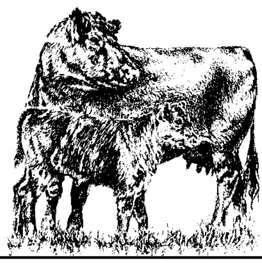

Western Beef Resource Committee Fourth Edition

Cattle Producer’s Handbook

Nutrition Section 310

Ration Balancing

David Bohnert, Oregon State University

Feed costs are a large part of the total operating expenses for most cattle operations. A balanced ration is necessary for the beef producer to achieve both low feed costs and optimum production levels, therefore, feeding a ration that meets, but does not exceed, animal requirements is economically beneficial.

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 and growth. This requires determining the nutrient composition of feedstuffs and knowing the animal’s nutrient requirements. Some terms commonly used in cattle nutrition include:

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

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.

Nutritionists and cattle 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 is directly related to the quality of information collected to balance the ration—“garbage in” will equal “garbage out.” It is essential to know the expected performance of the animal(s), the associated nutrient requirements, and the nutrient composition of the feedstuffs available before attempting to balance a ration.

Nutrient Requirements of Beef Cattle

Years of research have provided nutritionists with accurate estimates of 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 300, or contact your county extension office, for a listing of these requirements. Nutrient Requirements of Beef Cattle (1996) explains how these values are determined and how they can be applied. This publication is a useful resource for all commercial beef producers.

Nutrient Composition of Feedstuffs

To accurately prepare rations, samples of the available feedstuffs should be sent to an analytical laboratory to determine nutrient composition and content. Fact sheet 305, Common Sense Feed Analysis and Interpreting Forage Analysis, explains how to obtain and interpret feed analyses. If actual analyses cannot be obtained, there are feed composition tables available that list average nutrient values of feedstuffs. Contact your county extension office for a table of average values.

However, table values for feedstuffs should be used only if laboratory analyses are not available. **There is no substitute for analyses of feedstuffs.**

Feedstuff nutrient content is influenced by stage of maturity, harvest and storage conditions, processing, etc. Consequently, the actual nutrient content of a feedstuff can only be determined through analytical procedures.

Also, before rations are balanced, feedstuffs should be analyzed for moisture content and all nutrient values listed on a dry matter basis. After the mathematical computations of ration balancing are completed, these values can be converted to an as-fed basis (see 309) to facilitate actual feeding procedures.

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 feedstuffs can be analyzed at a time, but through multiple iterations, many feedstuffs can be included in the final ration.

An example is provided to help understand and use 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 when consuming 12.1 pound dry matter) 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

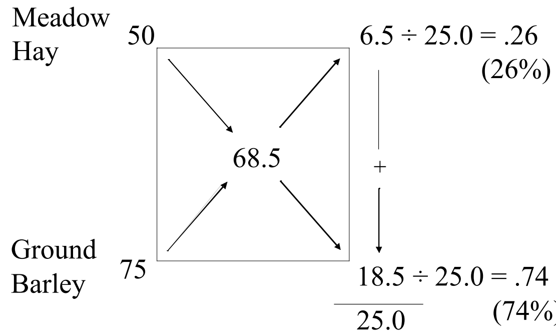

Fig. 1. Balancing for TDN using a Pearson Square.

   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 CP 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 CP. Ground barley is 74 percent of the mix and contains 11 percent CP. Therefore, the crude protein concentration in the mix is:

Meadow hay	.26 x 0.06 =	1.56%
Ground barley	.74 x 0.11 =	8.14%
		9.70%

   b. The concentration in the meadow hay:ground barley mix is 9.70 percent. The heifer requires 10.3 percent CP when consuming 12.1 pounds dry matter. Therefore, the CP content needs to be increased by adding a protein supplement—cottonseed meal (CSM) in this example.

3. Determine amount of protein supplement.
   a. Draw a square; put 10.3 in the center (Fig. 2).
   b. Write "Hay:Barley Mix 9.7" in the upper left corner and "CSM 41" in the lower left corner; these numbers indicate the CP percentage in each feedstuff.
   c. Subtract diagonally, smallest from the largest (10.3 - 9.7 = 0.6; 41 - 10.3 = 30.7) and write the numbers on the right side of the square.

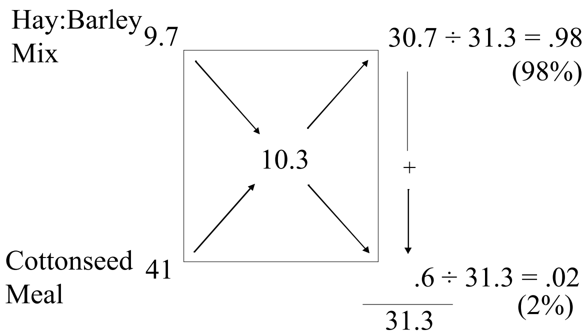

Fig. 2. Balancing for crude protein using a Pearson Square.

d. Add and total the numbers on the right side of the square (30.7 + 0.60 = 31.3). These numbers indicate that a ration of 30.7 parts meadow hay:ground barley mix and .60 parts CSM will give a 10.3 percent CP 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 CSM (.60 divided by 31.7 = 2%).

4. Determine the amount of each feedstuff, dry matter and as-fed, of the final ration.

a. Multiply pounds of dry matter required daily by the heifer (12.1) by the value for cottonseed meal (0.02 or 2%). The amount of CSM needed is calculated by 12.1 x 0.02 = 0.24 pound. Subtract this amount (0.24) 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 - 0.24 = 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 (#1, step e; 26% meadow and 74% ground barley). This yields 11.86 x 0.26 = 3.08 pounds meadow hay and 11.86 x 0.74 = 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 fact sheet 309 for more information on converting dry matter to as-fed.

Meadow hay = 3.08 divided by 0.92 (92% dry matter) = 3.35 pounds

Ground barley = 8.78 divided by 0.88 (88% dry matter) = 9.98 pounds

Cottonseed meal = .24 divided by 0.90 (90% dry matter) = 0.27 pound

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

Feedstuff	lb (DM basis)	lb (as-fed basis)
Meadow hay	3.08	3.35
Ground barley	8.78	9.98
Cottonseed meal	0.24	0.27
Total	12.1	13.6

Once the individual daily ration has been calculated the producer can plan the 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 but most will need to feed the grain and hay portions separately. Either way, it is recommended 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).

Table 3. Grain portion of ration.

Feedstuff	Individual ration	Ration	100 lb batch	2,000 lb batch
	(lb/day)	(%)	(lb)	(lb)
Ground barley	9.98	97.37	97.4	1,947
Cottonseed meal	0.27	2.63	2.6	53
Total	10.25	100.00	100.0	2,000

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. Also, these programs can account for changes in nutrient requirements due to management variables such as class of cattle, physiological stage, and environmental conditions. 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 needed in a balanced ration. Another benefit of many software programs is the ability to store and change the price of feedstuffs, which provides economic information about a rations being considered.

Even though computer programs make it much easier to develop balanced rations, they should be used with extreme caution. Computers hasten calculations and reduce/eliminate mathematical errors, but only the producer can select the correct input data. There is no substitute for personal experience, knowledge, 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 and is cost effective. However, the software program does not "know" that such a ration can result in nutritional issues, poor performance, and potentially death due to ruminal dysfunction. 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 to complex programs that build least cost rations that take into account many management variables and multiple feedstuffs.

Software prices vary from free to hundreds of dollars.Some commonly used ration balancing software programs/spreadsheets, in no specific order, are:

BRaNDS (Beef Ration and Nutrition Decisions Software); Iowa State University Extension and Outreach, Iowa Beef Center; (515) 294-BEEF (2333) or http://www.iowabeefcenter.org/software_BRANDS.html

CowBytes; Alberta Agriculture and Rural Development; (780) 427-0391 or http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex12486

Taurus 2006; UCDavis Department of Animal Science; http://animalscience.ucdavis.edu/extension/software/Taurus/index.htm

OSU Cow-Culator; Oklahoma State University; Microsoft Excel spreadsheet; http://www.beefextension.com/new%20site%202/cccalc.html

CowCulator Software (a modified version of the OSU Cow-Culator); Oregon State University - Beef Cattle Sciences; http://beefcattle.ans.oregonstate.edu/html/forage/Forage.htm

Beef Cow Ration Balancer; Feedlot Ration Balancer; University of Minnesota Extension; Microsoft Excel spreadsheets; http://www.extension.umn.edu/agriculture/beef/

Cattle Grower Ration Balancer; University of Arkansas Cooperative Extension Service; Microsoft Excel spreadsheet; (501) 671-2169 or http://www.uaex.edu/farm-ranch/animals-forages/beef-cattle/nutrition-feeding.aspx

For more detailed information on the use of computers in cattle nutrition please see fact sheet 380, Computers for Cattle Nutrition.

Points to Remember

It is important to gather accurate information concerning the composition of feedstuffs (305) and the nutrient requirements of beef cattle (300; Nutrient Requirements of Beef Cattle, 1996). This includes understanding how to convert as-fed values to dry matter values and vice-versa.An understanding of the mathematical computations will improve the cattle producer's ability to balance rations and double check computer generated rations. However, rations are only as good as the information used to develop them.

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

References

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