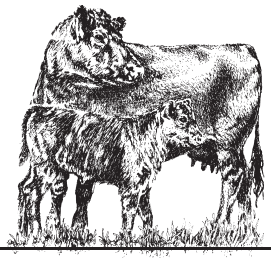

Western Beef Resource Committee

Cattle Producer's Library

Nutrition Section CL310

Ration Balancing

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Feed costs are a large part of the total operating expenses for most operations. A balanced ration is necessary for the beef producer to achieve both low feed costs and optimum production levels. Feeding rations that meet, but not exceed, animal requirements can often lower these costs.

The term "balanced ration" refers to a ration that supplies the proper amount and proportion of nutrients to meet an animal's needs for maintenance, growth, and/or production. This requires determining the nutrient composition of feedstuffs and knowing the animal's nutrient requirements. Other terms commonly used in cattle nutrition are:

Ration: The amount of feed an animal receives in a 24-hour period.

Feedstuff: An ingredient used in the formulation of a ration.

As-fed: The moisture and nutrient content of feedstuffs as they are normally fed to animals. Actual moisture content can vary greatly. That is why this value must be corrected to account for moisture content (determine the amount of dry matter) when balancing rations.

Dry matter: The portion of feed that remains after all the water has been removed. It contains the nutrients.

Nutrients: The chemical substances found in feedstuffs that can be used, and are necessary, for the maintenance, production, and health of animals. The chief classes of nutrients are carbohydrates, fats, proteins, minerals, vitamins, and water.

Nutrient content: The amount of specific nutrients contained in a ration or feedstuff. It is normally expressed as a percentage of the dry matter.

Nutrient requirement: The amount of a specific nutrient that is required to meet an animal's minimum need for maintenance, growth, reproduction, lactation, and work. Nutritional requirements are dependent on the type, size, and physiological status (e.g., stage of pregnancy or level of milk production) of the animal.

TDN: Total Digestible Nutrients, a measure of the energy content of feed.

CP: Crude Protein, a measure of the protein content of feed; it includes both protein and non-protein nitrogen in the feed.

Producers use mathematical computations to balance nutrient intake with nutrient requirements. These computations can be done either by hand or with a computer program. A ration's appropriateness (formulated either by hand or with a computer program) is directly related to the quality of information collected to balance the rations. In essence garbage in will equal garbage out. Before rations can be balanced, it is essential to know the nutrient requirements of the animal and the nutrient composition of the feedstuffs available.

Nutrient Requirements of Beef Cattle

Years of research has determined the energy, protein, vitamin, mineral, and other nutritional requirements of beef cattle. For growing cattle, these values are listed by animal weight, sex, frame size, and expected rate of gain. Nutritional requirements for breeding cattle are listed by production stage, weight, rate of gain, and milking ability. See CL300, or contact your county extension office for a listing of these requirements. Nutrient Requirements of Beef Cattle, 7th Revised Edition, National Academy of Sciences (NRC 1996) explains how these values are determined and how they can be applied. This publication is useful for all commercial beef producers.

Nutrient Composition of Feedstuffs

Samples of the feedstuffs available to prepare rations should be sent to an analytical laboratory to determine nutrient composition and content. CL305, Common Sense Feed Analysis and Interpreting Forage Analysis, explains how to get an accurate analysis. If actual analysis cannot be obtained, there are feed composition tables

available that list average nutrient values of feedstuffs. See CL301 or contact your county extension office for a table of average values.

Table values for forages should be used only if laboratory analysis is not possible. There is no substitute for analysis of the feedstuff a producer will use. Nutrient content is influenced by stage of maturity at harvest, harvest and storage conditions, processing, etc. These differences can be detected only through analytical procedures.

Before rations are balanced, all feed values should be listed on a dry matter basis. After the mathematical computations are completed, these values can be converted to an as-fed basis (see CL309). To avoid over- or under-feeding of nutrients, it is critical that accurate moisture determinations are used.

Methods of Balancing Rations

As mentioned before, rations can be balanced either by using a computer program, or by doing the mathematical calculations by hand. The widespread use of computers and the availability of simple, inexpensive ration balancing programs have made hand calculation less common. However, all producers should know how to balance a ration by hand.

Pearson Square

The "Pearson Square" is a relatively simple, direct, and easy way to balance a ration. This method can be used to determine the proportion of two feedstuffs which will result in a ration with a desired nutrient concentration. Only two can be analyzed at a time, but through multiple iterations, many feedstuffs can be included in the final ration.

An example is provided below to help in the understanding and use of the Pearson Square method. In this example, a ration is developed for a 500-pound heifer calf having a desired gain of 1.5 pounds/day. Her daily requirements are:

12.1 pounds dry matter intake
10.3% crude protein
68.5% TDN

The procedure for balancing a ration is: (1) balance for energy (TDN), the nutrient required in the greatest amount; (2) determine if the ration balanced for TDN will meet the heifer's crude protein needs; (3) if necessary, determine the amount of protein supplement needed; and (4) convert individual feedstuff amounts from dry matter to an as-fed basis.

The feedstuffs to be used in developing the balanced ration are listed in Table 1. Step by step, the procedures are as follows:

1. Balance for TDN.
   a. Draw a square and place 68.5 (the desired TDN level) in the center (Fig. 1).

Table 1. Feedstuffs used in Pearson Square example.

Feedstuff	Dry matter	TDN	CP
	(%)	(%)	(%)
Meadow hay	92	50	6
Ground barley	88	75	11
Cottonseed meal	90	65	41

   b. At the upper left hand corner of the square write "meadow hay = 50." At the lower left corner write "ground barley = 75." These numbers represent the TDN percentage in each feedstuff.
   c. Subtract diagonally, smallest from the largest (68.5 - 50 = 18.5; 75 - 68.5 = 6.5) and write the numbers on the right side of the square.
   d. Add and total the numbers on the right side of the square (6.5 + 18.5 = 25.0). These numbers indicate that a ration of 6.5 parts meadow hay and 18.5 parts ground barley will give a 68.5 percent TDN ration. This is a total of 25.0 parts.
   e. Divide the meadow hay and ground barley parts by 25.0 to get the preliminary percentages of hay (6.5 divided by 25.0 = 26%) and barley (18.5 divided by 25.0 = 74%).
2. Determine if crude protein is adequate.
   a. Determine the crude protein concentration in the meadow hay and ground barley mixture. Multiply the percent of each feedstuff in the mix by its crude protein content. Meadow hay is 26 percent of the mix and contains 6 percent crude protein. Ground barley is 74 percent of the mix and contains 11 percent crude protein. Therefore, the crude protein concentration in the mix is:

Meadow hay	.26 x 6.0	=	1.56%
Ground barley	.74 x 11.0	=	8.14%
			9.70%

   b. The concentration in the meadow hay:ground barley mix is 9.70 percent. The heifer requires 10.3 percent crude protein. Therefore, the crude protein content needs to be increased by adding a protein supplement (cottonseed meal in this example).

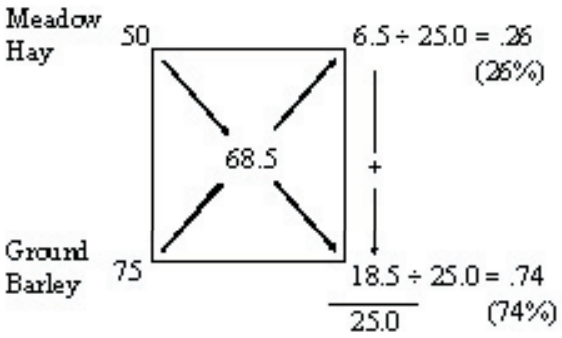

Fig. 1. Balancing for TDN using a Pearson Square.

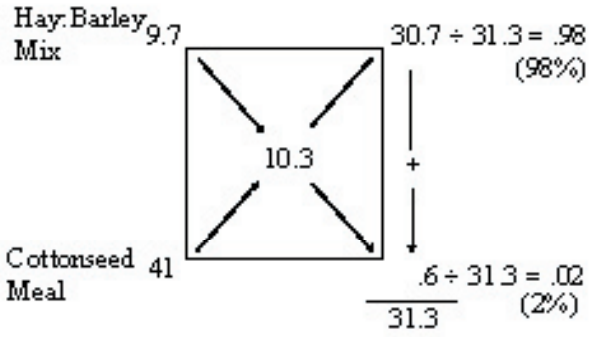

Fig. 2. Balancing for Crude Protein using a Pearson Square.

3. Determine amount of protein supplement.
   a. Use the square method to balance for crude protein. Draw a square; put 10.3 in the center (Fig. 2).
   b. Write meadow hay:ground barley mix = 9.70 in the upper left corner and cottonseed meal = 41.0 in the lower left corner; these numbers indicate the crude protein percentage in each feedstuff.
   c. Subtract diagonally, smallest from the largest (10.3 - 9.7 = .6; 41 - 10.3 = 30.7) and write the numbers on the right side of the square.
   d. Add and total the numbers on the right side of the square (30.7 + .60 = 31.3). These numbers indicate that a ration of 30.7 parts meadow hay: ground barley mix and .60 parts cottonseed meal will give a 10.3 percent crude protein ration. This is a total of 31.3 parts.
   e. Divide the meadow hay:ground barley mix and cottonseed meal parts by 31.3 to get the preliminary percentages of meadow hay:ground barley (30.7 divided by 31.3 = 98%) and cottonseed meal (.60 divided by 31.7 = 2%).
4. Determine the pounds of dry matter that each feedstuff contributes to the total.
   a. Multiply pounds of dry matter required daily by the heifer (12.1) by the value for cottonseed meal (.02 or 2%). Cottonseed meal is 12.1 x .02 = .24 pound. Subtract this amount (.24) from the total dry matter intake (12.1) to determine how much dry matter will come from the meadow hay:ground barley mix (12.1 - .24 = 11.86 pounds). There should be 11.86 pounds of meadow hay:ground barley on a dry matter basis. To determine the amount of dry matter for meadow hay and ground barley, multiply 11.86 by the relative amounts of meadow hay and ground barley obtained in the first square (step 5; 26% meadow and 74% ground barley). 11.86 x .26 = 3.08 pounds meadow hay and 11.86 x .74 = 8.78 pounds ground barley.
   b. Change each individual amount from a dry matter basis to an "as-fed" basis so that you know how much to actually feed. This is accomplished by dividing the pounds of dry matter from each feedstuff by the percentage of dry matter in each feed (Table 1). See CL309 for more information on converting dry matter to as-fed.

      Meadow hay = 3.08 divided by .92 (92% dry matter) = 3.35 pounds

      Ground barley = 8.78 divided by .88 (88% dry matter) = 9.98 pounds

      Cottonseed meal = .24 divided by .90 (90% dry matter) = .27 pound

Table 2. Daily ration for 500-pound heifer gaining 1.5 pounds/day.

Feedstuff	Amount in ration
Meadow hay	3.35 pounds
Ground barley	9.98 pounds
Cottonseed meal	.27 pound

Table 3. Grain portion of the example ration.

Feedstuff	Individual ration	% of ration	Pounds in 2,000 lb batch
	(lb/day)	(%)	(lb)
Ground barley	9.98	97.37	1,947
Cottonseed meal	.27	2.63	53
Total	10.25	100.00	2,000

Once the individual daily ration has been calculated the producer can plan his or her feeding program. Multiply the individual daily ration amounts by the number of head to determine the total amounts to feed each day (Table 2).

Some producers will have the equipment to feed a total mixed ration. Others will need to feed the grain and hay portions separately. Either way, it is wise to first mix the ground barley and cottonseed meal in proper proportions.

Premixing the grain portion will improve ration uniformity and ease daily handling and feeding (Table 3).

Computer Programs

Computers have the ability to store large amounts of information and retrieve it quickly. They also excel at performing complex mathematical calculations quickly and precisely. Usable results depend on accurate input of the necessary information. Computers, combined with appropriate software, can be powerful tools for cattle producers to lower feed costs and improve animal nutrition.

Ration balancing programs can store information on hundreds of feedstuffs, including nutrient content and prices. These programs often account for management variables, such as class of beef cattle and physiological stage. Additionally, nutrition programs often provide an

estimate of how much feed will be consumed. Intake is one of the more difficult values to accurately estimate and greatly influences the concentration of nutrients in a balanced ration. The ability of ration balancing software to store and change the price of feedstuffs enables the producer to obtain economic information about a particular ration in addition to nutrient analysis.

Computer programs make it much easier to develop balanced rations, but they should be used with extreme caution. Software alone cannot determine a nutrition program. Computers can hasten calculation and reduce/eliminate mathematical errors, but only the producer can select the correct input data. There is no substitute for personal experience and common sense.

Ration balancing programs can't determine if a particular diet is prudent or practical. For example, nutritional software may suggest a diet consisting of 100 percent barley because it meets the animal's nutrient requirements. A beef producer must have knowledge of feeds and ruminant nutrition to determine when computer-derived rations are not practical.

Ration balancing software is variable in both price and thoroughness. Capabilities range from simple spreadsheet formulas designed to speed the mathematical to complex programs that build least cost rations that take into account many management variables and multiple feedstuffs. Software prices vary from free to well over $1,000.

Some commonly used computer programs are available from universities.

TAURUS is available from the University of California-Davis for $400. Call (530) 752-1278 or visit the web site for more information.

http://animalscience.ucdavis.edu/extension/taurus.htm

Oklahoma State University has several ration balancing spreadsheets for Microsoft Excel. These spreadsheets can be downloaded for free from a web site.

http://www.ansi.okstate.edu/software/

Spartan Ration Balancing Software is a DOS-based program from Michigan State University. It can be downloaded for free from a web site.

http://www.msu.edu/user/ssl/index.htm

Points to Remember

It is important to gather accurate information concerning the composition of feedstuffs (CL305 and CL301) and the nutrient requirements of beef cattle [CL300 and Nutrient Requirements of Beef Cattle (NRC 1996)]. This includes knowing the dry matter percentage and understanding how to convert as-fed values to dry-matter values. An understanding of the mathematical computations will improve the cattle producer's ability to balance rations and double check computer generated rations. Balanced rations are only as good as the information used to develop them.

Overfeeding, underfeeding, or feeding unbalanced rations increase feed costs and reduce a producer's profitability. The most effective use of feedstuffs is by providing a diet that meets, but does not exceed, an animal's nutrient requirements.

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