

Ration formulation

- A ration is the feed allowed for a given animal during a period of 24 hours. The feed may be given at a time or in portions at intervals.
- Ration formulation is a process by which different feed ingredients are combined in a proportion necessary to provide the animal with proper amount of nutrients needed at a particular stage of production.
- It requires the knowledge about
 - Nutrients
 - Feedstuffs
 - Animal
- in the development of nutritionally adequate rations. When consumed in sufficient amount will provide the optimum level of production at a reasonable cost.
- The ration formulated should be palatable and should not cause any serious digestive disturbance or toxic effects to the animal.

DIGESTIBILITY

- It is the portion of the feed or nutrient present in the feed that is not excreted in feces by the animal.
- Digestibility can be determined by feeding experiments
- It is usually expressed as
 - Digestible nutrient
 - Digestibility coefficient
- There are various factors that affect feed digestibility.
- They may be grouped as
 - Feed factors
 - Animal factors

FEED FACTORS

The most important feed factors that affect digestibility of feed are feed composition, ration composition and preparation of the feed.

- *Feed composition:* The digestibility of a feed is closely related to its chemical composition. Other feeds, particularly fresh and conserved herbage show variation in composition and

therefore vary more in digestibility. The crude fiber fraction of feed has greater influence on its digestibility and both the amount and chemical composition of the crude fibre are important. If the lignin content in crude fibre is more it reduces the digestibility of the feed. Lignin content of any plant tissue increases with maturity.

- *Ration composition:* The digestibility of feed is influenced not only by its own composition, but also by the composition of other feeds consumed with it. This is known as associative effect. Associative effect of feeds represents a serious problem on the determination of the digestibility of concentrates by difference method.
- *Preparation of feeds:* Feed preparation also influences its digestibility. The commonest treatment applied to the feeds are chopping or chaffing, crushing or grinding and cooking. chopping or chaffing roughages increases their surface area and hence increases their digestibility. In order to obtain maximum digestibility cereal grains should be crushed for horses and ground for pigs and poultry: otherwise they may pass through the gut intact. Feed processing such as pelleting and extrusion cooking also enhances feed digestibility.

ANIMAL FACTORS

The most important animal factors that affect digestibility of feed are the species, age, physiological and health status of the animal and level of feeding:

- *Species:* There is a wide variation in the digestion of feed according to the species of animals. Hind gut fermenting animals like horses are able to digest fibrous feeds better than poultry and Swine.
- *Age:* In the young animals the digestive system is not fully functional especially with regard to secretion of enzymes, hence they are not able to digest feed as that in adults.
- *Physiological and health status of the animal:* Animals in advanced stages of pregnancy are not able to digest feed due to the pressure and suffering exerted by the gravid uterus on the gastrointestinal tract. Sick animals especially those suffering from diseases of gastrointestinal tract have reduced capacity to digest feed.
- *Level of feeding:* An increase in the quantity of feed eaten by an animal generally causes a faster rate of passage of digesta. The food is then exposed to the action of digestive enzymes for a shorter period, so that there may be reduction in its digestibility.
 - The nutrient requirements can be arrived using feeding standards.
 - The list of commonly available feeds in that region should be prepared.

- The nutritional value of the feeds can be obtained from any standard source such as NRC.
- Using the above information rations can be prepared by several methods that include
 - Pearson Square Method
 - Two-by-two Matrix method
 - Trial and Error Method and
 - Linear Programming (LP)

Factors to be considered in ration formulations

- Acceptability to the animal - The ration formulated has to be palatable.
- Digestibility - The nutrients in the feed should be digestible and released into the gastrointestinal tract to be utilized by the animal. Rations with high fiber content cannot be tolerated by poultry and swine.
- Cost - The requirement of the animal can be met through several combinations of feed ingredients. However, when the costs of these ingredients are considered, there can only be one least-cost formulation. The least-cost ration should ensure that the requirements of the animal are met and the desired objectives are achieved.
- Presence of anti-nutritional factors and toxins. The presence of anti-nutritional factors in the feed affects the digestion of some nutrients and makes them unavailable to the animal. The inclusion of these feed ingredients should therefore be limited in the formulation.
- Other factors that should be considered are texture, moisture and the processing the feed has to undergo.

Pearson Square method

- This is relatively simple and easy to follow. It satisfies only one nutrient requirement and uses only two feed ingredients.
- The limitation however is that the level of nutrient being computed should be intermediate between the nutrient concentration of the two feed ingredients being used.
- It is of greatest value when only two ingredients are to be mixed.
- The nutrient requirement is noted in the middle of the square this value in the middle of the square must be intermediate between the two values that are used on the left side of the square which are actually the nutrient content of the two ingredients that are to be used.

- For example, the 14 percent crude protein requirement has to be intermediate between the soybean meal that has 45 percent crude protein or the maize that has 10 percent crude protein.
- Subtract the nutrient value from the nutritional requirement on the diagonal and arrive at a numerical value and note it down on the right side of the square.
- Two sets of values will be got.
- By summing those parts and dividing by the total, you can determine the percent of the ration that each ingredient should represent in order to provide a specific nutrient level.

Using More Than Two Ingredients

- It is possible to prepare ration with more than two ingredients using the Pearson square.
- For example, to prepare a 15 percent crude protein mixture that consists of a supplement of 60 percent soybean meal (45 percent crude protein) and 40 percent ground nut oilcake (45 percent crude protein), and a grain mixture of 65 percent corn (9 percent crude protein) and 35 percent sorghum (12 percent crude protein), the following steps are followed. Since only two components can be used in the Pearson square method, the ingredients are combined first as follows:

$$60\% \text{ SBM} \times 45\% = 27.0$$

crude protein

$$40\% \text{ GNC} \times 45\% = \underline{18.0}$$

Protein in 45.0%

supplement

mixture

$$65\% \text{ corn} \times 9.0\% = 5.85$$

$$35\% \text{ sorghum} \times = \underline{4.20}$$

12.0%

Protein in grain 10.05%

mix

$$5.0 \text{ parts} \times 60\% = 3.0 \text{ parts SBM}$$

$$5.0 \text{ parts} \times 40\% = 2.0 \text{ parts GNC}$$

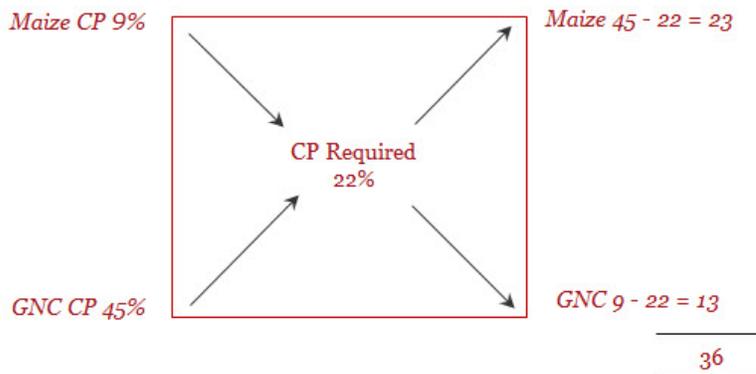
$$30.0 \text{ parts} \times 65\% = 19.5 \text{ parts corn}$$

$$30.0 \text{ parts} \times 35\% = \underline{10.5} \text{ parts}$$

Sorghum

$$\begin{aligned}
 & 35.0 \\
 (3.0 / 35.0) & = 8.57\% \text{ SBM} \\
 (2.0 / 35.0) & = 5.71\% \text{ GNC} \\
 (19.5 / 35.0) & = 55.72\% \text{ corn} \\
 (10.5 / 35.0) & = 30.00\% \\
 & \text{sorghum}
 \end{aligned}$$

Pearson Square Method



$ \begin{aligned} 36 \text{ parts } 23 \text{ maize } 100 \text{ parts maize} &= (100 \times 23) / 36 = 63.8 \\ 36 \text{ parts } 13 \text{ GNC } 100 \text{ parts GNC} &= (100 \times 13) / 36 = 36.1 \end{aligned} $

Two-by-two matrix method

- This method solves two nutrient requirements using two different feed ingredients. A 2 x 2 matrix is set and a series of equations are done to come up with the solution to the problem.

Trial and error method

- This is the most popular method of formulating rations for swine and poultry.
- As the name implies, the formulation is manipulated until the nutrient requirements of the animal are met.
- This method makes possible the formulation of a ration that meets all the nutrient requirements of the animal.
- Greater control can be had on implementing restrictions and judging inclusion levels
- It is a time consuming method involving a lot of calculations and meeting out specifications may not be very precise.

Linear programming (LP)

- This is a method of determining the least-cost combination of ingredients using a series of mathematical equations.
- There are many possible solutions to each series of equations, but when the factor of cost is applied, there can only be one least cost combination.
- An electronic computer is capable of making thousands of calculations in a very short time.
- However, the machine is incapable of correcting errors resulting from incorrect data and errors in setting up of the program.
- Therefore, the resultant rations obtained from linear programming will be no better than the information and values which are entered into the computer.
- There are many feed formulation software packages available in the market. The software range from simple, spreadsheet-based solutions to sophisticated and complex packages designed for large feed manufacturers that require multi-site, multi-server, and multi-blending capabilities.

Inputs required for formulating least cost rations using linear programming

- Details of animal or bird so as to fix their nutrient requirement
 - Species
 - Breed
 - Age
 - Sex
 - Physiological status
 - Production status
- Ingredients list and their nutritive value
- Critical nutritive ratios eg Ca:P ratio
- Maximum and minimum levels of inclusion of ingredients
- Cost of ingredients

Advantages

- Minimizes the cost of ration.
- It is convenient and saves manpower.
- It is a choice for the commercial feed Millers who handle large no of ingredients.

- It eliminates human error both in calculation and in speed