

## Lesson B3–4

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# Balancing Rations

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**Unit B.** Animal Science and the Industry

**Problem Area 3.** Meeting Nutritional Needs of Animals

**Lesson 4.** Balancing Rations

### **New Mexico Content Standard:**

**Pathway Strand:** Animal Systems

**Standard: III:** Provide proper nutrition to maintain animal performance.

**Benchmark: III-B.** Analyze a feed ration to determine whether or not it fulfills a given animal's nutrient requirements.

**Performance Standard: 2.** Create a balanced ration for a given animal.

**Student Learning Objectives.** Instruction in this lesson should result in students achieving the following objectives:

1. Identify the steps in balancing a ration.
2. Discuss the importance of feed analysis.
3. Discuss how nutritional information is used in developing rations.
4. Develop balanced rations using the Pearson Square method.

**List of Resources.** The following resources may be useful in teaching this lesson:

**Recommended Resources.** One of the following resources should be selected to accompany the lesson:

Lee, Jasper S., et. al. *Introduction to Livestock and Companion Animals, 2<sup>nd</sup> Edition*. Danville, Illinois: Interstate Publishers, Inc. 2000. (Chapter 3)

**Other Resources.** The following resources will be useful to students and teachers:

Ensminger, M. E. *Animal Science*, Danville, Illinois: Interstate Publishers, Inc. 1991. (Chapter 4)

Gillespie, James R. *Modern Livestock & Poultry Production, 6<sup>th</sup> Edition*. Albany, New York: Delmar, 2002. (Unit 8)

## List of Equipment, Tools, Supplies, and Facilities

Writing surface  
Overhead projector  
Transparencies from attached masters  
Copies of student lab sheets

**Terms.** The following terms are presented in this lesson (shown in bold italics):

Ash  
Calorie  
Crude protein  
Diet  
Dry matter  
Feed analysis  
Feeding standards  
Feedstuff  
Pearson square method  
Ration

**Interest Approach.** Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

*Give the students various tags from different types of livestock feed bags. Ask the students “What information is found on these tags?” Make a list on the board. Then ask, “Why does a producer need to know this information?” After a brief discussion ask “How did the nutritionist who developed this ration know what to put in it?” Lead discussion to objective one of lesson.*

# Summary of Content and Teaching Strategies

**Objective 1:** Identify the steps in balancing a ration.

**Anticipated Problem:** What are the steps in balancing a ration?

- I. A **ration** is the total amount of feed an animal consumes in a 24-hour period. A ration needs to provide the right amount and proportion of nutrients needed by the animal during its particular life cycle stage. A **diet** is the type and amount of feed an animal receives in its ration. Diets should be based on the needs of the animal being fed and the nutrient content of the feed available. There are four basic steps that should be followed when developing a balanced ration. They are:
  - A. Identify the needs of the animal—The first thing that must be done is to determine that nutrient needs of the animal. This is done by identifying the kind, age, weight, and function of the animal for which the ration is being formulated. A mature sow in lactation has different nutrient needs than a newborn piglet. The nutrient needs requirements are called **feeding standards**. Feeding standards are based on average requirements and may not meet the needs under specific feeding conditions. Adjustments should be made if unusual conditions are present.
  - B. Identify available feedstuffs. A **feedstuff** is an ingredient used in making feed for animals. The producer must then choose which feedstuffs to include in the ration. The decision is based on nutrient value of the feedstuff and availability.

Nutrient content of an item may be found by consulting a feed composition table. Values given in this table are average values and may not represent the actual composition values of the feeds being used. Nutrient analysis can be done if the producer wants to know exact nutrient values.

Availability of the feedstuff is determined by the location of the producer developing the ration. For example, a producer in the Midwest is more likely to use soybean meal as a source of protein while a producer in the southern United States would be more likely to use cottonseed meal as a protein source in livestock feed.
  - C. Calculate the amount of each feedstuff to use in the ration. There are several methods that may be used to do this. A commercial feed company would most likely use a computer program to develop the ration. Producers developing their own rations can use a simpler method known as the Pearson Square to manufacture a balanced ration on their own farm or ranch.
  - D. Check ration against nutrient needs of the animal. Make sure that the ration developed meets all of the requirements of the animal for minerals and vitamins. If there is an excess or deficiency, the ration will need to be recalculated to meet the requirements.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in identifying the steps in balancing a ration. Unit 8 in Modern Livestock and Poultry Production is recommended.*

**Objective 2:** Discuss the importance of feed analysis.

**Anticipated Problem:** Why is feed analysis important?

- II. A good ration should be balanced, have variety, be succulent, be palatable, bulky, economical, and suitable. A balanced ration will increase gain, decrease expense, and increase profits. A variety of feeds will make ration balancing easier and increase palatability. A succulent ration that is juicy and fresh will increase production. Bulky rations aid in digestibility because of the fiber. Economical rations should provide needed nutrients and maximize profits. Feed analysis plays an important role in determining if these factors are present in a feed ration. **Feed analysis** is the process of determining the nutrients in a feedstuff or prepared mixed feed. Feed analysis is most often done in a laboratory. The information gained through this process is important in selecting the diets of animals to assure a balanced ration. Labels on feed containers report some of the feed analysis information. An analysis provides information in several areas.
- A. Dry matter—**Dry matter** is the weight of feed materials after moisture has been driven out. Feed quality is based on the proportion of water in the feed.
  - B. Crude protein—**Crude protein** is the nitrogen content of feed multiplied by 6.25 (a constant factor). Feedstuffs with higher crude protein are typically more nutritious.
  - C. Fat—Fat content is determined by using an ether extract process. The ether dissolves the fat. The remaining feed material is weighed and a percentage of fat is calculated.
  - D. Ash—**Ash** is the residue that remains after the feed has been burned at a temperature of 600°C.
  - E. Crude fiber—Crude fiber is determined by boiling the feed material in an acid and using laboratory procedures to dry the feed. The weight before and after drying is measured and used to calculate percent.
  - F. Nitrogen-free extract (NFE)—The percentage of NFE is determined by subtracting the percentage of water, crude protein, ether extract, ash, and crude fiber from 100.
  - G. Minerals—Feed materials can be analyzed for mineral content.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding the importance of feed analysis. Chapter 3 in Introduction to Livestock and Companion Animals is recommended. Use TM: B3–4A and TM: B3–4B to aid in discussion.*

**Objective 3:** Discuss how nutritional information is used in developing rations.

**Anticipated Problem:** How is nutritional information used in developing rations?

- III. The two nutrients found in the greatest amounts in most rations are protein and energy.
- A. Protein is stated as crude protein and is given as percentage or grams on the feed label. Protein needs are higher for young, lactating, and pregnant animals. The needs of an animal must be matched with its diet.

- B. Energy comes from carbohydrates, fats, and some proteins in feed. Most concentrates have higher energy than do roughages. Energy is stated as total digestible nutrients (TDN). Energy is measured in calories. A *calorie* is the amount of heat needed to raise the temperature of one gram of water one degree C. Calories in feed or as requirements are stated as kilocalorie (kcal) or megacalorie (Mcal). A kcal is 1000 calories. An Mcal is 1000000 calories. Scientists have determined the energy available in most feedstuffs as well as energy needed by most animals. Nutritional information about feeds is used to formulate rations. The amount of each nutrient is figured into the ration. This is based on the nutrient requirements of the animal. The information tells how much roughage, concentrate, and supplement are needed.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid in understanding how nutritional information is used in developing rations. Chapter 3 in Introduction to Livestock and Companion Animals is recommended. Use TM: B3–4B and TM: B3–4C to aid in discussion.*

**Objective 4:** Develop balanced rations using the Pearson Square method.

**Anticipated Problem:** How are rations balanced using the Pearson Square method?

- IV. The *Pearson square method* is a simple way to calculate a ration for a specific animal. It can also be used to calculate ingredients for batches of feed. The method works well for most types of animal production. One weakness of this method is the calculated ration may be adequate in terms of protein but deficient in minerals and vitamins. Using this method requires information on the nutrient needs of the animal and the nutrient content of the feedstuffs used. The feedstuffs used must be appropriate and practical. Information on nutrient content of feedstuffs is available in feed composition tables. The average nutrient needs of most animals are available in feeding standards tables.

*There are many techniques that can be used to assist students in mastering this material. Students need text material to aid developing balanced rations using the Pearson Square method. Chapter 3 in Introduction to Livestock and Companion Animals is recommended. Use TM: B3–4D to aid in discussion on this topic and to discuss the steps of the Pearson Square method.*

**Review/Summary.** Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student responses can be used in determining which objectives need to be reviewed or taught from a different angle. Questions at end of chapters in the textbook may also be used in the review/summary.

**Application.** Have students complete section C4: Feed Labeling and C5: Ration Balancing Problems on pages 23 and 24 in the Activity Manual for *Introduction to Livestock and Companion Animals*.

**Evaluation.** Focus the evaluation of student achievement on mastery of the objectives stated in the lesson. Measure student performance on classroom participation, laboratory assignments, and written tests or quizzes.

## Answers to Sample Test:

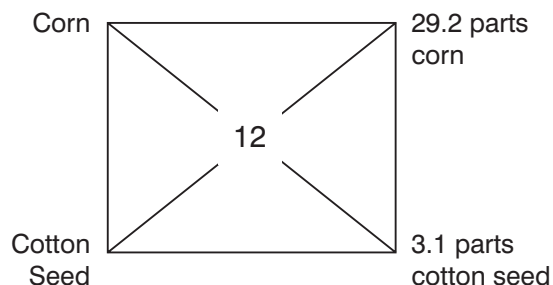
### Part One: Matching

1 = h, 2 = e, 3 = a, 4 = d, 5 = j, 6 = g, 7 = f, 8 = c, 9 = b, 10 = i

### Part Two: Completion

1. nutrient content
2. fiber
3. Energy
4. feedstuffs
5. location

### Part Three: Short Answer



$29.2 \text{ parts corn} + 3.1 \text{ parts cotton seed meal} = 32.3 \text{ Total parts}$

$29.2 / 32.3 = 90.4\% \text{ corn}$

$3.1 / 32.3 = 9.6\% \text{ cotton seed meal}$

If batch = 2000 lbs.:

Corn = 1,808 lbs

Cotton seed meal = 192 lbs

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# Test

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## Lesson B3–4: Balancing Rations

### Part One: Matching

*Instructions.* Match the term with the correct response. Write the letter of the term by the definition.

- |                  |                          |                      |
|------------------|--------------------------|----------------------|
| a. Ash           | b. Calorie               | c. Crude protein     |
| d. Diet          | e. Dry matter            | f. Feeding standards |
| g. Feedstuff     | h. Pearson Square method | i. Ration            |
| j. Feed analysis |                          |                      |

- \_\_\_\_\_ 1. A simple way to calculate a ration for a specific animal.
- \_\_\_\_\_ 2. The weight of feed materials after moisture has been driven out.
- \_\_\_\_\_ 3. The residue that remains after the feed has been burned at a temperature of 600°C.
- \_\_\_\_\_ 4. The type and amount of feed an animal receives in its ration.
- \_\_\_\_\_ 5. Nutrient needs requirements of an animal.
- \_\_\_\_\_ 6. An ingredient used in making feed for animals
- \_\_\_\_\_ 7. The process of determining the nutrients in a feedstuff or prepared mixed feed.
- \_\_\_\_\_ 8. The nitrogen content of feed multiplied by 6.25 (a constant factor).
- \_\_\_\_\_ 9. The amount of heat needed to raise the temperature of one gram of water one degree C.
- \_\_\_\_\_ 10. The total amount of feed an animal consumes in a 24-hour period

### Part Two: Completion

*Instructions.* Provide the word or words to complete the following statements.

- Diets should be based on the needs of the animal being fed and the \_\_\_\_\_ of the feed available.
- Bulky rations aid in digestibility because of the \_\_\_\_\_.
- \_\_\_\_\_ is stated as total digestible nutrients (TDN).
- The \_\_\_\_\_ used must be appropriate and practical.

5. Availability of the feedstuff is determined by the \_\_\_\_\_ of the producer developing the ration.

**Part Three: Short Answer**

*Instructions.* Provide information to answer the following questions.

Develop a 2,000 pound batch of a balanced ration for a pregnant sow with a crude protein level of 12%, using the Pearson Square method, with the following feedstuffs: corn (#2 grain) at 8.9% crude protein and cotton seed meal at 41.2% crude protein.



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# CO-OP FRY FISH FEED

—Manufactured By—

**ALABAMA FARMERS  
COOPERATIVE, INC.**

**DECATUR, ALABAMA 35609**

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## GUARANTEED ANALYSIS

Crude Protein, not less than .....49.00%  
Crude Fat, not less than .....9.00%  
Crude Fiber, not more than .....2.00%

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**INGREDIENTS:** Fish Meal, Meat Meal, Flash Dried Blood Meal, Dried Whey, Ground Corn, Fish Oil, Vitamin A Supplement, Vitamin D-3 Supplement, Vitamin E Supplement, Riboflavin Supplement, Calcium Pantothenate, Niacin Supplement, Vitamin B-12 Supplement, Choline Chloride, Menadione Sodium Bisulfite, Thiamine Mononitrate, Ascorbic Acid, Pyridoxine Hydrochloride, Folic Acid, Ethoxyquin (A preservative), Ground Limestone, and traces of Manganous Oxide, Calcium Iodate, Copper Oxide, Cobalt Carbonate, Zinc Oxide, Iron Carbonate and Sodium Selenite.

Tag Code: 021092

## EXAMPLES OF NUTRIENT CONTENT OF SELECTED FEEDSTUFFS

Feed	Dry Matter	Crude Protein	Fat	Ash	NFE*	TDN**	DE***
	%	%	%	%	%	%	(Mcal/kg)
<b>Roughages</b>							
Alfalfa hay (mid-bloom, sun-cured)	91	17.1	3.3	7.8	37.4	52	2.46
Bermudagrass (fresh)	29	4.2	0.6	3.3	13.0	17	0.77
Clover (fresh Ladino)	18	4.4	0.9	1.9	8.1	13	0.60
Millet (foxtail, fresh)	29	2.8	0.9	2.5	13.4	18	0.77
Sorghum fodder (with heads, sun-cured)	90	6.2	2.0	8.9	47.4	51	2.24
Wheat straw	90	3.2	1.8	6.9	40.4	40	1.90
<b>Concentrates</b>							
Barley grain (all analysis)	88	11.7	1.7	2.4	67.7	75	3.42
Corn (#2 grain)	87	8.9	4.0	1.2	71.3	80	3.47
Cotton Seed Meal (solvent)	93	41.2	4.7	6.1	28.9	70	3.27
Oats (grain, all analysis)	89	11.9	4.7	3.1	58.9	69	3.00
Soybean meal (solvent)	89	44.4	1.5	6.4	30.6	76	1.45
<b>Other</b>							
Molasses (black strap)	74	4.3	0.2	9.8	59.7	60	2.68

\*NFE = nitrogen-free extract.

\*\*Based on ruminant digestion.

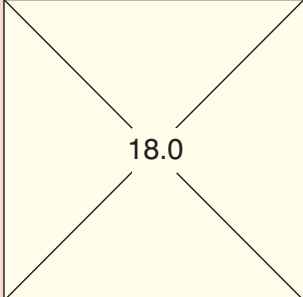
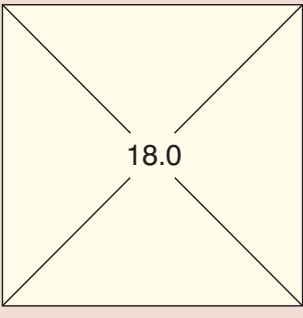
\*\*\*DE = digestible energy.

Source: Information in this table adapted from feed composition tables in M.E. Ensminger and R.C. Perry, Beef Cattle Science, Seventh Edition. Danville, Illinois: Interstate Publishers, Inc.

# PARTIAL DAILY NUTRIENT NEEDS OF SELECTED ANIMALS

Species/Condition	Weight (kg)	Selected Nutrient Needs		
		Digestible Energy	Calcium	Crude Protein
Mature working horse (moderate work such as roping cattle)	900	36.2 (Mcal)	44 (g)	10.4%
Colt (weanling, 6 months)	335	23.4 (Mcal)	44 (g)	14.5%
Swine (weaned pig)	20	3,230 (kcal)	—	18.0%
Swine (pregnant sow)	140	3,340 (kcal)	—	12.0%
Cow (dairy, lactating and pregnant)	450	19.9 (Mcal)	30 (g)	973 (g)
Rabbit (maintenance, adult)	2	4,200 (kcal)	—	12.0%
Chicken (4-week-old broiler)	0.5	—	0.9%	20.0%
<p><b>Mcal = 1,000,000 calories</b>  <b>kcal = 1,000 calories</b></p>				

**TM: B3-4D**

STEPS	EXAMPLE
<p><b>Step 1.</b> Draw a 1- to 2-inch square. Place diagonal lines across the square.</p> <p><b>Step 2.</b> Write the percentage of crude protein needed by the animal in the center of the square where the diagonal lines cross.</p> <p><b>Step 3.</b> Write the feeds to be used at each left corner. Place the percent of crude protein in the feeds after the name of feed.</p>	<p><b>Weaned pig weighing 20 kg (44 lbs.)</b></p> <p>Corn (#2 grain) 8.9</p>  <p>Soybean meal 44.4</p>
<p><b>Step 4.</b> Subtract the smaller of the numbers from the larger numbers. (This involves crude protein needed by the animal and that provided by the feed.) Write the difference at opposite corners.</p>	
<p><b>Step 5.</b> The numbers at the two right corners are parts of the two feed ingredients that are needed. (Parts can be measured as weight or volume just so the proportion remains as was calculated.)</p>	$\begin{array}{r} 26.4 \text{ parts corn} \\ + \quad 9.1 \text{ parts soybean meal} \\ \hline \mathbf{35.5 \text{ Total Parts}} \end{array}$
<p><b>Step 6.</b> The percentage of each feed needed in the ration can be found by dividing the number of parts by the total parts.</p>	$\begin{array}{l} 26.4 \div 35.5 = 74.4\% \text{ corn} \\ 9.1 \div 35.5 = 25.6\% \text{ soybean meal} \end{array}$
<p><b>Step 7.</b> The amount of each feed ingredient for a large batch of feed is determined by multiplying the percentage of each by the total amount of feed desired.</p>	<p>If batch = 1 ton (2,000 lbs.):</p> $\begin{array}{l} \text{shelled corn} = 1,488 \text{ lbs.} \\ \text{soybean meal} = \frac{512 \text{ lbs.}}{2,000 \text{ lbs.}} \end{array}$ <p>Note: Vitamin and mineral supplements may be needed in the feed.</p>