the sex hormones.\

Calculation of energy requirement of broilers:

Age	: 25 weeks
Weight of broiler breeder	: 2.5 kg
NE_m	: 83 X 1.99 =165 kcal/day
ME_m	: 165 X 100/82 = 201 kcal/day
Activity	: 50% of the ME = 101 kcal/day
ME_m + Activity	: 302 kcal/day
ME_m egg	: 86 kcal X 0.85 = 73 kcal/day

These pullets are still growing and body gain is approximately 500 g over 10 weeks 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 fat X 9.0 kcal =	9.45
	14.60 Kcal

Total ME required = $ME_m + ME_{activity} + ME_{egg} + ME_{gain}$
= 201 + 101 + 73 + 15
= 390 kcal/day/hen

Protein requirement of chickens

1. The protein requirement of growing chicken may be calculated as follows: growing 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
   = 1600 mg Protein/kg BW/day

b. Tissue growth (Tissue contains 18% protein)
daily gain in g X 0.18.

c. Feather growth. Feathers contain 82% protein and feather comprise 7% body weight at 4 weeks of age.
Daily protein requirement for a growing chicken = [(BW in g X 1.6/1000) + daily gain in g X 0.18) + (daily gain in g X 0.07 X 0.82)] ÷ % efficiency of protein utilization.

2. Calculation of protein requirement for egg production:
Maintenance requirement of W.L.H. 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%
Therefore, the protein requirement of the hen $9 \times \frac{100}{55}$ = = 16.36 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 per day, then the protein content of the diet should be 16.4%.

Broilers

The growth of meat birds depends upon the level of a balanced protein in their diet along with other nutrients. In absence of other nutrients.in absence of optimum level of protein and amino acids, the growth is retarded and birds may need a longer time to reach the marketable weight. Higher protein diets are fed during the first two weeks as pre-starter phase. Growing broilers strains of chicken are approximately 67% efficient in the retention of dietary protein. Feeding of the high protein pre-starter diets is beneficial since it gives a stimulus for the early growth of the broilers and it does not cost much because of very small feed intake during the first two weeks.

Enhancement of energy level of the diet in the finishing stage, accompanied with a decrease in broiler chicken to consume more calories than it can use for growth. This excess energy will be converted into body fat, thereby producing the desired body finish for the market broiler.

Minerals and vitamins

The minerals and vitamins that are critical in practical diets are mentioned here in alphabetical sequence, sodium and zinc; vitamins are choline, folic acid, pantothenic acid, pyridoxine, riboflavin, vitamin A, vitamin D_3 and vitamin E.

Questions:

1. **What are the peculiarities of feeding of layers?**
2. **Write the energy and crude protein requirements for different categories of poultry.**
3. **Formulate ration for broiler (starter) having 24% CP and 2900 Kcal ME/kg using following ingredients maize, barley, groundnut cake and fixed ingredients are fish meal 10%, premix 3%.**
4. **Formulate ration for layer (starter) having 22% CP and 2700 Kcal ME/kg using following ingredients maize, barley, groundnut cake and fixed ingredients are fish meal 10%, premix 3%.**
5. **What are important feed additives for poultry?**

Exercise-11

Formulation of ration for poultry

Objective:

1. To formulate proper concentrate ration for chicks, broilers, layers in view of appropriate calcium and protein ration.
2. Scientific approach for feeding of poultry.
3. To make economic use of locally available feed resources.

Introduction:

Birds have requirements like livestock for water, minerals, proteins, carbohydrates, fat and vitamins. The amount of water needed increases with increasing environmental temperature and content of ingestible organic matter in the diet and with adult in laying birds is greater than in non-layers. Water should be freely available at all time. Nutrient requirement and nutrient composition tables serves as guides are used to formulate nutritionally adequate and economically practical diets. These diets fed at recommended level, will allow optimum growth and production. Feed ingredients are selected on the basis of availability, price and quality of nutrients they contain. A large number of agricultural and industrial by products are available which may not contain optimum concentration of nutrients or many contain some deleterious factors, but they are to be included in livestock feeds to economize livestock production.

Following steps to be considered for formulation of poultry diets:

1. Poultry need cereal grains and less fibrous feeds as major component of the diet. Cheaper agro industrial by product as potential replacer of cereal grains and traditional protein byproducts should be used in economic poultry diets.
2. Maize is the conventional cereal which has been used to provide energy. The other energy sources which can replace maize partly/completely are sorghum, bajara, barley, oats, wheat bran, rice polish, DORB, molasses, damaged grains (low in uric acid and free from aflatoxins), maize germ, tapioca meal, hominy feed, triticale and salseed meal. Hominy damaged wheat can safely replace 50% of maize.
3. Vegetable protein feeds are oil cakes/meals of groundnut, till, mustard, cotton seed, linseed, rapeseed, soybean, sunflower and safflower and maize gluten meal, pea waste, fermentation products (yeast, sludge), guar meal, toasted guar meal etc.
4. Groundnut cake can be replaced on weight by weight basis with mustard cake (10%), toasted guar meal (10% in broiler and 15% in layer mash), till (sesame) cake (15%), cotton seed cake (8%), maize gluten meal (5%), and sunflower cake (8%), when used alone. Certain proteinous by products can also be used in combinations.
5. Animal protein feeds are fish meal, meat meal, blood meal, silk worm pupae meal, hatchery byproduct meal; cattle dung waste, meat and bone meal etc.
6. Mineral feed stuffs are bone meal, marble chips, limestone, snail shells, oyster shells, common salt, mineral mixture etc.

7. Green feeds may be berseem or Lucerne leaf meal. Dried leaf meal can save 2.5% of mash. Green leaves and dried leaf meal act as source of xanthophylls in the mashes for egg yolk colour specially in maize free diet.
8. Now-a-days ready to mix concentrate mixture are also available from the market which could be mixed with locally available grains to acquire the required ration following the manufacturer's direction. In general a months requirement of feed should be compounded in order to avoided rancidity problems.

Table 1: Maximum level of inclusion of feed ingredients in poultry diets:

Ingredients	**Max. level of inclusion (%)**
Maize	60
Wheat	50
Barley	20-40
Oats	10-20
Sorghum (dark variety)	10-20
Sorghum (white variety)	25-40
Pearl millet	50
Rice	40
Rice bran	10-20
De oiled rice bran	10-15
Wheat bran	10-15
Maize bran	10
Salseed meal	3-5
Molasses	5-10
Vegetable and animal fat	10
Poultry manure meal	10
Tapioca flour	10-20
Gram churi	10-15
Apple pomace	10
Leaf meals:	
Alfalfa meal	5
Groundnut meal	5
Mulberry	3
Protein source:	
Groundnut cake	40
Soybean meal	20
Sesame meal	20
Safflower meal	20
Sunflower meal	20
Linseed meal	4
Coconut meal	5
Mustard meal	10
Maize gluten meal	5
Fish meal	10
Fish scrap	5

Meat meal	10
Meat and bone meal	5
Blood meal	3
Poultry byproduct meal	5
Silk worm pupae meal	6
Feather meal	2
Skimmed milk meal	3
Fermentation byproducts:2	
Distillers yeast (dried)	5
Yeast sludge (dried)	10

Broiler: The broiler is required to be slaughter at an early age. Thus, the growth rate attained by broiler is higher than other categories of poultry and these birds are to be provided nutrients in a concentrated form. The requirement of protein and energy are higher, the ratio of these nutrients is lower in case of broiler.

Layer: The usual goal in the feeding of laying hens is to obtain the maximum production of egg of large size and internal and external quality with a least cost feed formulation.

Breeder: The nutrient requirement of breeder population are not greatly different from those od commercial layer, generally they require high levels of vitamins and minerals to ensure that the egg is sufficiently enriched in these nutrients to support optimal development and hatchability of the chick.

Table 2: Nutrient content of diets for broiler, layer and breeder poultry (ICAR 2013)

Nutrients	**Broiler feed**		**Layer feed**			**Breeder feed**
	Starter	**Finisher**	**Starter**	**Grower**	**Layer**	**Male**
ME (Kcal/Kg feed)	2,800	2,650	2,600	2,600	2,600	2750
CP%	20	16	18.5	15.5	20	14
Linoleic acid%	1	0.8	1	0.8	1.10	1
Calcium%	1	1	1	0.8	3.80	
Sodium%	0.17	0.17	0.15	0.15	0.17	0.15
Mn (mg/kg)	100	120	50	40	50	120
Iron (mg/kg)	80	80	60	60	55	80
Cu (mg/kg)	20	20	8.0	5.0	5.0	20
Zn (mg/kg)	100	100	40	35	50	100
Iodine (mg/kg)	2.0	3	0.35	0.35	0.040	2.5
Vitamin (per kg)						
Vitamin A (IU)	12,000	20,000	3,000	2,500	5,000	12,000
Vitamin D_3 (ICU)	3,000	4,500	300	250	500	2,000
Vitamin E (mg)	80	100	10	10	15	200
Thiamine (mg)	4	5	1	1	0.85	4.4
Riboflavin (mg)	20	20	3.6	1.8	3.5	20
Nicotinic acid (mg)	60	80	25	11	12	60
Vitamin B_5 (mg)	30	30	10	10	2.5	25
Pyridoxine (mg)	5	8	3	3	3.5	6
Biotin (mg)	0.25	0.30	0.15	0.10	0.12	0.25
Folic acid (mg)	4	4	0.55	0.25	0.30	4
Vitamin B_{12}	0.03	0.03	0.009	0.003	0.004	0.03
Choline (mg)	1,200	1,200	1,300	900	1,200	1,200

Table 3: General guidelines for inclusion of the different categories of feed ingredients in poultry ration.

S. No.	Class of feed	Layer			Broiler	
		Starter	Grower	Layer	Starter	Finisher
1.	Protein supplement					
	a. Animal protein	8	6	7	8	8
	b. Vegetable protein	30.5	16.5	20	32.5	27.5
2.	Energy feeds					
	a. High energy	49	53	57	55	59
	b. Low energy	10	22	10	-	-
	c. Animal fat	-	-	-	-	-
3.	Mineral mixture	2.5				
4.	Premix cotaining	-	-	-	-	-
	Vitamins & other feed					
	Additives					

***In layer additional 3% shell grit or lime stone is added**

***Quantity will differ according to category**

Note:

1. As animal protein supplement mainly fish meal is used but half of it can be replaced by meat meal, liver meal or silk worm pupae meal.
2. As vegetable protein supplement mainly groundnut cake is used but an amount of it can be replaced by till cake or soyabean cake and combination of other oil cakes and by-products etc.
3. As high energy feed mainly maize is used but an amount can be replaced by other cereals like jowar, bajara, damaged/broken rice and other by-products like rice polish and hominy feeds etc.
4. As low energy feeds mainly wheat bran, de-oiled rice bran, barley oats, molasses are used.
5. As animal fat source mainly tallow, lard of any edible oil (except rape seed) can be used.
6. Any commercial cameral mixture can be used as mineral source.
7. Premix should contain vitamin supplement (Rovimix or vitablend @ 25g/100 kg), cocciodiostat dose, mixed thoroughly in bran or ground cereal.

Table 4: Some representative feed mixes

S. No.	Nutrient	Broiler starter feed	Broiler finisher feed	Layer chick feed	Layer grower feed	Layer feed
1.	Maize	50	55	40	40	53.5
2.	Groundnut cake	30	25	5	5	20
3.	Deoiled rice bran	-	5	12	12	5
4.	Wheat bran	10	6	10	10	6
5.	Fish meal	8	6.5	6	6	5
6.	Lucerne meal	-	-	-	-	3
7.	Mineral mix.	2	2.5	2.0	2.0	2.5

8.	Vitamin mix.	0.02	0.01	0.01	0.02	0.01
9.	DL methionine	0.10	-	-	-	-
10	L-lysine HCL	0.15	-	-	-	-
11.	Coccidiostat	0.05	-	-	-	-
12.	Shell grit	0	-	-	-	-

Example of ration for Quail

Ingredients	**% inclusion**
Ground corn	40.0
Soybean	19.25
Sorghum	20.0
Corn gluten meal	10.0
Wheat bran	2.0
Calcium carbonate	6.25
Ca HPO_4	1.8
Vit. Trace mineral mix.	1.0
Salt	0.5
Lysine	0.1
Methionine	0.04

Example of ration for Pheasant

Ingredients	**Amount in diet (g/kg)**
Ground corn	324.14
Wheat soft	2340.6
Brewers grain	222.48
Meat meal	100.00
Vitamin premix	100.00
Salt	5.00
Methionine	1.43
Calcium carbonate	1.43
Ca HPO_4	0.65
Lysine	0.61
Mn SO_4	0.10
ZnO	0.10

Example of ration for Ducks

Ingredients	**Amount in diet (Kg/100 Kg)**
Maize	33.69
Rice polish	40.00
Wheat bran	10.00
Sunflower cake	5.00
Mustard cake	5.00
Fish meal	5.00
Bone meal	0.70

Salt	0.20
Limestone	0.30
Mineral & Vitamin mix	0.11

Exercise-12

Formulation of ration for swine

Objectives:

1. To prepare the concentrate ration for grower, finisher and adult swine.
2. For scientific approach for practical feeding of swine.

Introduction:

Feed cost represent about 70-75% of total cost of production of pigs. Therefore feeding programme should be efficient and carefully planned. Pig grows faster than any other farm animals. They are usually slaughtered while still in active growth at about 80-90 kg body weights which is achieved in six months. Pig have a simple digestive tract. Pigs are prefer coarsely ground material instead of fine mixture. The commonly used feeds are oats, maize, barely, fishmeal, groundnut cake, skim milk, meat meal, and molasses. Swine tend to eat to meet energy needs. There are four types of ration fed to pigs. These are:

1. Creep ration (during suckling period is from birth to 15 kg live weight).
2. Starter (5-15 kg).
3. Grower (15-45 kg) and
4. Finisher ration (between 45-90 kg).

The nutrient requirements for swine during various stages of life cycle are given in table 1. (ICAR, 2013).

Table 1: Nutrient content of diets for growing and finishing pigs

Feed unit	Live weight (Kg)					
	5-10	10-20	20-30	30-40	40-50	50-60
CP%						
TDN%						
DE (Kcal/kg)						
Ca %						
P %						
Common salt (%)						

Growing and finishing pigs:

The feed intake by the growing and finishing pigs mainly depends on the energy content to the ration. If the pigs are fed according to the requirements shown in table 1, they are expected to gain at a rate of 180, 350, 400, 490, 520 and 540 g, respectively during the body weight changes of 5-10, 10-20, 20-30, 30-40, 40-50, 50-60 kg on feed intake level of 0.25, 1.05, 1.30, 1.80, 2.10 and 2.40 kg per day.

Breeding pigs:

Breeding pigs can successfully be maintained on diets prescribed for finishing pigs in body weight range of 40 kg and above when fed at the rate of 2% of body weight, lactating sows should be fed at the rate of 3% of body weight and gestating sows and gilts should be fed at the rate of 1.5 and 2% of their body weight, respectively.

Ration formulae for different kinds of pigs:

Pre-starter ration:

Rations offered to piglets from second week of life up to weaning having high protein and energy content is pre-starter ration. Suckling piglets under intensive management are prone to anaemia in early life due to deficient supply of iron in dam's milk, thus iron preparations are injected during the first and third weeks of life.

Piglets learn to eat in 2-3 days period. Their voluntary intakes depends on the milk production of dam and palatability of ration.

Table 2: composition of pre-starter

	Per cent content in ration		
Constituents	I	II	III
Maize	40	30	20
Barley / Jowar flour	-	10	20
Skim milk powder	10	10	10
Fish meal	6	6	6
Groundnut cake	30	30	30
Molasses	10	10	10
Brewer's yeast	2	2	2
Mineral mixture	1.5	1.5	1.5
Common salt	0.5	0.5	0.5
Vitamin premix	10g	10g	10g

Starter ration:

The ration offered to piglets from the day of weaning to about 20 kg body weight or 3-4 weeks period is almost similar to the pre-starter ration except that the skim milk powder is replaced by either fish meal or meat meal.

Grower ration:

The ration fed to growing piglets from 20 kg body weight to 35 kg body weight of exotic pigs are called grower ration. The cereals grains can be replaced with grain processing by products and several agro-industrial waste materials.

Table 3: composition of pre-starter

	Per cent content in ration		
Constituents	I	II	III
Crushed maize	60	40	20
Jowar	-	10	20

Minor millets	-	10	-
Groundnut cake	20	20	20
Wheat bran	10	10	15
DORB	-	-	15
Fish meal/meat meal	8	8	8
Mineral mixture	1.5	1.5	1.5
Common salt	0.5	0.5	0.5
Vitamin premix	10g	10g	10g

Finisher ration:

The ration fed to fattening pigs from 35 kg live body weight to slaughtering at 70-90 kg body weight are known as finisher ration.

Table 4: Composition of finisher ration

	Per cent content in ration		
Constituents	I	II	III
Crushed maize	50	30	20
Jowar/Bajra/Ragi	-	20	20
Wheat bran	18	18	28
Groundnut cake	15	15	15
Fish meal/meat meal	5	5	5
Molasses	10	10	10
Mineral mixture	1.5	1.5	1.5
Common salt	0.5	0.5	0.5
Vitamin premix	10g	10g	10g

Feeding of pregnant and lactating sows:

Pregnant sows should be fed about 2 kg mixed feed daily supplying about 300 g protein and 6600 Kcal DE. The lactating sows are fed a similar ration at rate o3-4 kg daily depending upon the body size. In addition to this, piglet allowance is offered at the rate of 200 g per piglet during 6-8 weeks of lactation period. The ration is drastically reduced to 2 kg daily during the last week of weaning period for the drying sows.

Questions:

1. **What is creep ration?**
2. **Prepare a finishing pig ration containing 16% CP, DE=3000 Kcal using following ingredients maize, sorghum, wheat bran, ground nut cake, molasses 10%, mineral mixture 1.5%, salt 0.5%, vitamin mixture 10g.**

3. **Prepare a pre-starter ration containing 18% CP, 3100 Kcal DE using using following ingredients maize, skim milk (10%), groundnut cake, barley, molasses (100%), brewer's yeast (2%), mineral mixture 1.5% common salt 0.5%, vitamin premix 10g.**
4. **Write the nutrient requirement of different kinds of pigs.**

Exercise-13

Principles of compounding and mixing of feeds

Objectives:

1. To use various types of feed for efficient use of feed
2. To avoid wastage of feeds
3. To produce readymade feed

Introduction:

Mixing of various feed ingredients in single compound feed or in the form of balanced ration in homogenous mass and packaging of that is collectively called compounding and mixing of feeds. There are mainly two principles-

1. The nutrients should be evenly disturbuted in the compound feed. It means that the smallest amount (10g) must contain the level of energy, protein, all vitamins and minerals for which the lot of feed has been manufactured. This can be achieved by proper selection of ingredients and proper mixing.
2. The amount of different feed ingredients and additives prescribed to be mixed should be convenient to the personnel working in the mill. In other terms, prescribed material should be in multiple of 5 or 10 weights. It is more easy, if it is done as standard bags.

Premixing:

The prescribed vitamins and other feed additives are in very small amount i.e. 40-60 g/100 kg feed. For their proper mixing and distribution, premix is formed. Stepwise increase in their amount is made by adding extender taken from grounded feed material to be mixed. When it reaches to a satisfactory level, say 5 kg and then it is mixed with whole lot.

Mixing of liquids:

Mainly there are two liquid which find it place in animal feeds. One is molasses which is economically available but creates problem by formation of lumps. A good absorber has to be selected for its use and then mixing as such or after seasoning. Hominy feed, oat meal and wheat bran serves as good absorbers for molasses. Now, technology is available for spraying of molasses in the process of mixing. Another liquid is edible oil or animal fat used to enhance energy content of mixed feed. The problem is acute when more than 5% added fat diet has to be fat pelleted. This can be overcome by spraying of more than half of added fat on hot plates. This prevents the crumbling of pellets.

Types of feed mixers:

Mainly 2 types of mixers are used in feed industry

1. Batch mixers
2. Continuous flow mixers

1. Batch mixers: It can be either vertical or horizontal

a. Vertical mixer: These are cylindrical shape with an inverted cone shaped bottom. There is a shaft/rod, vertically fitted, having screw type structure. There is one or more auger

that rotates to moves ingredients from bottom to the top of the mixers and mixing remains continue and ingredients falls due to gravity force. A uniform mixture of all ingredients is attained within 15-20 minutes.

b. Horizontal mixers: these are 'U' shaped paddles or ribbon like blades attached to a horizontal revolving shaft, direction is horizontally, has only one auger but may 2 or more depending upon capacity of mixer. They may be of two types- right or left handed can rotate right/left ride. Ingredients move from one end to other in circular motion and are mixed thoroughly & at other and mixed material is discharged. Blowers can be fitted to take out ingredients easily or air can be blown. Horizontal mixer can accommodate mixtures of chopped hay, silage, grains, molasses & other ingredients differing in particle size, density & texture. Mixing time is 2-15 minutes.

Advantages:

i. Have shot cycle w.r.t vertical mixer.
ii. Used at large scale feed miles.
iii. Liquids ingredients (fat, molasses) can be added easily in large amount (>5%) while in vertical mixer in small quantity (up to 4-5%).

2. Continuous flow mixers:

All the ingredients are continuously mixed in the proper ratio to produce the desired diet. These are not very different from horizontal mixers, here 2 or more shafts are used on which there are paddles & moves continuously & blend the feed ingredients into desired composition. A proper calibration is essential. The system is once calibrated can be operated automatically without direct intervention.

Advantages: In the mixers more liquid ingredients can be added, mixed properly. Speed of shaft is very high**.**

Disadvantages:

- For changing in feed, less flexibility is present compared to batch mixers.
- Most bulky ingredients such as hay & silage can not be used.
- Besides these, there are other operations takes places.

Receiving and conveyors system: Different mechanical equipments, conveyors are used to move feed material from one place to other.

Exercise-14

Ration formulation for equine with conventional and unconventional feed ingredients

To formulate a ration for horse, following steps should be followed:

1. Determine the class of horse.
2. List the nutrient concentrations needed in the ration for class of horse.
3. List the feeds which are available or which you wish to use in the ration.
4. From the digestible energy composition of the forage to be used in the ration, decide the percentage of forage and grain mix to be used.
5. Calculate the amounts of nutrients which will be provided by the forage and subtract these from the total requirements. The remaining nutrients must be provided by the grain mix.
6. Calculate the amount of concentrate feeds (grains, soybean meal, etc.) needed to provided the remaining nutrients in the following order: A. Digestible energy; B. Crude protein; C. Calcium; D. Phosphorus; and E. Vitamin A.

Horse are naturally trickle feeding herbivores and therefor ration must be based on forage for mature horses, Ideally; horses should consume a minimum of 1.0% of the body weight as forage each day and, as a general rule, forage should comprise at least 50% of the total weight of daily feed. Concentrates, fat, supplemental protein, vitamins and minerals, are important, but should make up a much smaller portion of the ration and only when required. Here we will assess energy, protein, lysine (an important essential amino acids) Ca and P requirements for two different types of horse.

Step 1 – Assessment of body weight

The horse's body weight may also be calculated from the following formula which use the horse's heart girth measurement and length as measured with a tape measure from point of shoulder to point of buttock.

$$\text{Body weight (kg)} = \frac{\text{Heart girth(cm) X Length (cm)}}{11.880}$$

For foals up to 6 weeks of age use the following

$$\text{Body weight (kg)} = \frac{\text{Heart girth(cm)} - 63.70}{0.38}$$

Once the body weight is ascertained, the total dry matter intake per day may be calculated.

Step 2 – Calculation of dry matter intake

It will depended upon the work level and condition of the horses. As a general rule need from 1.5% to 2.5% of body weight per day depending upon the individual needs. Horses in hard work or lactating mares will need 2.5% of body weight per day whereas a very overweight horse or pony may to minimum of 1.5% per day. For horses at maintenance or in light work, 2% BW should be used.

If BW of Horse is 550 kg:

According to 2.0% dry matter requirement = $\frac{2.0 \text{ X } 550}{100}$ = 11 kg DM/day

- DM intake for foals up to 6 months is about 0.5-0.75% BW while nursing
- DM intake for weaning is up to 3.5% BW per day.

Step 3 - Forage to concentrate ration

Mature horses should be fed a minimum of 1% BW or 50% of the total ration as forage, whichever is the greater. This includes pasture hay or haylage and any chaff products or other forage. Foals and yearlings may need more concentrate rations are given in Table.

Category	Forage	Concentrate
Maintenance / light work	80-100	0-20
Medium work	60	40
Hard work	50	50
Pregnant mare last 3 months	70	30
Lactating mare	50	50
Foal nursing	30	70
Weanling	50	50
Yearling	60	40

eg. Light work horse would therefore be given 80% forage and 20% concentrates

0.8 X 11 = 8.8 kg forage DM/day

0.2 X 11 = 2.2 kg concentrates DM/day

Some horses at maintenance or in light work on good quality pasture and hay/haylage might meet all their energy and protein needs without the need for extra concentrate feeds supplying further energy and protein. However, a pasture balancer or

broad spectrum vitamin and mineral supplement may still be required particularly in the winter months to make up any micronutrient deficiencies in the pasture.

Step 4 – Energy calculations (NRC-1989)

Energy requirements are given as Mcal DE or MJ per day (mega-calories or mega-joules digestible energy).

A. Maintenance : 200-600 kg body weight DE = 1.4 + 0.03 W

Greater than 600 kg of BW; DE = 1.82+0.0383 BW – 0.000015 BW^2

B. Stallions (breeding season): DE = 1.25 (maintenance DE)

C. Pregnant mares: 9 months DE = 1.11 (maintenance DE)

10 months DE = 1.13 (maintenance DE)

11 months DE = 1.20 (maintenance DE)

D. Lactating mares

1. **Foaling to 3 months:**

   200-299 kg of BW; DE = (maintenance DE) + 0.04 BW X 0.792)

   300-600 kg of BW; DE = (maintenance DE) + 0.03 BW X 0.792)

2. **3 months to weaning**:

   200-299 kg of BW; DE = (maintenance DE) + 0.03 BW X 0.792)

   300-600 kg of BW; DE = (maintenance DE) + 0.02 BW X 0.792)

E. Working horses

Light work	DE = 1.25 (maintenance DE)
Moderate work	DE = 1.50 (maintenance DE)
Heavy work	DE = 200 (maintenance DE)

Step 5 – Crude protein calculations

A. Maintenance : CP = (40) (Mcal of DE/day)

B. **Stallion:** CP = (40) (Mcal of DE/day)

C. **Pregnant mares,** 9-11 months: CP = (40) (Mcal of DE/day)

D. **Lactating mares**

1. **Foaling to 3 months:**

   200-299 kg of BW:

$$CP = \frac{\text{(maintenance DP)} + [(0.04\ BW \times 0.021 \times 1000)/0.65]}{0.55}$$

300-900 kg of BW;

$$CP = \frac{\text{(maintenance DP)} + [(0.04 \text{ BW} \times 0.021 \times 1000)/0.65]}{0.55}$$

2. 3 months to weaning:

200-299 kg of BW:

$$CP = \frac{\text{(maintenance DP)} + [(0.04 \text{ BW} \times 0.018 \times 1000)/0.65]}{0.55}$$

300-900 kg of BW;

$$CP = \frac{\text{(maintenance DP)} + [(0.04 \text{ BW} \times 0.018 \times 1000)/0.65]}{0.55}$$

E. Working horses

CP = (40) (Mcal of DE/day)

F. G**rowing horses:**

Weanlings	CP = (50) (Mcal of DE/day)
Yearlings and long yearlings	CP = (45) (Mcal of DE/day)
2 Years old	CP = (42.5) (Mcal of DE/day)

Crude protein intake is calculated from the energy requirements for all horses. The essential amino acids lysine requirements may then calculated from the crude protein.

From these formulas we can work out protein requirements for maintenance. Then we can add the extra protein required for different work levels. Working horses need some additional protein to replace nitrogen losses from sweat and building additional muscle. Although these increases are relatively small.

Step 6 – Estimation of lysine requirements

Lysine can be calculated from the daily crude protein requirement.

Lysine g/day = 4.3% of the crude protein requirement.

Step 7 – Estimation of calcium requirements

Maintenance – 0.04 g Ca/kg BW

Light exercise – 0.06 g Ca/kg BW

Medium/Hard exercise – 0.07 g Ca/kg BW

Step 8 – Estimation of phosphorus requirements

Maintenance – 0.04 g Ca/kg BW

Light exercise – 0.046 g P/kg BW

Medium/Hard exercise – 0.058 g P/kg BW.

Exercise -15

Formulation of balance diet for dogs and cats

Table: Daily dry matter requirement for maintenance of Dog (on dry matter basis)

Body weight (kg)	Dry matter requirement (g/kg body weight)		
	3.3 Kcal/g	3.5 Kcal/g	4.0 Kcal/g
2.5	33	31	27
5	28	26	23
7.5	25	23	21
10.0	23	22	19
15.0	21	20	17
20.0	18	17	15
25.0	18	17	15
30.0	17	16	14
40.0	17	16	14
50.0	15	14	13
60.0	15	14	13
70.0 and above	14	13	12

*Calculated from the values of NRC (1974) for diet containing 3.3 Kcal ME/g dry matter.

Food requirement and balanced diet chart for dog:

A standard balanced dog food should contain 20-22% CP, 4-5% Fat, 5-10% CF and 4-5% ash on DM basis. Average energy content should be 3.3-4.0 Mcal per kg of feed on DM basis. It should be balanced for essential mineral and vitamins.

The requirement for production i.e. growth, work, pregnancy and lactation are higher than for maintenance. Diets supplying 3.5 to 4.0 Kcal ME per gram dry matter are fed for production. Young pups in early life may require even higher energy content in their diets for optimum growth and development. Average ME requirement of mature idle dog is 132Kcal per kg $W^{0.75}$ in terminal trimester of pregnancy and lactation.

Table: Dog food categories

Growth foods – Growth or All life stages claim (Appropriate for reproduction and hard working dogs)	
Protein	21% or greater
Fat	8%
Adult all life stages claim or maintenance claim	
Protein	21-26%
Fat	8-18%
Reduced calorie foods maintenance claim	
Protein	14-25%

Fat	7-8%
Performance foods all life stages claim	
Protein	27%
Fat	9%

Table: An example formula for a dry food

Ingredients	Percentage
Ground yellow corn	56.0
Ground wheat	5.0
Corn gluten meal (60% CP)	5.0
Soybean meal (48% CP)	15.0
Meat and bone meal	10.0
Dicalcium phosphate	0.2
Salt	0.5
Trace mineral premix	0.5
Vitamin premix	0.8
Annual fat5	7.0
Total	100

Table: Cat food categories

Growth foods Growth or All life stage claim	
Protein	30% or greater
Fat	8% or greater
Adult foods all life stages claim or maintenance claim	
Protein	30%
Fat	6%
Reduced calorie foods maintenance claim	
Protein	30%
Fat	6-8%

Table: An example formula for a dry cat food

Ingredients	Percentage
Gound yellow corn	33.77
Poultry meal	17.4
Corn gluten meal (60% CP)_	12.8
Soybean meal (48% CP)	10.0
Ground wheat	9.0
Meat or bone meal	3.0
Phosphoric acid solution	2.3
Calcium carbonate	1.16
Fish meal	1.0
Salt	0.7
Potassium chloride	0.48
Trace mineral premix	0.50
Vitamin premix	0.80

Taurine	0.08
Citric acid	0.01
Animal fat	6.0
Animal digesta	1.0
Total	**100**

Exercise – 16

Feeds and feeding schedule fof Zoo animals and birds diet charts

Diet for zoo animals

Diets for zoo animals developed on the basis of food performance of the free ranging animals, domestic animal data and experience for the animal. It is observed that the variation in feeding schedules among the different zoos is very high. It has become imperative to prepare a standard diet schedule for zoo animals that could be used by the zoos spread across the Indian Union.

Table: Feeding schedule of carnivorous mammals

Name of the animal	Diet prescribed	Quantity per day	Additional supplements
Indian lion and Indian tiger	Beef with bone	7 in 10 kg	Chicken 1 kg per week; 2 eggs weekly twice (lion male and tiger male are given 2-4 kg beef extra)
	Liver	150-500 g	Tiger cub is given chicken and beef at o.65 kg and 2.0 kg respectively.
Jaguar	Beef with bone and liver	4 kg and 150 g	……
Leopard or panther	Beef without bone	3 to 4 kg	Chicken 1 kg per week
	Liver	100 to 250 g	Leopard cub is given1.5 kg beef/day
Wolf	Milk	0.5 lit.	Beef without bone (and calcium supplement) of 2 kg is given in afternoon
	Eggs	2 nos given in morning	
Hyena	Beef with bone	30 kg	Chicken 500 g per week
	Liver	100 g	
Jackal	Beef without bone	0.5 to 1.5 kg	
	Liver	100 g	

Table: Feeding schedule of herbivorous mammals

Name of the animal	Diet prescribed	Quantity per day	Additional supplements
Indian elephants	Ragi cooked	20 kg	
	Horse gram	4 kg	
	Rice	2 kg	
	Common salt	250 g	
	Jaggery	250 g	
	Grass	200 g	
	Sugarcane	12 nos	
	Green tree		
	Leaves bamboo	100 kg	
	Coconuts	4 nos	
	Banana	10 nos	
	Papaya	2 kg	
	Seasonal fruits		
	Wood apple	500 g	
	Water melon	2 kg	
Hippopotamus	Wheat bran	10 kg	
	Bengal gram	500 g	
	Common salt	250 g	
	Apple	2 nos	
	Potato	500 g	
	Carrot	2 kg	
	Cabbage	1 kg	
	Onion	250 kg	
	Banana	10 nos	
	Grass	100 kg	
	Greens	1 kg	
	Bread	2 loaves (800 g/40 slices	
Giraffe	Sweet potato/Beet root	4 kg	
	Carrot	2 kg	
	Onion	2 kg	
	Beans	1 kg	
	Cowpea	500 g	
	Bengal gram	500 g	
	Banana	3 kg	
	Orange	2 kg	
	Mango	300 g	
	Apple	1 kg	

Black buck/ Spotted deer or Chital	Wheat bran	0.5 to 1 kg	
	Cattle feed	05 to 1 kg	
	White Bengal gram	30 to 100 g	
Sambar deer	Grass	7 kg	
	Green leaves	3 kg	
	Common salt	10 g	
	cabbage	3 kg	
Nilgai	Wheat bran	1.5 kg	
	Cattle feed	1.5 kg	
	Bengal gram	250 g	
	Green gram	500 g	
	Groundnut cake	250 g	
	Common salt	20 g	
	Carrot	1 kg	
	Cabbage	250 g	
	Grass	20 kg	
	Green leaves	5 kg	

Table: Feeding schedule of birds

Name of the birds	Diet prescribed	Quantity per day	Additional supplements
House sparrow	Paddy, Bajra, Ragi	15 g	
Ducks	Paddy	100 g	
Flamingo	Thinai	150 g	
	Wheat bran	50 g	
	Mixed grains	50 g	
Owl	Beef with bone	250 g	
Pelican	Fish	0.75 to 1 kg	Chicks 10 g weekly once

Exercise-17

Visit to animal farm and feed mill