

Methods used for feed formulation

Introduction

- To formulate an aqua feed, the proximate composition of each ingredient that constitutes the aqua feed should be known.
- There are two major classification for feed formulation methods.
- They are manual method and mathematical or statistical method
- Manual method includes Pearson's square Method
- Mathematical or statistical method includes linear programming and algebraic solution using simultaneous equation

Pearson's Square method

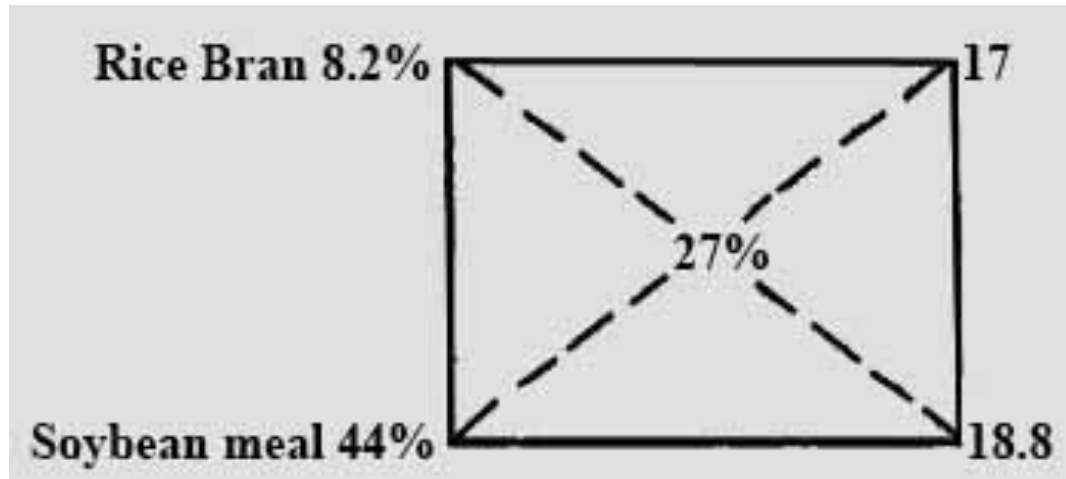
- In most fish diets, protein is the most expensive portion and is usually the first nutrient that is computed in diet formulation.
- The energy level of the diet is then adjusted to the desired level by addition of high energy supplements which are less expensive than protein supplements.
- The Pearson square method is an easy way to determine the probable ratios of mixing different protein ingredient and to formulate a feed with desired dietary protein level.

- **Procedure for Pearson's Square Method**

- Percent of protein needed in the feed ration should be placed in the center of the square
- Percent of crude protein in the basal feed should be placed in the upper left corner
- Percent of crude protein in protein supplement in the lower left corner
- Connect the diagonal corners of squares with lines
- Then, subtract diagonally across the square preferably smaller figure from the larger
- Place the answer in the opposite corner
- Now, add the figures in the right side corner of the square
- Find out relative per cent of inclusion from the total values

- For example, consider rice bran (with 8.2% protein) and soybean meal (with 44% protein) were available as feedstuffs to prepare a diet for carp with 27% protein, a square is constructed and the two feedstuffs with their protein values are put on the two left corners along with the protein content of each ingredient.

The desired protein level (27%) of the feed is placed in the middle of the square. Next, the protein level of the feed is subtracted from that of the feedstuffs, placing the answer in the opposite corner from the feedstuff. Ignore positive or negative signs.



Thus to make the 27 percent crude protein of carp feed, we must mix 17/35.8 of rice bran and 18.8/35.8 soybean meal.

Now, we have to calculate the proportion of mixing the ingredients by weight in relation to their protein content. This could be elucidated as given below.

Rice bran = $\frac{17}{35.8} \times 100 = 47.50$	Soybean meal = $\frac{18.8}{35.8} \times 100 = 52.50$
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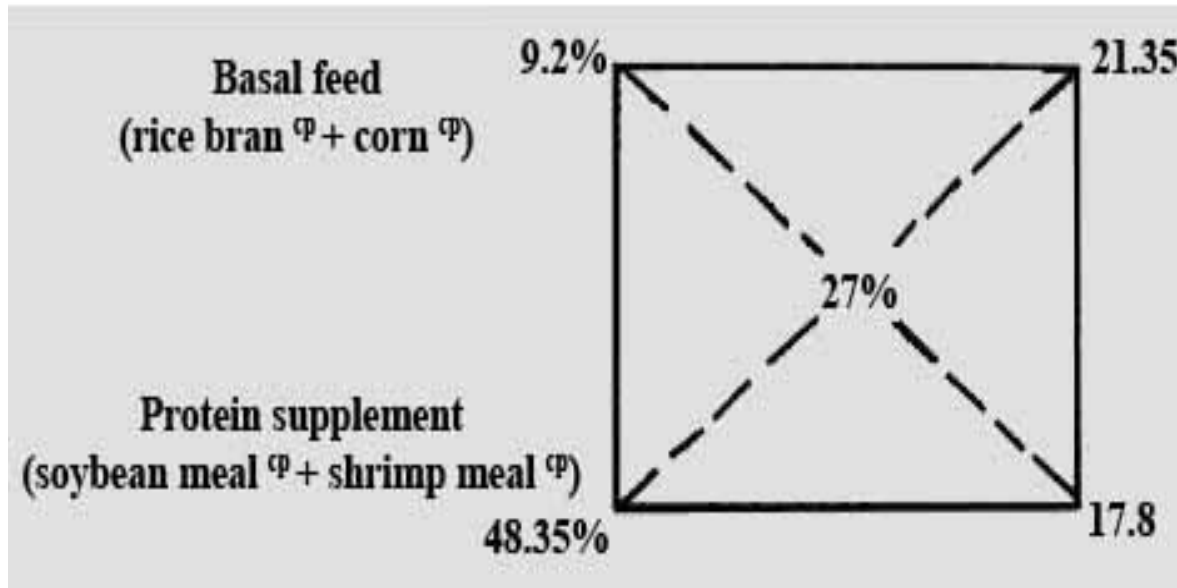
That is, for the preparation of 100 kg of fish feed with 27 percent protein, 47.50 kg of rice bran and 52.50 kg of soybean meal are to be mixed.

Procedure for Double Pearson's Square Method

- Group the ingredients into two broad categories viz., less than 20 per cent crude protein and more than 20 per cent crude protein and take average value.
- Put the average in the two left corner of the square (Average less than 20 per cent in upper left corner and average of greater than 20 per cent in the lower left corner of the square)
- Connect the diagonal corners of square with lines
- Then, subtract diagonally across the square preferably smaller figure from the larger
- Place the answer in the opposite corner
- Now, add the figures in the right side corner of the square.
- Find out relative per cent of inclusion from the total values.

Procedure for Pearson's Square Method

- If more than two feedstuffs are used in a feed, they may be grouped into basal feeds (CP < 20 percent) and protein supplements (CP > 20 percent), averaged within each group, and plugged into the square method.
- For example, suppose shrimp meal and corn were also available for the carp feed mentioned above.
- The crude protein levels of the shrimp meal (52.7 percent) and of corn (10.2 percent), rice bran (with 8.2% protein) and soybean meal (with 44% protein) respectively



Basal feed = $(21.35/39.15) \times 100 = 54.53\%$

Protein supplement = $(17.8/39.15) \times 100 = 45.47\%$

Thus, to make 100 kg of this feed one would mix the following:

Rice bran 27.265 kg

Corn 27.265 kg

Soybean meal 22.735 kg

Shrimp meal 22.735 kg

- The square method is helpful to novice feed formulators because it can get them started in diet formulation without the need to resort to trial and error.
- The square method can also be used to calculate the proportion of feed ingredients to mix together to achieve a desired dietary energy level as well as a crude protein level.

Linear Programming (LP)

- LP is to determine which combination will provide the desired nutrient levels at the lowest possible cost
- It is a quantitative procedure by which limited resources such as capital, raw material, manpower etc., can be allocated, selected, scheduled or evaluated to achieve an optimal solution to a particular objective.
- This objective may be to minimize cost or maximize profit.
- Linear programming was first employed animal feed industry in mid fifties (to obtain least cost feed).
- Application of LP in aqua feed formulation is a recent development

- It is not practically possible for small scale aquaculturist when choices of ingredients are limited.
- It is a mathematical and statistical technique in which one can develop least cost feed which require the following:
 - Nutrient content and digestible energy of ingredients
 - Unit price of a feed ingredients including vitamins and minerals

- Any other additives (fillers) used
- Minimum and maximum per cent of amounts of each ingredient in the feed
- Amino acid profile of fish as well as feed
- Physical or non-nutritive limitations
- The more information is available on nutritional and physical characteristics of ingredients, the more effective in formulating low cost nutritionally adequate feeds
- Common spread sheets such as Lotus 1-2-3, MS STAT, INDO STAT are normally used for least cost feed formulation

- Least-cost linear programming software for diet formulation is readily available and the cost varies with the sophistication.
- A simple Lotus 1-2-3 spread sheet can also be utilized for formulating feeds, incorporating a smaller number of variables.
- It should be noted that least-cost feed formulation is not always practical for small scale aquaculturists using on-farm feed manufacture facilities where the choice of ingredients available is limited.

Quadratic programming

- Nutrient requirements used in linear programming feed formulation are usually fixed for maximum rate of growth.
- This may not be the best decision from economic point of view. Nutrient constraints may be relaxed to bring down feed cost while still achieving acceptable lower growth.

- Quadratic programming takes into account the growth response within a range of nutrient constraint.
- Therefore, good understandings of biological response functions from actual feeding trials are essential in the use of quadratic programming.
- For example, inclusion level of arginine could be reduced by 20% with only a 5% likely reduction of growth of Nile tilapia. Thus high cost towards arginine supplement can be brought down by hardly losing likely growth of 5% in the fish.