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Beef Cattle Nutrition Workbook

Oregon State University | Extension Service

Ration Balancing

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Feed costs are a major component of the total operating expense for most beef operations. By formulating and feeding balanced rations, you can conserve feed dollars while allowing for the most efficient level of production. Ration balancing depends on having accurate and reliable nutrient analyses of feedstuffs in addition to knowing the animals' nutrient requirements. Terms commonly used in ration balancing include the following.

Feedstuff—An ingredient used in formulating a ration.

As-fed—Refers to the moisture and nutrient content of feedstuffs normally fed to animals. This value must be corrected to account for moisture content (determination 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 other than water.

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.

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

Balanced ration—A ration that supplies nutrients in the proper amount and proportion for an animal's maintenance, growth, lactation, and/or gestation. Information necessary to compose a balanced ration includes the nutrient composition of feedstuffs and the animal's nutrient requirements.

Nutrient composition—The amount of specific nutrients contained in a ration or feedstuff. Normally expressed as a percentage of 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 depend on the type, size, and physiological status of the animal.

TDN—Total digestible nutrients. A term used to express energy in feeds.

There are several ways to balance daily nutrient intake with daily nutrient requirements. All of these methods rely primarily on mathematical computations, which can be carried out by hand or with computer software. However, in order to formulate a balanced ration, you first must know the animal's nutrient requirements (see Chapter 1) and the nutrient composition of the feedstuffs to be included in the ration (see Chapters 2 and 3).

Send samples of feedstuffs to a certified analytical laboratory to determine nutrient composition (see Chapter 3). If this is not possible, ask your local Extension office for average values. However, there is no substitute for a lab analysis of your particular feedstuff. Feedstuff nutrient composition can be greatly influenced by stage of maturity, harvesting, processing, storage conditions, etc.

Methods of ration balancing

As mentioned previously, you can balance rations by hand or by using specifically designed computer software. We will describe one of the more common and useful methods of hand balancing a diet (Pearson Square) and review the positive aspects of computer programs.

Pearson Square

Use of the Pearson Square is relatively easy. You can use this technique to determine the proportions of two feedstuffs that will yield a ration containing a desired nutrient concentration. It can be used only for two feed materials; however, one or both can be a mixture. An example is provided here.

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 as follows (from page 12, Table 1.1, Chapter 1):

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

The feedstuffs to be used in developing the balanced ration are listed in Table 5.1. Step by step, the procedure is as follows.

1. Balance for TDN. Draw a square and place 68.5 (the desired TDN level) in the center (Figure 5.1).
2. At the upper left corner of the square, write "meadow hay = 50," and at the lower left corner write "ground barley = 75." These numbers represent the TDN percentage in each feedstuff.
3. Subtract diagonally, smaller from larger (68.5 – 50 = 18.5; 75 – 68.5 = 6.5) and write the numbers on the right side of the square as shown in Figure 5.1.
4. Add the numbers on the right side of the square (6.5 + 18.5 = 25). 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 parts.

Table 5.1. Feedstuffs used in Pearson Square example.

Feedstuff	Dry matter (%)	Total digestible nutrients (%)	Crude protein (%)
Meadow hay	92	50	6
Ground barley	88	75	11
Cottonseed meal	90	65	41

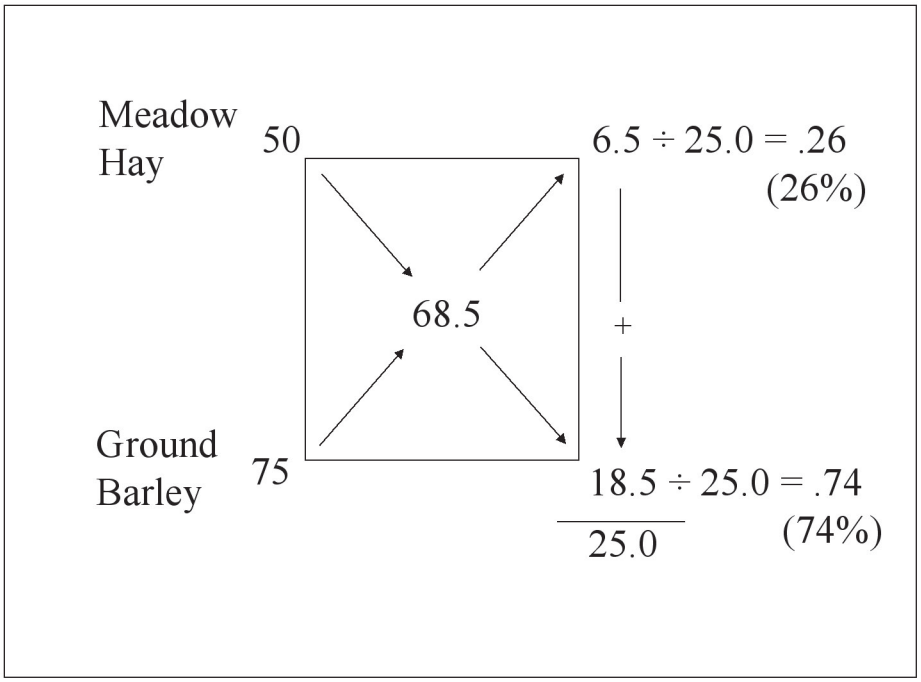

Figure 5.1—Balancing for TDN using a Pearson Square.

5. Divide the meadow hay and ground barley parts by 25 to get the preliminary percentages of hay (6.5 ÷ 25 = 26%) and barley (18.5 ÷ 25 = 74%).
6. Determine the crude protein concentration in the meadow hay and ground barley mixture. Multiply the percentage 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. Add the results. Therefore, the crude protein concentration in the mix is:

Meadow hay	0.26 x 6	= 1.56%
Ground barley	0.74 x 11	= 8.14%
		9.70%

7. Determine whether crude protein is adequate. The concentration in the meadow hay/ground barley mix is 9.7 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).

8. Use the Pearson Square method again to balance for crude protein. Draw a square and put 10.3 in the center (Figure 5.2).
9. Write "meadow hay/ground barley mix = 9.7" in the upper left corner, and "cottonseed meal = 41" in the lower left corner; these numbers indicate the crude protein percentage in each feedstuff.
10. Subtract diagonally, smaller from larger (10.3 – 9.7 = 0.6; 41 – 10.3 = 30.7), and write the numbers on the right side of the square.
11. Add the numbers on the right side of the square (30.7 + 0.6 = 31.3). These numbers indicate that a ration of 30.7 parts meadow hay/ground barley mix and 0.6 part cottonseed meal will give a 10.3 percent crude protein ration. This is a total of 31.3 parts.
12. 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 ÷ 31.3 = 98%) and cottonseed meal (0.6 ÷ 31.7 = 2%).
13. Determine the pounds of dry matter that each feedstuff contributes to the total. Multiply pounds of dry matter required daily by the heifer (12.1) by the percentage for cottonseed meal (0.02, or 2 percent). Thus, the dry matter component made up by cottonseed meal is 12.1 x 0.02 = 0.24 lb.

    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 lb). There should be 11.86 lb 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 percentages of meadow hay and ground barley obtained in the first square (step 5): 26 percent meadow hay and 74 percent ground barley. 11.86 x 0.26 = 3.08 lb meadow hay and 11.86 x 0.74 = 8.78 lb ground barley.

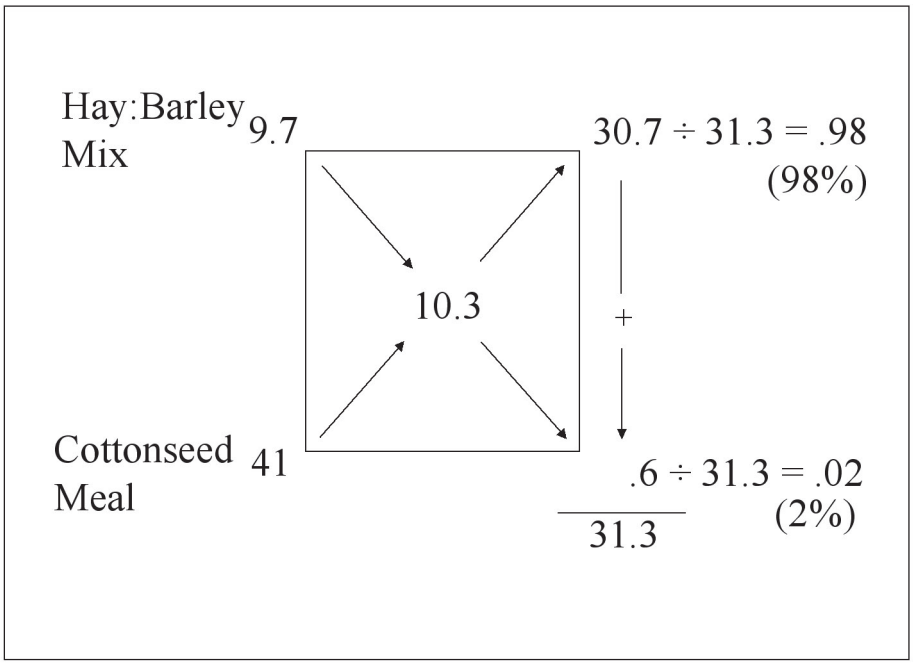

Figure 5.2—Balancing for crude protein using a Pearson Square.

14. Change each amount from a dry matter basis to an "as-fed" basis so that you know how much to feed. To do so, divide the pounds of dry matter for each feedstuff by the percentage of dry matter in each feed (see Table 5.1).

Meadow hay	= 3.08 lb ÷ 0.92 (92% dry matter)	= 3.35 lb
Ground barley	= 8.78 lb ÷ 0.88 (88% dry matter)	= 9.98 lb
Cottonseed meal	= 0.24 lb ÷ 0.90 (90% dry matter)	= 0.27 lb

A blank Pearson Square is included for your use as Worksheet 5.1.

Computer software

Computers provide immediate access to vast amounts of information concerning feedstuff nutrient content and animal nutrient requirements. As a result, computers and associated software can be powerful management tools to help lower feed costs and improve animal nutrition.

Computer programs designed for ration balancing include databases containing information on nutrient content and prices of hundreds of feedstuffs. Also, you can update databases with your current nutrient analyses and/or locally available feedstuffs. Most programs use management variables, such as class of beef cattle and physiological stage, to calculate nutrient requirements.

In addition, nutrition programs often provide an estimate of the quantity of feed consumed. Intake greatly influences the concentration of nutrients in a balanced ration, but it can be difficult to estimate. Intake is important because the total quantity of nutrients obtained by an animal in a given day depends on both the total intake and concentration of nutrients in the ration.

Ration balancing software also can allow you to store and change the price of individual feedstuffs. This enables you to obtain economic information about a particular ration in addition to nutrient analysis.

The ability to have feedstuff nutrient and price information available in a computer database is a major improvement over having to obtain information from tables and/or memory. Computers can evaluate numerous rations in the time it takes to formulate one ration by hand. In addition, you can evaluate and compare various feedstuffs to determine which are most cost-effective.

Exercise extreme caution when using computer programs to balance or evaluate rations and/or feedstuffs. Ration balancing software alone cannot determine a nutritional management program. Software is only one of many tools used in developing a complete nutritional program. There is no substitute for personal experience and common sense. Ration balancing programs can't determine whether 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. You need a knowledge of feeds and ruminant nutrition to realize that rations such as this are not practical.

Some commonly used computer programs from educational services include the following.

- SPARTAN, from Michigan State University (http://www.msu.edu/user/ssl/index.htm). Available for $100 from the MSU Software Distribution Center, 517-353-6740.
- TAURUS, from University of California–Davis (http://animalscience.ucdavis.edu/extension/software.htm). Available for $400 from the Department of Animal Science at the University of California Davis, 530-752-5886.
- AUTONRCAF, from Oklahoma State University (http://www.ansi.okstate.edu/software/). Available free of charge on the Web from the Department of Animal Sciences at Oklahoma State University.

Contact suppliers for updated cost of programs.

Important points to remember

Successful ration balancing and/or evaluation requires accurate information regarding feedstuff nutrient composition and beef cattle nutrient requirements. You need to know the dry matter percentage of feedstuffs and understand how to convert as-fed values to dry-matter values.

In addition, a fundamental understanding of mathematics will improve your ability to formulate rations and interpret hand- and computer-generated diets. Your ability to balance and evaluate rations is only as good as the information used to develop them.

Efficient use of feedstuffs means providing a diet that meets an animal's nutritional requirements. Overfeeding, underfeeding, and/or feeding nutritionally unbalanced diets are inefficient management practices that increase feed costs and reduce profitability.

Worksheet 5.1
Pearson Square Diagram for Balancing Rations

Note: The Pearson Square can be used to balance rations containing two feed ingredients. The feed ingredients can be single feedstuffs or mixtures of feedstuffs.