CHAPTER IV

Computation of Ration for Ruminants

Ration: The feed given to an animal in one day *(24 hours)*.

Balanced ration: The ration, which provides proper amount, proportion and variety of all the required nutrients to keep the animal in its optimum form to perform best in respect of production and health.

Desirable characteristics of the ration:

1. ***Liberal feeding:*** Animal should be fed liberally (***ad libitum***), however, should not be overfed.
2. ***Individual feeding:*** Individually offered feed helps in supplying nutrients as per requirement of a particular animal. Lactating animals should be fed individually for achieving optimum milk yield.
3. Ration should be **properly balanced**.
4. Ration should be **palatable** and free from foul smell. Dustiness should also be avoided.
5. Ration should offer **variety** to the animal (straw, silage, green fodder, concentrates *etc.*). This ensures optimum ruminal function, prevention of excesses and deficiencies (balanced) and dilution of incriminating factors.
6. Feeds should be of **good quality**.
7. The ration should contain plenty of **mineral matter**. Particularly during lactation period 0.7% mineral matter is excreted through one liter of milk.
8. The ration should be **laxative**. For this purpose, wheat bran is generally added in concentrate.
9. Ration should be **bulky** to fill up the rumen and provide satiety to the animal.
10. **Avoid sudden changes** in diet, as it causes digestive disturbances and reduction in milk yield. The change, if required must always be gradual.
11. The feeding should be done at **regular interval** in order to avoid digestive disturbances.
12. The ration should be **economical**.
13. Ration should be **free from incriminating factors/anti-nutritional factors**.

Note: *Green succulent fodders are essential in ration as they contain vitamin A and other essential nutrients and a time they are laxative, bulky and easily digestible. To make the food more digestible and palatable, coarse fodders should be chaffed in small edible pieces and grains may be crushed well and soaked in water before offering to the animal.*

Feed formulation is a mathematical calculation to prepare a balanced ration. Important points considered during feed formulation are requirements of livestock for a particular functional purpose, nutrient composition and cost of the feed ingredients. Moreover, there is need to have a comprehensive knowledge on different feed ingredients that are used in feeds for a particular species; their nutritional merits and demerits including nutrient supply, palatability, anti-nutritional factors, bulkiness, *etc*., their safe and effective level of inclusion in feeds and compatibility with other feed ingredients mixed in the diet. The ingredients must be palatable, sound and free from anti-nutritional factors, moulds and toxins. Therefore, formulation of economic ration based on scientific nutritional recommendations, availability and cost of the feed ingredients is very crucial to achieve desired performance, good health and welfare of livestock.

How to balance a ration?

Computer ration formulation program offers several advantages compared to manual calculation. Many computer program balance the ration on a least cost basis which permits the user to select feed ingredients that provide a nutritionally balanced ration at the lowest possible cost. In addition to rapid calculations, computer programs can easily balance a ration for a multitude of nutrients, which would be impossible or impractical to perform manually.

Despite the advantage of computer ration balancing; at times manual calculation of balanced rations may be required. Following is a step-by-step description of how to balance a ration for the livestock.

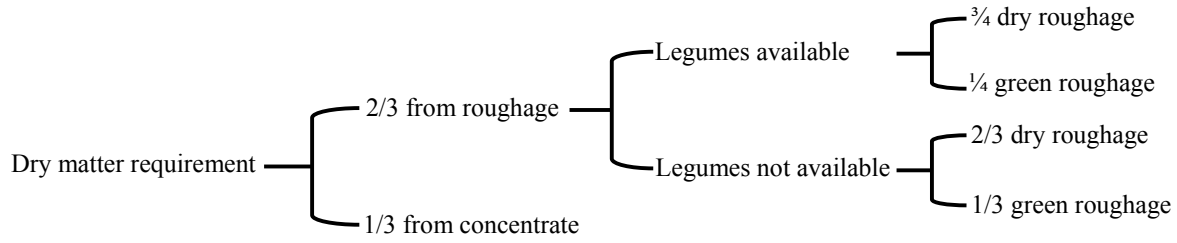
Step I: Obtain information on the composition of the feeds and forages (Appendix 1) to be used in the formulation. Minimum information needed includes dry matter, crude protein, digestible crude protein, total digestible nutrients, calcium and phosphorus contents of the feeds.

Step II: Estimate the amount of dry matter (DM) to be consumed. Dry matter intake is affected by many factors including body weight, milk production *etc*.

Probable dry matter intake can be calculated as follows:

Species	Dry matter intake (% of live weight)
Cattle	2.00-2.50
Buffalo	2.50-3.00

Step III: Appropriate ratio of forages DM to concentrate DM based upon the level of milk production and the quality of forage available. Since the bulk is essential for the ruminants, the dry matter allowances should be divided as follows.



Step IV: ***Calculation of nutrient requirement of the animal in terms of CP, DCP and TDN***

Nutrient requirements of the animals in terms of protein, energy, minerals, vitamins and water are the basis for scientific feeding. The requirements of animals include two components *viz.* maintenance and production. While a maintenance requirement varies with body size of the animal, the requirement for production depends upon its physiological state.

Nutrient requirements recommendations are based on the results of a large number of feeding experiments conducted through-out the world. Feeding standard developed by National Research Council (NRC) of USA and Agricultural Research Council (ARC) of UK, for livestock and poultry are considered to be the best general guides for computation of ration. In India, Sen, Ray and Ranjhan have recommended nutrient requirements for dairy cattle and buffalo based on 'Mid Morrison Values'. Since then Indian Council of Agricultural Research (ICAR), New Delhi has been publishing and revising the bulletins on nutrient requirements of Indian livestock. The ICAR current requirements were published in 2013 and are the principal nutrient requirements referred in this manual.

Nutrient requirements for cattle and buffaloes

Attribute	Maintenance (per kg $W^{0.75}$)	Milk production requirement for cattle (per lt of 4% FCM)
TDN	36.0 g	330 g
ME	0.133 Mcal	1.20 Mcal
MP	2.65 g	51.0 g
CP	4.87 g	96.0 g
DCP (Ranjhan, 1998)	2.84 g	45.0 g

Calculation of nutrient requirement based on metabolic body weight

Example exercise: Calculate the DCP and TDN requirement for maintenance of a cow weighing 500 kg.

Solution: Metabolic body weight of cow corresponding to 500 kg live weight would be

$500^{3/4} = 105.74$, therefore,

DCP required = 2.84 ×105.74 = 300.30 g

TDN required = 36.0 ×105.74 = 3806.64 g

Pregnancy requirement for cattle

Month of gestation	DM (kg)	TDN (kg)	ME (Mcal)	MP (g)	RDP (g)	RUP (g)	CP (g)
6-7	0.85	0.64	2.30	109	96	56	169
7-8	0.99	0.74	2.67	143	112	85	216
8-9	1.13	0.84	3.05	178	128	113	263

***Example exercise*:** Calculate the DCP and TDN requirement of a cow weighing 450 kg yielding 10 liters of milk with 4.0 % fat. The cow is in advance stage of pregnancy.

Solution: The total nutrient requirements are calculated as follows:

	DCP (kg)	**TDN (kg)**
For maintenance	0.254	3.52
For production of 10.0 lt. of milk	0.450	3.3
	(0.045 × 10)	(0.33 ×10)
For gestation	0.140	0.84
Total requirements	0.844 kg	7.66 kg

Step V: ***Preparation of concentrate mixture:***

Concentrate mixtures used in cattle feeding consists of following ingredients:

- ***Grain:*** To provide energy
- ***Cakes:*** To provide protein
- ***Byproducts like wheat bran, rice bran, or gram chuni etc.:*** These substances act as a laxative, dilutes and as a source of minerals particularly phosphorus.
- ***Mineral mixture:*** To the extent of 2 % of the total concentrate mixture.
- ***Salt:*** 1 % of the total concentrate mixture
- For calves, animal protein sources like fish meal, skim milk powder *etc.* should be added.
- Add vitamin A +D_3

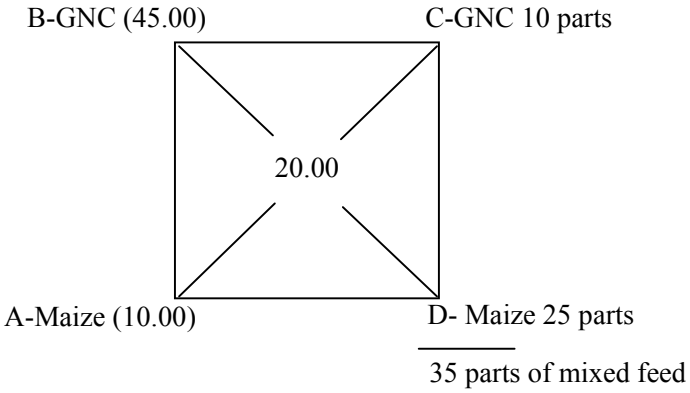
Methods for computation of concentrate mixture include:

1. Pearson's square method: This method is used for the compounding of concentrate mixture from two feed ingredients only. In this method either protein or energy density in the compound feed is calculated.

Exercise: Calculation for the fixing of protein percentage in the concentrate mixture by taking two ingredients.

Solution: For this purpose, protein content of one ingredient should be higher and that of other ingredient lower than the proposed protein content of concentrate mixture. For the compounding of feed mixture of 20% CP on DM basis, the feed ingredients available are groundnut cake (GNC) containing 45% CP and 75% TDN and maize grain containing 10% CP and 85% TDN on DM basis.

Now, place the values of CP % in the two ingredients at point A and B of the square and desired level of CP% in the center. After this, subtract the value of the ingredients and the centre value (lower value will always be subtracted from the higher value diagonally). Record the difference without any symbol at point C & D. Now add the figures at C & D, which is total part of the compounded feed and the values at C is the part of GNC and that at D part of maize grain as shown in the Pearson's square.



Since in 35 parts mixed feed GNC is 10 parts

Hence in 100 parts GNC will be: 10/35 x 100 = 28.57 %

The percentage of maize grain will be: 100 - 28.57 = 71.43 %

Thus, the feed mixture will be prepared by mixing 28.57% GNC with 71.43%, maize grain and the mixture will contain 20 % CP on DM basis. Now, the calculation of TDN in the mixture: TDN % = 28.57 x 75/100 + 71.43 x 85/100 = 21.42 + 60.72 = 82.14 %

2. Algebraic method or simultaneous equation for computation of concentrate mixture

Simple equation like A + B = 100 or A + B + C = 100 can be used for computation of concentrate mixture. The equations of two ingredients are used for determining the level of any one nutrient *i.e.* either CP or TDN/DE/ME, whereas that with three ingredients may be used for the calculation of both protein (CP/DCP) and energy (TDN/DE/ME) contents in the mixture, provided the ingredients selected for the preparation of concentrate mixture contain lower as well as higher values of the nutrients to be worked out.

Exercise: Compute a concentrate mixture of 20 % CP content with the help of simultaneous equation from two ingredients *i.e.* maize grain and GNC. Also determine the TDN %.

Name of the feed ingredients	**CP %**	**TDN %**
Maize	10.00	85.00
GNC	45.00	75.00

Solution: Suppose maize is A and GNC is B feed.

Then, A + B =100 ----------(i)

and 0.1 A + 0.45 B = 20----------(ii)

Now multiplying equation (i) by 0.1 to get the following equation,

0.1 A = 0.1 B = 10----------(iii)

Now subtract (iii) from equation (ii)

$$0.1\,A + 0.45\,B = 20$$
$$-0.1\,A + 0.10\,B = 10$$
$$0.35\,B = 10$$
$$B = 10/0.35 = 28.57\ \%$$

Hence A = 100-28.57 = 71.43 %

Thus the concentrate mixture will be prepared by mixing 71.43 kg of maize grain and 28.57 kg of GNC. TDN % in the concentrate mixture will be

TDN% = 28.57 x 75/100 + 71.43 x 85/100 = 82.14

3. Simultaneous balancing of energy and protein for computation of concentrate mixture by double Pearson method.

- Select the ingredients in such a way that putting the values in the square should give desired CP % and more than desired TDN % for Mix 1. Calculate the TDN % in mixture.
- Select the ingredients in such a way that putting the values in a square should give desired CP % and less than desired TDN % for Mix 2. Calculate the TDN % in the mixture.
- Put the values of TDN percentage in Mix 3 of Mix 1 and Mix 2 so that the Mix 3 should give desired CP % and TDN % and calculate the parts (%) of Mix 1 and Mix 2 to be used in 3rd mixture.
- Calculate the ingredients used in 3rd mixture of 1st mixture as under:

$$= \frac{(\%\ ingredients\ in\ mix\ I\ x\ \%\ of\ mix\ I\ in\ Mix\ 3)}{100}$$

- Similarly, calculate ingredients of Mix 2 used in Mix 3.
- Total the ingredients used in Mix 3 *i.e.* having desired CP% and TDN%.
- Check the CP and TDN% in the concentrate mixture by multiplying the quantity of ingredients with CP and TDN % in the ingredients.