



# Lesson to Grow

## The Mystery Ration

**Grade Level:** 6-12

**Essential Skills:** 1, 3, 4, 9

**Math:** 6.NS, 7.NS, HS.AEE.A, HS.AEE.B.4

**Time:** 90 minutes

**Materials:**

**Per Group:**

- 4 Escape Boxes\*
- 1 Group Scenario Cards\*
- 3 Box Cards\*
- (4) 3-Digit Locks\*
- Treat for the final box \*
- The Mystery Ration* Activity Sheet per student

**\*Materials Available from Oregon Agriculture in the Classroom.**

**Vocabulary:**

**Ration:** a nutrient balance meal for animals.

**Dry Matter (DM):** feed with the water content removed to reduce the dilution of nutrients.

**Crude Protein(CP):** the amount of nitrogen in feed.

**Total Digestible Nutrients (TDN):** the total amount of nutrients absorbed including protein, fiber, starch and sugars and fat.

**More Lessons:**

- At Home on the Range
- Beef: Making the Grade
- Carbon Hoofprints: Cows and Climate Change
- Double the Muscle:
- Probabilities and Pedigrees
- The Remarkable Ruminant

02/20

**Description:**

Discover the nutrient requirements of dairy cows! Students will collaborate in teams to unlock feed examples through a series of escape boxes. As students work to unlock each escape box, they will be tasked with calculating rations using the Pearson Square method to provide a balanced meal for dairy cows to enjoy!

**Background:**

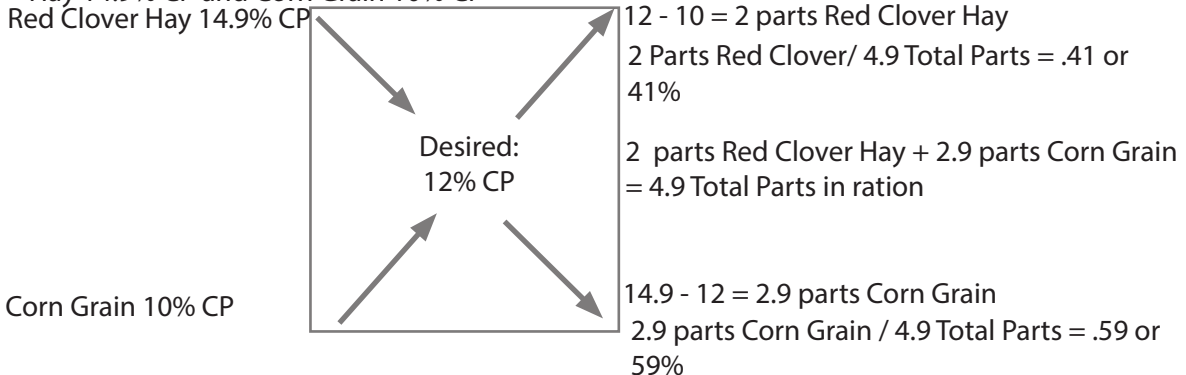
According to the USDA Census of Agriculture, in 2017 there were 54,599 dairy farms with over 9.5 million dairy cows in the United States. In 2018, dairy products ranked 4th in the top agricultural commodities in the United States with over \$35 billion in cash receipts. In Oregon, dairy products are ranked 6th, with a value of over \$70 million for exports in 2017. As one of our highest valued industries, caring for their animals is a top priority for dairy farmers.



Oregon dairy farmers care for their animals providing for their essential needs and collaborate with highly trained professionals such as nutritionists among others to ensure they are providing a well balanced meal for their cows to produce a nutritious wholesome product. 45-55% of a dairy farms operating cost goes to purchasing feed. This is one of the reasons producers pay special attention to ensure their herd's needs are met through the formulated ration's ingredients.

In this lesson, students will explore simple ration balancing through the Pearson Square method. In this mathematical computation, two feeds on a dry matter basis are balanced for one nutrient need. This can be helpful when grains are mixed for a ration to determine the amount of each ingredient needed to achieve your desired nutrient rate. In this method, you can calculate crude protein (CP), energy or total digestible nutrients (TDN). When using the Pearson Square method, there should be one feed with a nutrient concentrate above the desired rate and one with a lower rate. Begin by writing the desired nutrient rate in the center of the square, this rate is often set based on the National Research Council's Nutrient Requirement tables or by an experienced producer and their nutritionist. The two feeds are then placed on the corners of the left side (see diagram below). After the square is set up, begin by subtracting the smaller number from the larger number diagonally, follow the arrows below for reference, this will result in parts per ration. Total the sum of parts in the ration. Then using the dry matter parts on the right side, create a percentage of each feed's presence in the ration.

**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

### **Directions:**

#### **Part I: Watch the Rickreall Dairy Virtual Farm Field Trip**

Watch the virtual field trip on our website called *Rickreall Dairy - The Scoop on Cow Nutrition*. This tour will provide students with background knowledge of a dairy cow's diet and how this relates directly to their production of milk and capability of producing a wholesome nutritious product that we can enjoy!

After watching the video, use these guiding questions to transition students into the next activity.

- a. Why is dairy cow nutrition an important aspect of managing a dairy farm?
- b. How do dairy farmers ensure that their animals are receiving adequate nutrition?
- c. When developing rations for their animals, what considerations would farmers use to determine the types of feeds that go into their animal's ration?

#### **Part II: Introduction to Pearson Squares**

1. Distribute the *The Mystery Ration Activity* worksheet to students.
2. As a class, read through the background information provided at the top of the worksheet.
3. Explain to students that today we will be acting as a dairy farmer working to determine the amount of different feeds to include in our cow's ration based on the desired rate of nutrients.
4. Using the example provided on the worksheet, show students how to calculate rations using the Pearson Square method.
5. After demonstrating the Pearson Square method, have students practice this concept by completing the practice problems in Part 1 of the worksheet.
6. When students have completed the practice problems, have a few student volunteers show their work on the board to help reinforce the concepts of calculating the rations using the Pearson Square method.

#### **Part III: The Escape Box Ration Challenge!**

1. Place the escape boxes spaced out around the classroom in numerical order.
2. Divide students into 6 groups, distribute one Scenario Card to each group containing their desired nutrient rate that they will use in their Pearson Square math problems as they unlock each box.
3. Students will use Part II on their worksheet as they discover the contents of each box to do their Pearson Square math.
4. Each box will have a lock on it that students will unlock as they solve Pearson Squares. Each box will contain a card and two feed examples. Each group will solve their Pearson Square using the information on the card. On the bottom of their card it provides instructions for which number students will use to unlock the next box.

*Reference materials used in creating this lesson:*

*Kellems, Richard O., and D. C. Church. Livestock Feeds and Feeding. Prentice Hall, 2010.*

*Nutrient Requirements of Dairy Cattle. National Academy Press, 2001.*

*Tisch, David. Animal Feeds, Feeding and Nutrition, and Ration Evaluation: with CD-ROM. Thomson Delmar Learning, 2006.*



## The Mystery Ration

Student Name: \_\_\_\_\_

Dairy producers pay special attention to feed components that are included in their cow's Total Mixed Ration (TMR) to ensure their cow's nutritional needs are met through the formulated ration's ingredients. The health of their herd is crucial in the overall productivity of their farm. Dairy cow's nutrient needs change depending on their age and stage of production (producing milk or not producing milk) similar to the changes in a human's nutritional needs. On a dairy farm, feed costs account for 45-55% of the farms operating cost. This means that farmers make critical decisions on the type of feed, the cost and the nutrient levels provided to determine the most palatable and nutritious rations for their animals.

Today, you will explore simple ration balancing through the Pearson Square method. In this mathematical computation, two feeds on a dry matter basis are balanced for one nutrient need. This can be helpful when grains are mixed for a ration to determine the amount of each ingredient needed to achieve your desired nutrient rate. In this method, you can calculate crude protein (CP), energy or total digestible nutrients (TDN).

### How to Calculate using the Pearson Square Method

When using the Pearson Square method, there should be one feed with a nutrient concentrate above the desired rate and one with a lower rate.

**Step 1:** Begin by writing the desired nutrient rate in the center of the square, this rate is often set based on the National Research Council's Nutrient Requirement tables or by an experienced producer and their nutritionist.

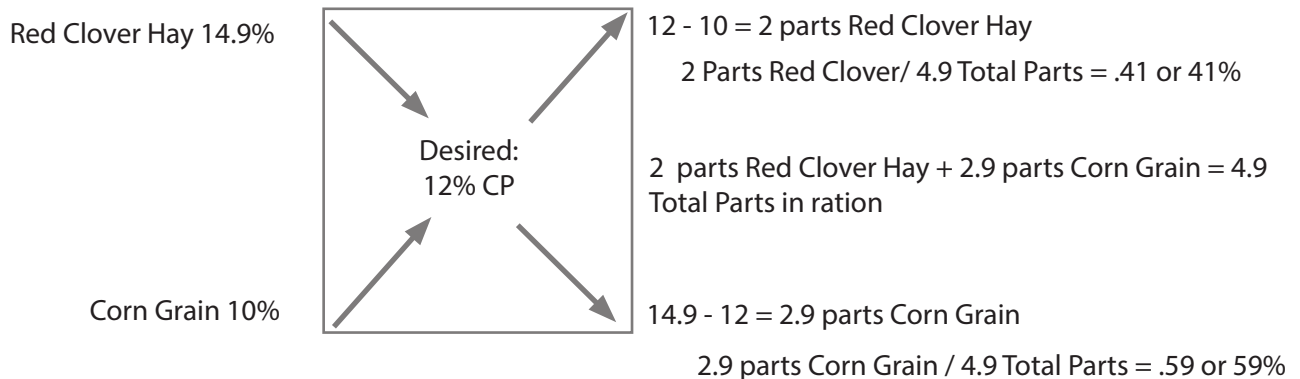
**Step 2:** The two feeds are then placed on the corners of the left side (see diagram below).

**Step 3:** After the square is set up, begin by subtracting the smaller number from the larger number diagonally follow the arrows below for reference. This will result in parts per ration.

**Step 4:** Total the sum of the parts in ration.

**Step 5:** Using the dry matter parts on the right side, create a percentage of each feed's presence in the ration.

**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



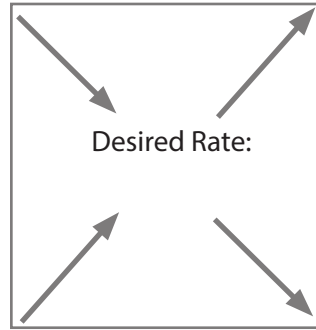
In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

## Part I: Practicing with Pearson Squares

1. Balance a ration with a desired rate of 10% CP using Ground Corn 9% CP and Soybean Seeds 42.8% CP.

**Feed 1:**



**Feed 1:**

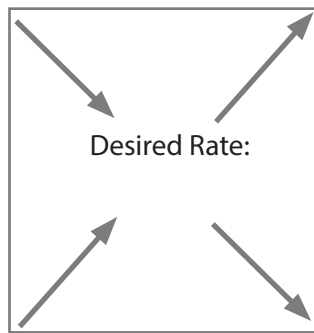
**Feed 2:**

**Feed 2:**

**Check your work:**

2. Balance a ration with a desired rate of 58% TDN using Corn Distillers Grain 86% TDN and Fescue Hay 48% TDN.

**Feed 1:**



**Feed 1:**

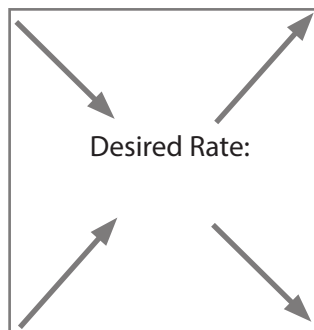
**Feed 2:**

**Feed 2:**

**Check your work:**

3. Balance a ration with a desired rate of 10% CP using Soybean Seeds 42.8% CP and Fescue Hay 9.5% CP.

**Feed 1:**



**Feed 1:**

**Feed 2:**

**Feed 2:**

**Check your work:**

**Part II: The Escape Box Ration Challenge**

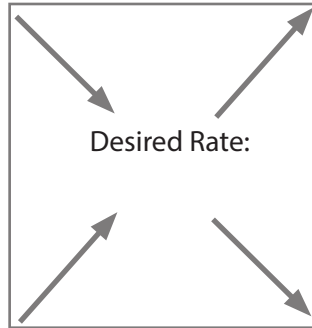
With your assigned group, read the scenario card provided by your teacher to determine your desired rate for the Pearson Square calculations. Each of the first three boxes contains a card with feed examples, using the information on your group's card, create a Pearson Square and determine how much of each of the feeds listed on the box card would be required in a ration to reach your group's desired nutrient rate. After you've finished the calculation for the box, you will use the answer the box card tells you to unlock the next locked box. The fourth and final box contains a delicious treat for your group to enjoy!

**Combination for Box 1(Use the directions at the bottom of the scenario card to determine the last digit of the combination below.):**

**Box 1**

<b>Lock #1</b>		
1	1	_____

**Feed 1:**



**Feed 1:**

**Feed 2:**

**Feed 2:**

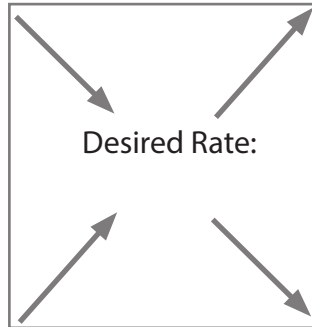
**Check your work:**

**Combination for Box 2(Use the directions at the bottom of the card from box 1 to determine the last digit of the combination below):**

**Box 2**

<b>Lock #2</b>		
1	2	_____

**Feed 1:**



**Feed 1:**

**Feed 2:**

**Feed 2:**

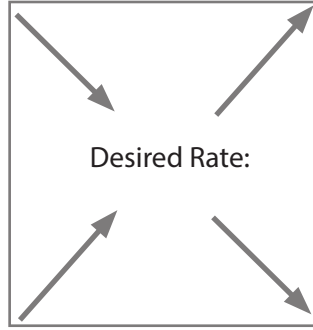
**Check your work:**

**Combination for Box 3(Use the directions at the bottom of the card from box 2 to determine the last digit of the combination below):**

<b>Lock #3</b>		
1	3	_____

**Box 3**

**Feed 1:**



**Feed 1:**

**Feed 2:**

**Feed 2:**

**Check your work:**

**Combination for Box 4(Use the directions at the bottom of the card from box 3 to determine the last digit of the combination below):**

<b>Lock #4</b>		
<b>1</b>	<b>4</b>	_____

**Box 4**

**Enjoy your treat!**



## Scenario Card: Group A

Farmer Joe is working with his nutritionist to determine the cost of different feed options that meet the nutritional needs of his dairy cow herd.

Your group will calculate each boxes feed options to determine the amount needed in the ration of each feed based on the desired nutrient rate below. Use a Pearson square to determine the amounts needed of each feed.

**DESIRED RATE: 17% Crude Protein**

To unlock the first box with the first feed combination option, you will use the digit in the ones location of your desired rate.



## Scenario Card: Group B

Farmer Joe is working with his nutritionist to determine the cost of different feed options that meet the nutritional needs of his dairy cow herd.

Your group will calculate each boxes feed options to determine the amount needed in the ration of each feed based on the desired nutrient rate below. Use a Pearson square to determine the amounts needed of each feed.

**DESIRED RATE: 68% Total Digestible Nutrients**

To unlock the first box with the first feed combination option, you will use the digit in the ones location of your desired rate.



## Scenario Card: Group C

Farmer Joe is working with his nutritionist to determine the cost of different feed options that meet the nutritional needs of his dairy cow herd.

Your group will calculate each boxes feed options to determine the amount needed in the ration of each feed based on the desired nutrient rate below. Use a Pearson square to determine the amounts needed of each feed.

**DESIRED RATE: 17.9% Crude Protein**

To unlock the first box with the first feed combination option, you will use the digit in the ones location of your desired rate.



## Scenario Card: Group D

Farmer Joe is working with his nutritionist to determine the cost of different feed options that meet the nutritional needs of his dairy cow herd.

Your group will calculate each boxes feed options to determine the amount needed in the ration of each feed based on the desired nutrient rate below. Use a Pearson square to determine the amounts needed of each feed.

**DESIRED RATE: 78% Total Digestible Nutrients**

To unlock the first box with the first feed combination option, you will use the digit in the ones location of your desired rate.



## Scenario Card: Group E

Farmer Joe is working with his nutritionist to determine the cost of different feed options that meet the nutritional needs of his dairy cow herd.

Your group will calculate each boxes feed options to determine the amount needed in the ration of each feed based on the desired nutrient rate below. Use a Pearson square to determine the amounts needed of each feed.

**DESIRED RATE: 14.1% Crude Protein**

To unlock the first box with the first feed combination option, you will use the digit in the ones location of your desired rate.



## Scenario Card: Group F

Farmer Joe is working with his nutritionist to determine the cost of different feed options that meet the nutritional needs of his dairy cow herd.

Your group will calculate each boxes feed options to determine the amount needed in the ration of each feed based on the desired nutrient rate below. Use a Pearson square to determine the amounts needed of each feed.

**DESIRED RATE: 78% Total Digestible Nutrients**

To unlock the first box with the first feed combination option, you will use the digit in the ones location of your desired rate.



# Group A

## Box 1:

Cottonseed 23.9% CP

Alfalfa Hay 13% CP

Calculate the amount of each ingredient needed to reach your desired rate using the Pearson Square method. To unlock box 2, use the number in the **tens** spot of the percentage of **alfalfa** needed to reach your desired crude protein rate.



# Group B

## Box 1:

Cottonseed 96% TDN

Alfalfa Hay 50% TDN

Calculate the amount of each ingredient needed to reach your desired rate using the Pearson Square method. To unlock box 2, use the number in the **tens** spot of the percentage of **alfalfa** needed to reach your desired Total Digestible Nutrients rate.



# Group C

## Box 1:

Cottonseed 23.9% CP

Alfalfa Hay 13% CP

Calculate the amount of each ingredient needed to reach your desired rate using the Pearson Square method. To unlock box 2, use the number in the **tens** spot of the percentage of **alfalfa** needed to reach your desired crude protein rate.



# Group D

## Box 1:

Cottonseed 96% TDN

Alfalfa Hay 50% TDN

Calculate the amount of each ingredient needed to reach your desired rate using the Pearson Square method. To unlock box 2, use the number in the **tens** spot of the percentage of **alfalfa** needed to reach your desired Total Digestible Nutrients rate.



# Group E

## Box 1:

Cottonseed 23.9% CP

Alfalfa Hay 13% CP

Calculate the amount of each ingredient needed to reach your desired rate using the Pearson Square method. To unlock box 2, use the number in the **tens** spot of the percentage of **alfalfa** needed to reach your desired crude protein rate.



# Group F

## Box 1:

Cottonseed 96% TDN

Alfalfa Hay 50% TDN

Calculate the amount of each ingredient needed to reach your desired rate using the Pearson Square method. To unlock box 2, use the number in the **tens** spot of the percentage of **alfalfa** needed to reach your desired Total Digestible Nutrients rate.





# Group A

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## Box 2:

Soybean Meal 49.9% CP

Ground Corn 3.2% CP

To unlock box 3, use the number in the **tens** spot of the percentage of **soybean meal** needed to reach your desired Crude Protein rate.



# Group B

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## Box 2:

Soybean Meal 84% TDN

Ground Corn 50% TDN

To unlock box 3, use the number in the **tens** spot of the percentage of **soybean meal** needed to reach your desired Total Digestible Nutrients rate.



# Group C

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## Box 2:

Soybean Meal 49.9% CP

Ground Corn 3.2% CP

To unlock box 3, use the number in the **tens** spot of the percentage of **soybean meal** needed to reach your desired Crude Protein rate.



# Group D

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## Box 2:

Soybean Meal 84% TDN

Ground Corn 50% TDN

To unlock box 3, use the number in the **tens** spot of the percentage of **soybean meal** needed to reach your desired Total Digestible Nutrients rate.



# Group E

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## Box 2:

Soybean Meal 49.9% CP

Ground Corn 3.2% CP

To unlock box 3, use the number in the **tens** spot of the percentage of **soybean meal** needed to reach your desired Crude Protein rate.



# Group F

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## Box 2:

Soybean Meal 84% TDN

Ground Corn 50% TDN

To unlock box 3, use the number in the **tens** spot of the percentage of **soybean meal** needed to reach your desired Total Digestible Nutrients rate.



# Group A

## Box 3:

Dried Distillers Grain 29.7% CP

Grass Hay 10.6% CP

To unlock box 4, use the number in the **tens** spot of the percentage of **grass hay** needed to reach your desired Crude Protein rate.



# Group B

## Box 3:

Dried Distillers Grain 79.5% TDN

Grass Hay 56.3% TDN

To unlock box 4, use your the number in the **tens** spot of the percentage of **grass hay** needed to reach your desired Total Digestible Nutrients rate.



# Group C

## Box 3:

Dried Distillers Grain 29.7% CP

Grass Hay 10.6% CP

To unlock box 4, use the number in the **tens** spot of the percentage of **grass hay** needed to reach your desired Crude Protein rate.



# Group D

## Box 3:

Dried Distillers Grain 79.5% TDN

Grass Hay 56.3% TDN

To unlock box 4, use your the number in the **tens** spot of the percentage of **grass hay** needed to reach your desired Total Digestible Nutrients rate.



# Group E

## Box 3:

Dried Distillers Grain 29.7% CP

Grass Hay 10.6% CP

To unlock box 4, use the number in the **tens** spot of the percentage of **grass hay** needed to reach your desired crude protein rate.



# Group F

## Box 3:

Dried Distillers Grain 79.5% TDN

Grass Hay 56.3% TDN

To unlock box 4, use your the number in the **tens** spot of the percentage of **grass hay** needed to reach your desired Total Digestible Nutrients rate.



## The Mystery Ration

Student Name: \_\_\_\_\_

Dairy producers pay special attention to feed components that are included in their cow's Total Mixed Ration (TMR) to ensure their cow's nutritional needs are met through the formulated ration's ingredients. The health of their herd is crucial in the overall productivity of their farm. Dairy cow's nutrient needs change depending on their age and stage of production (producing milk or not producing milk) similar to the changes in a human's nutritional needs. On a dairy farm, feed costs account for 45-55% of the farms operating cost. This means that farmers make critical decisions on the type of feed, the cost and the nutrient levels provided to determine the most palatable and nutritious rations for their animals.

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When using the Pearson Square method, there should be one feed with a nutrient concentrate above the desired rate and one with a lower rate.

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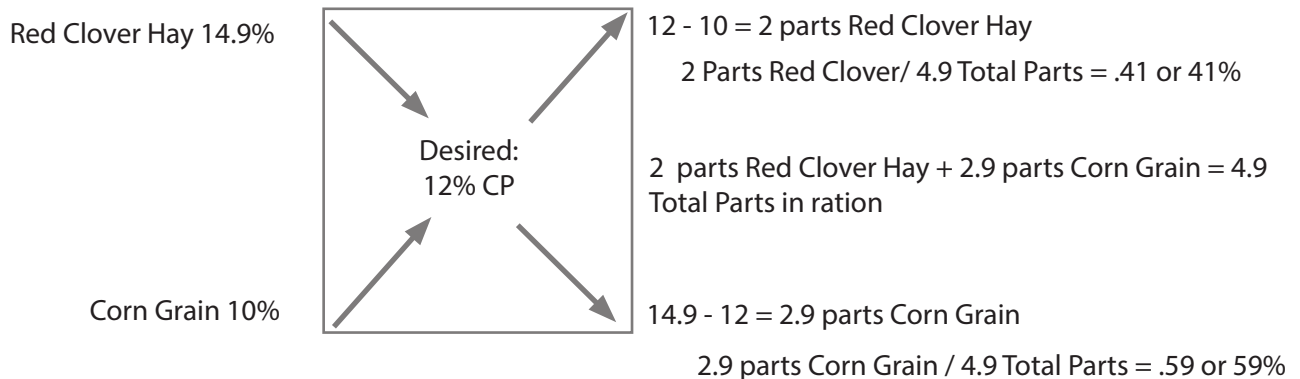
**Step 2:** The two feeds are then placed on the corners of the left side (see diagram below).

**Step 3:** After the square is set up, begin by subtracting the smaller number from the larger number diagonally follow the arrows below for reference. This will result in parts per ration.

**Step 4:** Total the sum of the parts in ration.

**Step 5:** Using the dry matter parts on the right side, create a percentage of each feed's presence in the ration.

**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



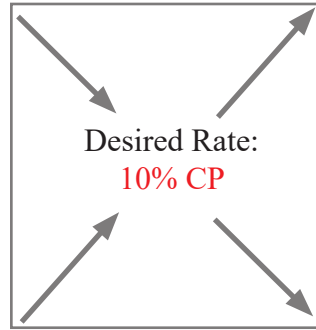
In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

**Part I: Practicing with Pearson Squares - Group A Answer Key**

1. Balance a ration with a desired rate of 10% CP using Ground Corn 9% CP and Soybean Seeds 42.8% CP.

**Feed 1:**  
Ground Corn 9% CP



**Feed 2:**  
Soybean Seed 42.8% CP

**Feed 1:**

$$42.8 - 10 = 32.8 \text{ parts Ground Corn}$$

$$32.8 / 33.8 = .97 \text{ or } 97\% \text{ Ground Corn}$$

32.8 parts Ground Corn + 1 part Soybean Seed = 33.8 total parts in ration

**Feed 2:**

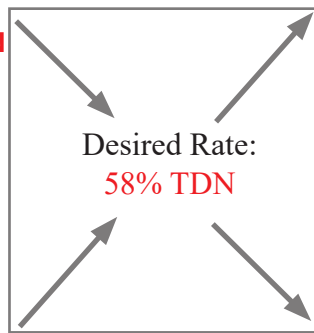
$$10 - 9 = 1 \text{ part Soybean Seed}$$

$$1 / 33.8 = .029 \text{ or } 3\% \text{ Soybean Seed}$$

**Check your work:**  $97 (.09) + 3 (.428) = 10$

2. Balance a ration with a desired rate of 58% TDN using Corn Distillers Grain 86% TDN and Fescue Hay 48% TDN.

**Feed 1:**  
Corn Distillers Grain 86% TDN



**Feed 2:**  
Fescue Hay 48% TDN

**Feed 1:**

$$86 - 48 = 38 \text{ parts Corn Distillers Grain}$$

$$38 / 138 = .26 \text{ or } 26\% \text{ Corn Distillers Grain}$$

28 parts Fescue Hay + 38 parts Corn Distillers Grain = 66 total parts in ration

**Feed 2:**

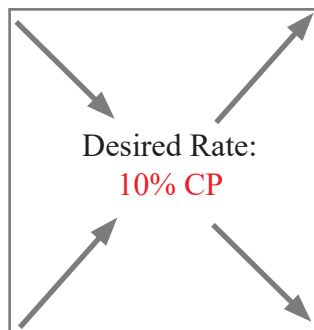
$$86 - 58 = 28 \text{ parts Fescue Hay}$$

$$28 / 66 = .42 \text{ or } 42\% \text{ Fescue Hay}$$

**Check your work:**  $26 (.86) + 42 (.48) = 58$

3. Balance a ration with a desired rate of 10% CP using Soybean Seeds 42.8% CP and Fescue Hay 9.5% CP.

**Feed 1:**  
Soybean Seeds 42.8% CP



**Feed 2:**  
Fescue Hay 9.5% CP

**Feed 1:**

$$42.8 - 10 = 32.8 \text{ parts Soybean Seeds}$$

$$32.8 / 33.3 = .98 \text{ or } 98\% \text{ Soybean Seeds}$$

32.8 parts Fescue Hay + .5 parts Soybean Seeds = 33.3 total parts in ration

**Feed 2:**

$$10 - 9.5 = .5 \text{ parts Fescue Hay}$$

$$.5 / 33.3 = .015 \text{ or } 1.5\% \text{ Fescue Hay}$$

**Check your work:**  $2 (.428) + 98 (.095) = 10$

## Part II: The Escape Box Ration Challenge - Answers for Group A

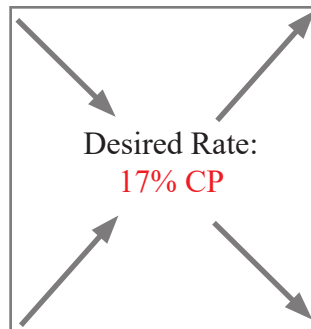
With your assigned group, read the scenario card provided by your teacher to determine your desired rate for the Pearson Square calculations. Each of the first three boxes contains a card for each group and feed examples, using the information on your group's card to create a Pearson Square and determine how much of each of the feeds listed on the box card would be required in a ration to reach your group's desired nutrient rate. After each group has finished their calculations for a box, you will use the answer the box card tells you to unlock the next locked box. The fourth and final box contains a delicious treat for your class to enjoy!

**Combination for Box 1 (Use the directions at the bottom of the scenario card to determine the last digit of the combination below.):**

<b>Lock #1</b>		
1	1	7

### Box 1

**Feed 1:**  
Cottonseed 23.9% CP



**Feed 1:**

$17 - 13 = 4$  parts Cottonseed  
 $4 / 10.9 = .366$  or 37% Cottonseed  
 $6.9$  parts Alfalfa Hay +  $4$  parts Cottonseed =  $10.9$  total parts in ration

**Feed 2:**  
Alfalfa Hay 13% CP

**Feed 2:**

$23.9 - 17 = 6.9$  parts Alfalfa Hay  
 $6.9 / 10.9 = .633$  or 63% Alfalfa Hay

**Check your work:**  $37 (.239) + 63 (.13) = 17$

**Combination for Box 2 (Use the directions at the bottom of the card from box 1 to determine the last digit of the combination below.):**

<b>Lock #2</b>		
1	2	6

### Box 2

**Feed 1:**  
Soybean Meal 49.9% CP



**Feed 1:**

$17 - 3.2 = 13.8$  parts Soybean Meal  
 $13.8 / 46.7 = .295$  or 30% Soybean Meal  
 $13.8$  parts Soybean Meal +  $32.9$  parts Ground Corn =  $46.7$  Total parts in ration

**Feed 2:**  
Ground Corn 3.2% CP

**Feed 2:**

$49.9 - 17 = 32.9$  parts Ground Corn  
 $32.9 / 46.7 = .704$  or 70% Ground Corn

**Check your work:**  $30 (.499) + 70 (.032) = 17$

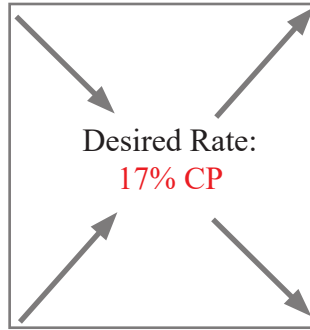
**Combination for Box 3 (Use the directions at the bottom of the card from box 2 to determine the last digit of the combination below.):**

<b>Lock #3</b>		
1	3	3

**Box 3**

**Feed 1:**  
**Dried Distillers Grain 29.7%CP**

**Feed 2:**  
**Grass Hay 10.6% CP**



**Feed 1:**  
 $17 - 10.6 = 6.4$  parts Dried Distillers Grain  
 $6.4 / 19.1 = .335$  or 34% Dried Distiller Grain

$6.4$  parts Dried Distillers Grain +  $12.7$  parts Grass Hay  
=  $19.1$  total parts in ration

**Feed 2:**  
 $29.7 - 17 = 12.7$  parts Grass Hay  
 $12.7 / 19.1 = .664$  or 66% Grass Hay

**Check your work:**  $34 (.297) + 66 (.106) = 17.0$

Combination for Box 4(Use the directions at the bottom of the card from box 3 to determine the last digit of the combination below.)

<b>Lock #4</b>		
<b>1</b>	<b>4</b>	<b>6</b>

**Box 4**

Enjoy your treat!



## The Mystery Ration

Student Name: \_\_\_\_\_

Dairy producers pay special attention to feed components that are included in their cow's Total Mixed Ration (TMR) to ensure their cow's nutritional needs are met through the formulated ration's ingredients. The health of their herd is crucial in the overall productivity of their farm. Dairy cow's nutrient needs change depending on their age and stage of production (producing milk or not producing milk) similar to the changes in a human's nutritional needs. On a dairy farm, feed costs account for 45-55% of the farms operating cost. This means that farmers make critical decisions on the type of feed, the cost and the nutrient levels provided to determine the most palatable and nutritious rations for their animals.

Today, you will explore simple ration balancing through the Pearson Square method. In this mathematical computation, two feeds on a dry matter basis are balanced for one nutrient need. This can be helpful when grains are mixed for a ration to determine the amount of each ingredient needed to achieve your desired nutrient rate. In this method, you can calculate crude protein (CP), energy or total digestible nutrients (TDN).

### How to Calculate using the Pearson Square Method

When using the Pearson Square method, there should be one feed with a nutrient concentrate above the desired rate and one with a lower rate.

**Step 1:** Begin by writing the desired nutrient rate in the center of the square, this rate is often set based on the National Research Council's Nutrient Requirement tables or by an experienced producer and their nutritionist.

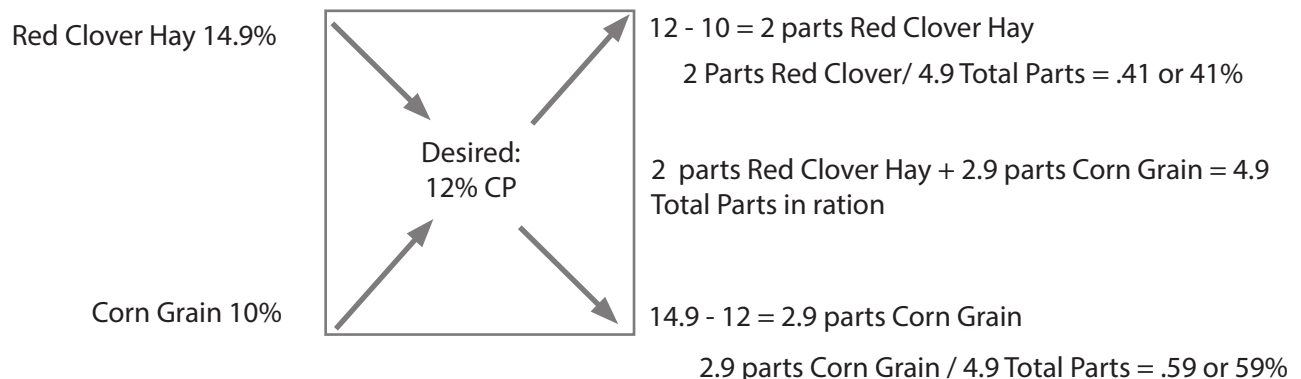
**Step 2:** The two feeds are then placed on the corners of the left side (see diagram below).

**Step 3:** After the square is set up, begin by subtracting the smaller number from the larger number diagonally follow the arrows below for reference. This will result in parts per ration.

**Step 4:** Total the sum of the parts in ration.

**Step 5:** Using the dry matter parts on the right side, create a percentage of each feed's presence in the ration.

**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



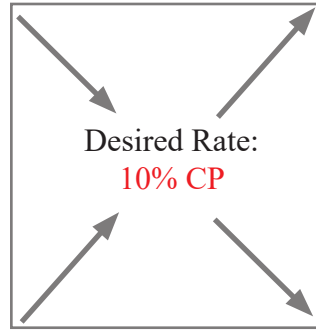
In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

**Part I: Practicing with Pearson Squares - Group B Answer Key**

1. Balance a ration with a desired rate of 10% CP using Ground Corn 9% CP and Soybean Seeds 42.8% CP.

**Feed 1:**  
Ground Corn 9% CP



**Feed 1:**

$$42.8 - 10 = 32.8 \text{ parts Ground Corn}$$
$$32.8 / 33.8 = .97 \text{ or } 97\% \text{ Ground Corn}$$

32.8 parts Ground Corn + 1 part Soybean Seed = 33.8 total parts in ration

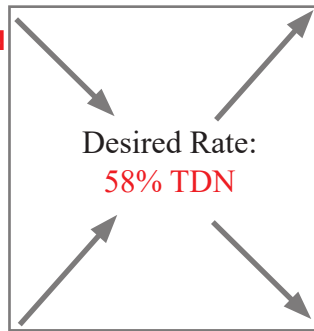
**Feed 2:**

$$10 - 9 = 1 \text{ part Soybean Seed}$$
$$1 / 33.8 = .029 \text{ or } 3\% \text{ Soybean Seed}$$

**Check your work:**  $97 (.09) + 3 (.428) = 10$

2. Balance a ration with a desired rate of 58% TDN using Corn Distillers Grain 86% TDN and Fescue Hay 48% TDN.

**Feed 1:**  
Corn Distillers Grain 86% TDN



**Feed 1:**

$$58 - 48 = 10 \text{ parts Corn Distillers Grain}$$
$$10 / 38 = .26 \text{ or } 26\% \text{ Corn Distillers Grain}$$

28 parts Fescue Hay + 10 parts Corn Distillers Grain = 38 total parts in ration

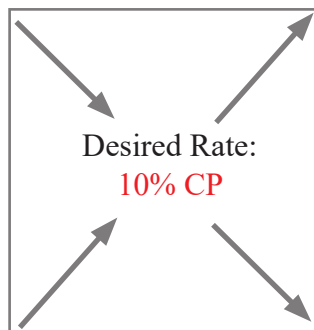
**Feed 2:**

$$86 - 58 = 28 \text{ parts Fescue Hay}$$
$$28 / 38 = .74 \text{ or } 74\% \text{ Fescue Hay}$$

**Check your work:**  $26 (.86) + 74 (.48) = 58$

3. Balance a ration with a desired rate of 10% CP using Soybean Seeds 42.8% CP and Fescue Hay 9.5% CP.

**Feed 1:**  
Soybean Seeds 42.8% CP



**Feed 1:**

$$10 - 9.5 = .5 \text{ parts Soybean Seeds}$$
$$.5 / 33.3 = .02 \text{ or } 2\% \text{ Soybean Seeds}$$

32.8 parts Fescue Hay + .5 parts Soybean Seeds = 33.3 total parts in ration

**Feed 2:**

$$42.8 - 10 = 32.8 \text{ parts Fescue Hay}$$
$$32.8 / 33.3 = .98 \text{ or } 98\% \text{ Fescue Hay}$$

**Check your work:**  $2 (.428) + 98 (.095) = 10$



## Part II: The Escape Box Ration Challenge - Answers for Group B

With your assigned group, read the scenario card provided by your teacher to determine your desired rate for the Pearson Square calculations. Each of the first three boxes contains a card for each group and feed examples, using the information on your group's card to create a Pearson Square and determine how much of each of the feeds listed on the box card would be required in a ration to reach your group's desired nutrient rate. After each group has finished their calculations for a box, you will use the answer the box card tells you to unlock the next locked box. The fourth and final box contains a delicious treat for your class to enjoy!

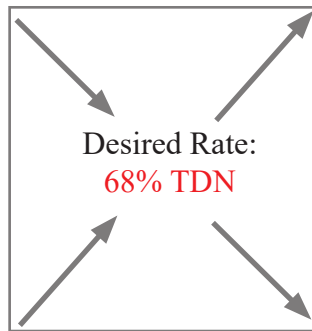
**Combination for Box 1 (Use the directions at the bottom of the scenario card to determine the last digit of the combination below.):**

Lock #1		
2	1	8

### Box 1

Feed 1:

Cottonseed 96% TDN



Feed 1:

$$68 - 50 = 18 \text{ parts Cottonseed}$$

$$18 / 46 = .391 \text{ or } 39\% \text{ Cottonseed}$$

18 parts Cottonseed + 28 parts Alfalfa Hay = 46 total parts in ration

Feed 2:

$$96 - 68 = 28 \text{ parts Alfalfa Hay}$$

$$28 / 46 = .608 \text{ or } 61\% \text{ Alfalfa Hay}$$

Feed 2:

Alfalfa Hay 50% TDN

Check your work:  $39 (.96) + 61 (.50) = 68$

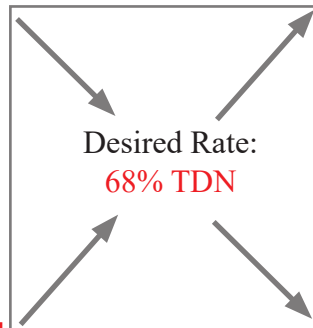
**Combination for Box 2 (Use the directions at the bottom of the card from box 1 to determine the last digit of the combination below.):**

Lock #2		
2	2	6

### Box 2

Feed 1:

Soybean Meal 84% TDN



Feed 1:

$$68 - 50 = 18 \text{ parts Soybean Meal}$$

$$18 / 34 = .529 \text{ or } 53\% \text{ Soybean Meal}$$

18 parts Soybean Meal + 16 parts Ground Corn = 34 total parts in ration

Feed 2:

$$84 - 68 = 16 \text{ parts Ground Corn}$$

$$16 / 34 = .470 \text{ or } 47\% \text{ Ground Corn}$$

Feed 2:

Ground Corn 50% TDN

Check your work:  $47 (.5) + 53 (.84) = 68$

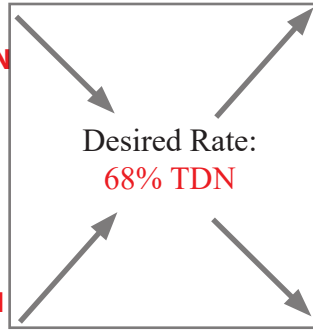
**Combination for Box 3 (Use the directions at the bottom of the card from box 2 to determine the last digit of the combination below.):**

Lock #3		
2	3	5

**Box 3**

**Feed 1:**  
**Dried Distillers Grain 79.5% TDN**

**Feed 2:**  
**Grass Hay 56.3% TDN**



**Feed 1:**  
 $68 - 56.3 = 11.7$  parts Dried Distillers Grain  
 $11.7 / 23.2 = .504$  or 50% Dried Distillers Grain

$11.7$  parts Dried Distillers Grain +  $11.5$  parts Grass Hay  
=  $23.2$  total parts in ration

**Feed 2:**  
 $79.5 - 68 = 11.5$  parts Grass Hay  
 $11.5 / 23.2 = .495$  or 50% Grass Hay

**Check your work:**  $50 (.563) + 50 (.795) = 67.9$

Combination for Box 4 (Use the directions at the bottom of the card from box 3 to determine the last digit of the combination below.):

<b>Lock #4</b>		
<b>2</b>	<b>4</b>	<b>5</b>

**Box 4**

Enjoy your treat!



## The Mystery Ration

Student Name: \_\_\_\_\_

Dairy producers pay special attention to feed components that are included in their cow's Total Mixed Ration (TMR) to ensure their cow's nutritional needs are met through the formulated ration's ingredients. The health of their herd is crucial in the overall productivity of their farm. Dairy cow's nutrient needs change depending on their age and stage of production (producing milk or not producing milk) similar to the changes in a human's nutritional needs. On a dairy farm, feed costs account for 45-55% of the farms operating cost. This means that farmers make critical decisions on the type of feed, the cost and the nutrient levels provided to determine the most palatable and nutritious rations for their animals.

Today, you will explore simple ration balancing through the Pearson Square method. In this mathematical computation, two feeds on a dry matter basis are balanced for one nutrient need. This can be helpful when grains are mixed for a ration to determine the amount of each ingredient needed to achieve your desired nutrient rate. In this method, you can calculate crude protein (CP), energy or total digestible nutrients (TDN).

### How to Calculate using the Pearson Square Method

When using the Pearson Square method, there should be one feed with a nutrient concentrate above the desired rate and one with a lower rate.

**Step 1:** Begin by writing the desired nutrient rate in the center of the square, this rate is often set based on the National Research Council's Nutrient Requirement tables or by an experienced producer and their nutritionist.

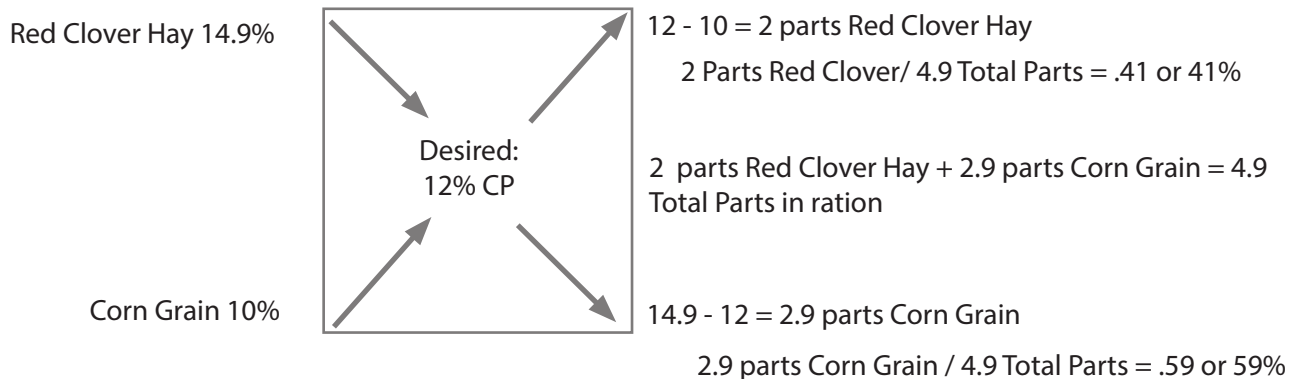
**Step 2:** The two feeds are then placed on the corners of the left side (see diagram below).

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**Step 4:** Total the sum of the parts in ration.

**Step 5:** Using the dry matter parts on the right side, create a percentage of each feed's presence in the ration.

**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



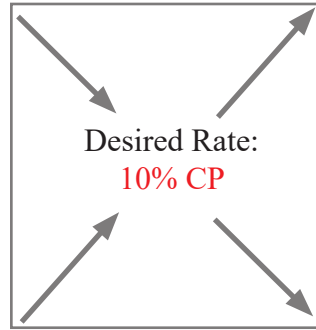
In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

**Part I: Practicing with Pearson Squares - Group C Answer Key**

1. Balance a ration with a desired rate of 10% CP using Ground Corn 9% CP and Soybean Seeds 42.8% CP.

**Feed 1:**  
Ground Corn 9% CP



**Feed 2:**  
Soybean Seed 42.8% CP

**Feed 1:**

$$42.8 - 10 = 32.8 \text{ parts Ground Corn}$$

$$32.8 / 33.8 = .97 \text{ or } 97\% \text{ Ground Corn}$$

32.8 parts Ground Corn + 1 part Soybean Seed = 33.8 total parts in ration

**Feed 2:**

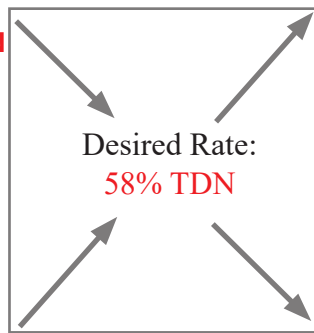
$$10 - 9 = 1 \text{ part Soybean Seed}$$

$$1 / 33.8 = .029 \text{ or } 3\% \text{ Soybean Seed}$$

**Check your work:**  $97 (.09) + 3 (.428) = 10$

2. Balance a ration with a desired rate of 58% TDN using Corn Distillers Grain 86% TDN and Fescue Hay 48% TDN.

**Feed 1:**  
Corn Distillers Grain 86% TDN



**Feed 2:**  
Fescue Hay 48% TDN

**Feed 1:**

$$86 - 48 = 38 \text{ parts Corn Distillers Grain}$$

$$38 / 158 = .26 \text{ or } 26\% \text{ Corn Distillers Grain}$$

28 parts Fescue Hay + 10 parts Corn Distillers Grain = 38 total parts in ration

**Feed 2:**

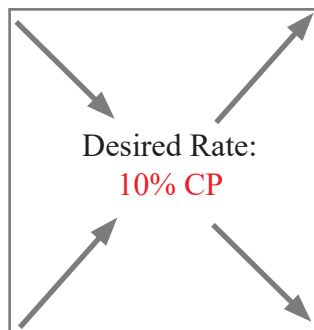
$$86 - 58 = 28 \text{ parts Fescue Hay}$$

$$28 / 38 = .74 \text{ or } 74\% \text{ Fescue Hay}$$

**Check your work:**  $26 (.86) + 74 (.48) = 58$

3. Balance a ration with a desired rate of 10% CP using Soybean Seeds 42.8% CP and Fescue Hay 9.5% CP.

**Feed 1:**  
Soybean Seeds 42.8% CP



**Feed 2:**  
Fescue Hay 9.5% CP

**Feed 1:**

$$42.8 - 9.5 = 33.3 \text{ parts Soybean Seeds}$$

$$33.3 / 33.3 = 1.00 \text{ or } 100\% \text{ Soybean Seeds}$$

33.3 parts Fescue Hay + 0 parts Soybean Seeds = 33.3 total parts in ration

**Feed 2:**

$$42.8 - 10 = 32.8 \text{ parts Fescue Hay}$$

$$32.8 / 33.3 = .98 \text{ or } 98\% \text{ Fescue Hay}$$

**Check your work:**  $2 (.428) + 98 (.095) = 10$

## Part II: The Escape Box Ration Challenge - Answers for Group C

With your assigned group, read the scenario card provided by your teacher to determine your desired rate for the Pearson Square calculations. Each of the first three boxes contains a card for each group and feed examples, using the information on your group's card to create a Pearson Square and determine how much of each of the feeds listed on the box card would be required in a ration to reach your group's desired nutrient rate. After each group has finished their calculations for a box, you will use the answer the box card tells you to unlock the next locked box. The fourth and final box contains a delicious treat for your class to enjoy!

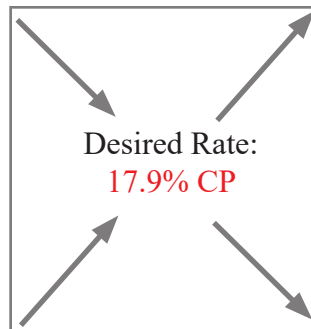
**Combination for Box 1 (Use the directions at the bottom of the scenario card to determine the last digit of the combination below.):**

<b>Lock #1</b>		
<b>3</b>	<b>1</b>	<b>7</b>

### Box 1

**Feed 1:**

**Cottonseed 23.9% CP**



**Feed 1:**

$17.9 - 13 = 4.9$  parts Cottonseed  
 $4.9 / 10.9 = .449$  or 45% Cottonseed

$6$  parts Alfalfa hay +  $4.9$  parts Cottonseed =  $10.9$  total parts in ration

**Feed 2:**

**Alfalfa Hay 13% CP**

**Feed 2:**

$23.9 - 17.9 = 6$  parts Alfalfa Hay  
 $6 / 10.9 = .550$  or 55% Alfalfa Hay

**Check your work:**  $45 (.239) + 55 (.13) = 17.9$

**Combination for Box 2 (Use the directions at the bottom of the card from box 1 to determine the last digit of the combination below.):**

<b>Lock #2</b>		
<b>3</b>	<b>2</b>	<b>5</b>

### Box 2

**Feed 1:**

**Soybean Meal 49.9% CP**



**Feed 1:**

$17.9 - 3.2 = 14.7$  parts Soybean Meal  
 $14.7 / 46.7 = .314$  or 31% Soybean Meal

$32$  parts Ground Corn +  $14.7$  parts Soybean Meal =  $46.7$  total parts in ration

**Feed 2:**

**Ground Corn 3.2% CP**

**Feed 2:**

$49.9 - 17.9 = 32$  parts Ground Corn  
 $32 / 46.7 = .685$  or 69% Ground Corn

**Check your work:**  $31 (.499) + 69 (.032) = 17.9$

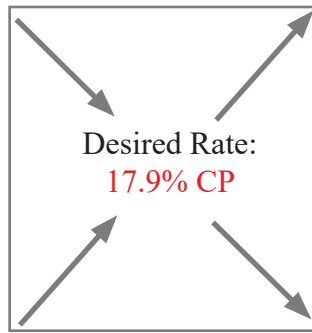
**Combination for Box 3 (Use the directions at the bottom of the card from box 2 to determine the last digit of the combination below.):**

<b>Lock #3</b>		
<b>3</b>	<b>3</b>	<b>3</b>

**Box 3**

**Feed 1:**  
**Dried Distillers Grain 29.7% CP**

**Feed 2:**  
**Grass Hay 10.6% CP**



**Feed 1:**  
 $17.9 - 10.6 = 7.3$  parts Dried Distillers Grain  
 $7.3 / 19.1 = .382$  or 38% Dried Distillers Grain

$7.3$  parts Dried Distillers Grain +  $11.8$  parts Grass Hay  
=  $7.7$  total parts in ration

**Feed 2:**  
 $29.7 - 17.9 = 11.8$  parts Grass Hay  
 $11.8 / 19.1 = .617$  or 62% Grass Hay

**Check your work:**  $38 (.297) + 62 (.106) = 17.85$

Combination for Box 4 (Use the directions at the bottom of the card from box 3 to determine the last digit of the combination below.):

<b>Lock #4</b>		
<b>3</b>	<b>4</b>	<b>6</b>

**Box 4**

Enjoy your treat!



## The Mystery Ration

Student Name: \_\_\_\_\_

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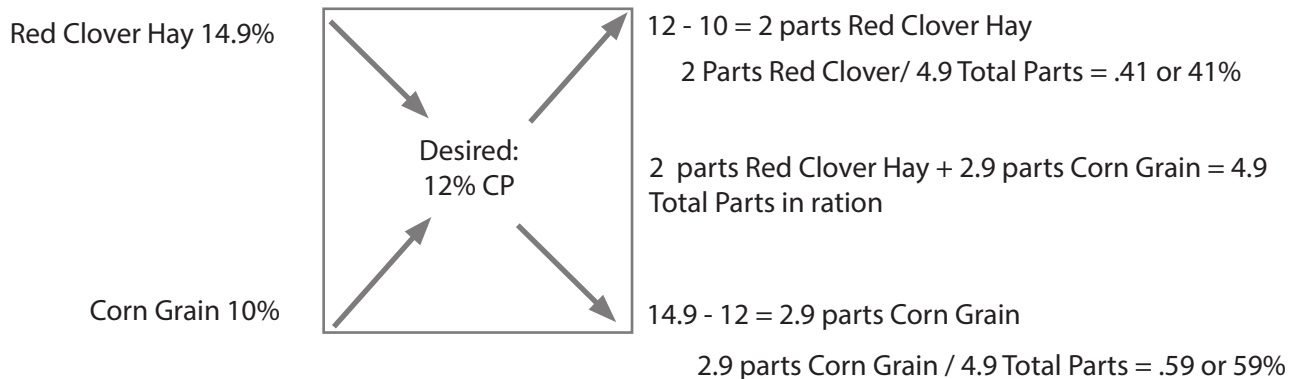
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**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



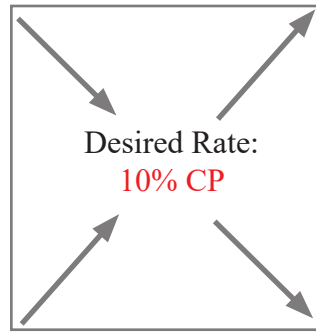
In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

**Part I: Practicing with Pearson Squares - Group D Answer Key**

1. Balance a ration with a desired rate of 10% CP using Ground Corn 9% CP and Soybean Seeds 42.8% CP.

**Feed 1:**  
Ground Corn 9% CP



**Feed 1:**

$$42.8 - 10 = 32.8 \text{ parts Ground Corn}$$
$$32.8 / 33.8 = .97 \text{ or } 97\% \text{ Ground Corn}$$

32.8 parts Ground Corn + 1 part Soybean Seed = 33.8 total parts in ration

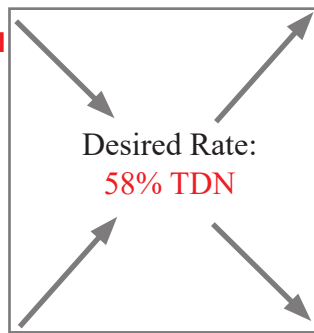
**Feed 2:**

$$10 - 9 = 1 \text{ part Soybean Seed}$$
$$1 / 33.8 = .029 \text{ or } 3\% \text{ Soybean Seed}$$

**Check your work:**  $97 (.09) + 3 (.428) = 10$

2. Balance a ration with a desired rate of 58% TDN using Corn Distillers Grain 86% TDN and Fescue Hay 48% TDN.

**Feed 1:**  
Corn Distillers Grain 86% TDN



**Feed 1:**

$$58 - 48 = 10 \text{ parts Corn Distillers Grain}$$
$$10 / 38 = .26 \text{ or } 26\% \text{ Corn Distillers Grain}$$

28 parts Fescue Hay + 10 parts Corn Distillers Grain = 38 total parts in ration

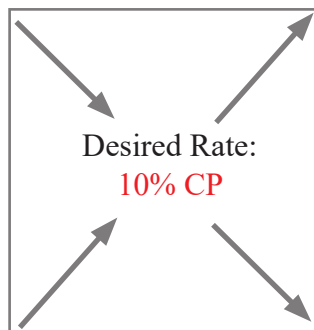
**Feed 2:**

$$86 - 58 = 28 \text{ parts Fescue Hay}$$
$$28 / 38 = .74 \text{ or } 74\% \text{ Fescue Hay}$$

**Check your work:**  $26 (.86) + 74 (.48) = 58$

3. Balance a ration with a desired rate of 10% CP using Soybean Seeds 42.8% CP and Fescue Hay 9.5% CP.

**Feed 1:**  
Soybean Seeds 42.8% CP



**Feed 1:**

$$10 - 9.5 = .5 \text{ parts Soybean Seeds}$$
$$.5 / 33.3 = .02 \text{ or } 2\% \text{ Soybean Seeds}$$

32.8 parts Fescue Hay + .5 parts Soybean Seeds = 33.3 total parts in ration

**Feed 2:**

$$42.8 - 10 = 32.8 \text{ parts Fescue Hay}$$
$$32.8 / 33.3 = .98 \text{ or } 98\% \text{ Fescue Hay}$$

**Check your work:**  $2 (.428) + 98 (.095) = 10$



## Part II: The Escape Box Ration Challenge - Answers for Group D

With your assigned group, read the scenario card provided by your teacher to determine your desired rate for the Pearson Square calculations. Each of the first three boxes contains a card for each group and feed examples, using the information on your group's card to create a Pearson Square and determine how much of each of the feeds listed on the box card would be required in a ration to reach your group's desired nutrient rate. After each group has finished their calculations for a box, you will use the answer the box card tells you to unlock the next locked box. The fourth and final box contains a delicious treat for your class to enjoy!

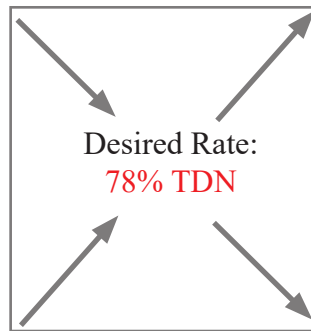
**Combination for Box 1 (Use the directions at the bottom of the scenario card to determine the last digit of the combination below.):**

<b>Lock #1</b>		
<b>4</b>	<b>1</b>	<b>8</b>

### Box 1

**Feed 1:**

**Cottonseed 96% TDN**



**Feed 1:**

$$78 - 50 = 28 \text{ parts Cottonseed}$$

$$28 / 46 = .608 \text{ or } 61\% \text{ Cottonseed}$$

28 parts Cottonseed + 18 parts Alfalfa Hay = 46 total parts in ration

**Feed 2:**

**Alfalfa Hay 50% TDN**

**Feed 2:**

$$96 - 78 = 18 \text{ parts Alfalfa Hay}$$

$$18 / 46 = .391 \text{ or } 39\% \text{ Alfalfa Hay}$$

**Check your work:**  $61 (.96) + 39 (.50) = 78$

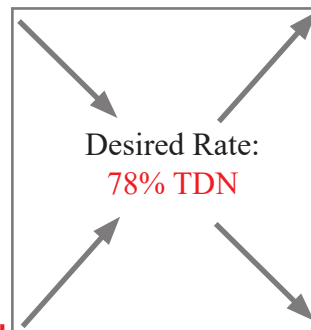
**Combination for Box 2 (Use the directions at the bottom of the card from box 1 to determine the last digit of the combination below.):**

<b>Lock #2</b>		
<b>4</b>	<b>2</b>	<b>3</b>

### Box 2

**Feed 1:**

**Soybean Meal 84% TDN**



**Feed 1:**

$$78 - 50 = 28 \text{ parts Soybean Meal}$$

$$28 / 34 = .823 \text{ or } 82\% \text{ Soybean Meal}$$

28 parts Soybean Meal + 6 parts Ground Corn = 34 total parts in ration

**Feed 2:**

**Ground Corn 50% TDN**

**Feed 2:**

$$84 - 78 = 6 \text{ parts Ground Corn}$$

$$6 / 34 = .176 \text{ or } 18\% \text{ Ground Corn}$$

**Check your work:**  $82 (.84) + 18 (.50) = 78$

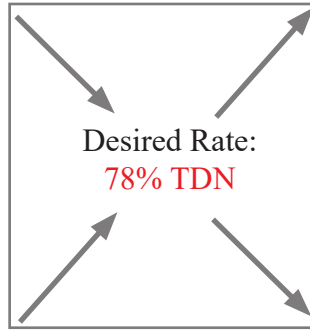
**Combination for Box 3 (Use the directions at the bottom of the card from box 2 to determine the last digit of the combination below.):**

<b>Lock #3</b>		
<b>4</b>	<b>3</b>	<b>8</b>

**Box 3**

**Feed 1:**  
**Dried Distillers Grain 79.5% TDN**

**Feed 2:**  
**Grass Hay 56.3% TDN**



**Feed 1:**  
 $78 - 56.3 = 21.7$  parts Dried Distillers Grain  
 $21.7 / 23.2 = .935$  or 94% Dried Distillers Grain

$21.7$  parts Dried Distillers Grain +  $1.5$  parts Grass Hay  
=  $23.2$  total parts in ration

**Feed 2:**  
 $79.5 - 78 = 1.5$  parts Grass Hay  
 $1.5 / 23.2 = .064$  or 6% Grass Hay

**Check your work:**  $6 (.563) + 94 (.795) = 78.10$

Combination for Box 4 (Use the directions at the bottom of the card from box 3 to determine the last digit of the combination below.):

<b>Lock #4</b>		
<b>4</b>	<b>4</b>	<b>0</b>

**Box 4**

Enjoy your treat!



## The Mystery Ration

Student Name: \_\_\_\_\_

Dairy producers pay special attention to feed components that are included in their cow's Total Mixed Ration (TMR) to ensure their cow's nutritional needs are met through the formulated ration's ingredients. The health of their herd is crucial in the overall productivity of their farm. Dairy cow's nutrient needs change depending on their age and stage of production (producing milk or not producing milk) similar to the changes in a human's nutritional needs. On a dairy farm, feed costs account for 45-55% of the farms operating cost. This means that farmers make critical decisions on the type of feed, the cost and the nutrient levels provided to determine the most palatable and nutritious rations for their animals.

Today, you will explore simple ration balancing through the Pearson Square method. In this mathematical computation, two feeds on a dry matter basis are balanced for one nutrient need. This can be helpful when grains are mixed for a ration to determine the amount of each ingredient needed to achieve your desired nutrient rate. In this method, you can calculate crude protein (CP), energy or total digestible nutrients (TDN).

### How to Calculate using the Pearson Square Method

When using the Pearson Square method, there should be one feed with a nutrient concentrate above the desired rate and one with a lower rate.

**Step 1:** Begin by writing the desired nutrient rate in the center of the square, this rate is often set based on the National Research Council's Nutrient Requirement tables or by an experienced producer and their nutritionist.

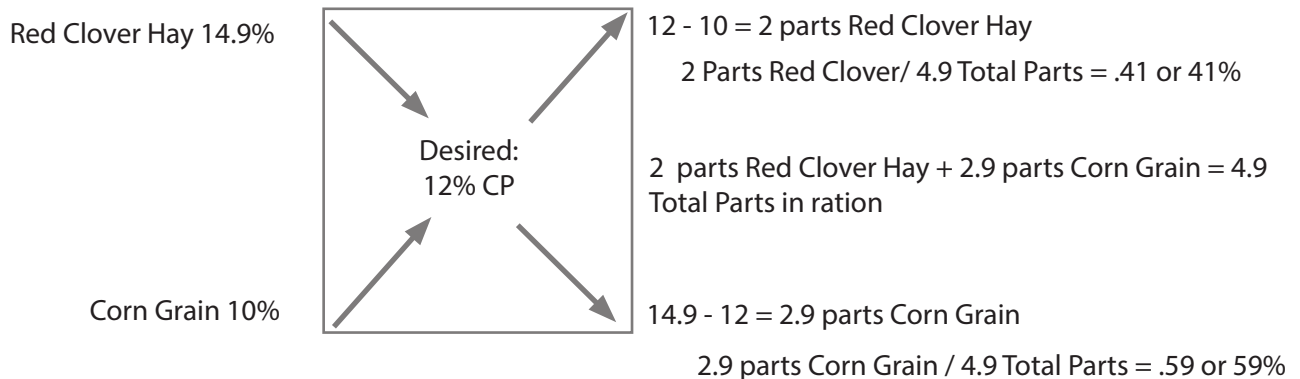
**Step 2:** The two feeds are then placed on the corners of the left side (see diagram below).

**Step 3:** After the square is set up, begin by subtracting the smaller number from the larger number diagonally follow the arrows below for reference. This will result in parts per ration.

**Step 4:** Total the sum of the parts in ration.

**Step 5:** Using the dry matter parts on the right side, create a percentage of each feed's presence in the ration.

**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



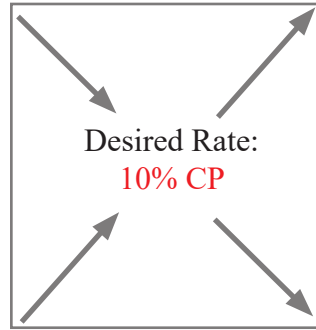
In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

**Part I: Practicing with Pearson Squares - Group E Answer Key**

1. Balance a ration with a desired rate of 10% CP using Ground Corn 9% CP and Soybean Seeds 42.8% CP.

**Feed 1:**  
Ground Corn 9% CP



**Feed 1:**

$$42.8 - 10 = 32.8 \text{ parts Ground Corn}$$

$$32.8 / 33.8 = .97 \text{ or } 97\% \text{ Ground Corn}$$

32.8 parts Ground Corn + 1 part Soybean Seed = 33.8 total parts in ration

**Feed 2:**

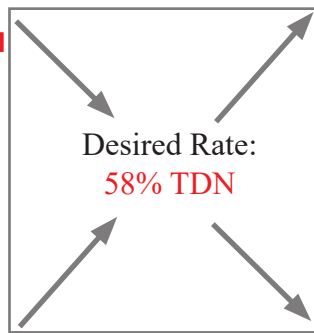
$$10 - 9 = 1 \text{ part Soybean Seed}$$

$$1 / 33.8 = .029 \text{ or } 3\% \text{ Soybean Seed}$$

**Check your work:**  $97 (.09) + 3 (.428) = 10$

2. Balance a ration with a desired rate of 58% TDN using Corn Distillers Grain 86% TDN and Fescue Hay 48% TDN.

**Feed 1:**  
Corn Distillers Grain 86% TDN



**Feed 1:**

$$58 - 48 = 10 \text{ parts Corn Distillers Grain}$$

$$10 / 38 = .26 \text{ or } 26\% \text{ Corn Distillers Grain}$$

28 parts Fescue Hay + 10 parts Corn Distillers Grain = 38 total parts in ration

**Feed 2:**

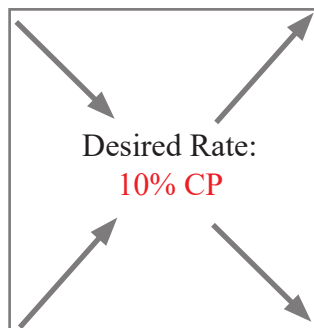
$$86 - 58 = 28 \text{ parts Fescue Hay}$$

$$28 / 38 = .74 \text{ or } 74\% \text{ Fescue Hay}$$

**Check your work:**  $26 (.86) + 74 (.48) = 58$

3. Balance a ration with a desired rate of 10% CP using Soybean Seeds 42.8% CP and Fescue Hay 9.5% CP.

**Feed 1:**  
Soybean Seeds 42.8% CP



**Feed 1:**

$$10 - 9.5 = .5 \text{ parts Soybean Seeds}$$

$$.5 / 33.3 = .02 \text{ or } 2\% \text{ Soybean Seeds}$$

32.8 parts Fescue Hay + .5 parts Soybean Seeds = 33.3 total parts in ration

**Feed 2:**

$$42.8 - 10 = 32.8 \text{ parts Fescue Hay}$$

$$32.8 / 33.3 = .98 \text{ or } 98\% \text{ Fescue Hay}$$

**Check your work:**  $2 (.428) + 98 (.095) = 10$

## Part II: The Escape Box Ration Challenge - Answers for Group E

With your assigned group, read the scenario card provided by your teacher to determine your desired rate for the Pearson Square calculations. Each of the first three boxes contains a card for each group and feed examples, using the information on your group's card to create a Pearson Square and determine how much of each of the feeds listed on the box card would be required in a ration to reach your group's desired nutrient rate. After each group has finished their calculations for a box, you will use the answer the box card tells you to unlock the next locked box. The fourth and final box contains a delicious treat for your class to enjoy!

**Combination for Box 1 (Use the directions at the bottom of the scenario card to determine the last digit of the combination below.):**

<b>Lock #1</b>		
<b>5</b>	<b>1</b>	<b>4</b>

### Box 1

**Feed 1:**  
**Cottonseed 23.9% CP**



**Feed 2:**  
**Alfalfa Hay 13% CP**

**Feed 1:**  
 $14.1 - 13 = 1.1$  parts Cottonseed  
 $1.1 / 10.9 = .100$  or 10% Cottonseed

$1.1$  parts Cottonseed +  $9.8$  parts Alfalfa =  $10.9$  total parts in ration

**Feed 2:**  
 $23.9 - 14.1 = 9.8$  parts Alfalfa Hay  
 $9.8 / 10.9 = .899$  or 90% Alfalfa Hay

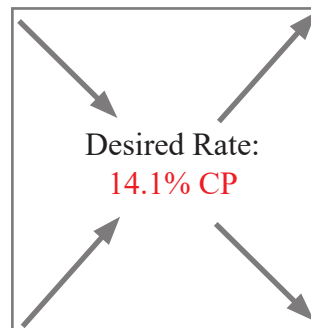
**Check your work:**  $10 (.239) + 90 (.13) = 14.1$

**Combination for Box 2 (Use the directions at the bottom of the card from box 1 to determine the last digit of the combination below.):**

<b>Lock #2</b>		
<b>5</b>	<b>2</b>	<b>9</b>

### Box 2

**Feed 1:**  
**Soybean Meal 49.9% CP**



**Feed 2:**  
**Ground Corn 3.2% CP**

**Feed 1:**  
 $14.1 - 3.2 = 10.9$  parts Soybean Meal  
 $10.9 / 46.7 = .233$  or 23% Soybean Meal

$35.8$  parts Ground Corn +  $10.9$  parts Soybean Meal =  $46.7$  total parts in ration

**Feed 2:**  
 $49.9 - 14.1 = 35.8$  parts Ground Corn  
 $35.8 / 46.7 = .766$  or 77% Ground Corn

**Check your work:**  $23 (.499) + 77 (.032) = 14$

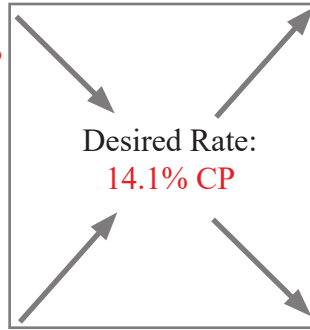
**Combination for Box 3 (Use the directions at the bottom of the card from box 2 to determine the last digit of the combination below.):**

<b>Lock #3</b>		
<b>5</b>	<b>3</b>	<b>2</b>

**Box 3**

**Feed 1:**  
**Dried Distillers Grain 29.7% CP**

**Feed 2:**  
**Grass Hay 10.6% CP**



**Feed 1:**  
 $14.1 - 10.6 = 3.5$  parts Dried Distillers Grain  
 $3.5 / 19.1 = .183$  or 18% Dried Distillers Grain

$3.5$  parts Dried Distillers Grain +  $15.6$  Grass Hay =  
 $19.1$  total parts in ration

**Feed 2:**  
 $29.7 - 14.1 = 15.6$  parts Grass Hay  
 $15.6 / 19.1 = .816$  or 82% Grass Hay

**Check your work:**  $18 (.297) + 82 (.106) = 14.038$

Combination for Box 4 (Use the directions at the bottom of the card from box 3 to determine the last digit of the combination below.):

<b>Lock #4</b>		
<b>5</b>	<b>4</b>	<b>8</b>

**Box 4**

Enjoy your treat!



## The Mystery Ration

Student Name: \_\_\_\_\_

Dairy producers pay special attention to feed components that are included in their cow's Total Mixed Ration (TMR) to ensure their cow's nutritional needs are met through the formulated ration's ingredients. The health of their herd is crucial in the overall productivity of their farm. Dairy cow's nutrient needs change depending on their age and stage of production (producing milk or not producing milk) similar to the changes in a human's nutritional needs. On a dairy farm, feed costs account for 45-55% of the farms operating cost. This means that farmers make critical decisions on the type of feed, the cost and the nutrient levels provided to determine the most palatable and nutritious rations for their animals.

Today, you will explore simple ration balancing through the Pearson Square method. In this mathematical computation, two feeds on a dry matter basis are balanced for one nutrient need. This can be helpful when grains are mixed for a ration to determine the amount of each ingredient needed to achieve your desired nutrient rate. In this method, you can calculate crude protein (CP), energy or total digestible nutrients (TDN).

### How to Calculate using the Pearson Square Method

When using the Pearson Square method, there should be one feed with a nutrient concentrate above the desired rate and one with a lower rate.

**Step 1:** Begin by writing the desired nutrient rate in the center of the square, this rate is often set based on the National Research Council's Nutrient Requirement tables or by an experienced producer and their nutritionist.

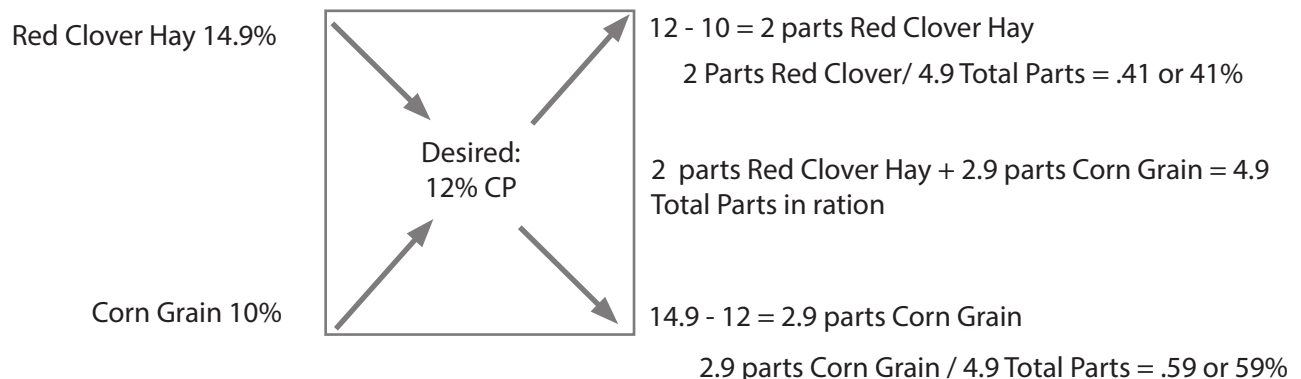
**Step 2:** The two feeds are then placed on the corners of the left side (see diagram below).

**Step 3:** After the square is set up, begin by subtracting the smaller number from the larger number diagonally follow the arrows below for reference. This will result in parts per ration.

**Step 4:** Total the sum of the parts in ration.

**Step 5:** Using the dry matter parts on the right side, create a percentage of each feed's presence in the ration.

**Example:** Balance a ration for a desired Crude Protein (CP) rate of 12% using Red Clover Hay 14.9% CP and Corn Grain 10% CP



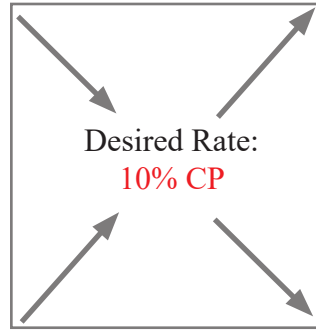
In summary, with a desired rate of 12% Crude Protein using Red Clover Hay and Corn Grain, the ration should be 41% Red Clover Hay and 59% Corn Grain.

**Check your work:**  $41(.149) + 59(.10) = 12$

**Part I: Practicing with Pearson Squares - Group F Answer Key**

1. Balance a ration with a desired rate of 10% CP using Ground Corn 9% CP and Soybean Seeds 42.8% CP.

**Feed 1:**  
Ground Corn 9% CP



**Feed 1:**

$$42.8 - 10 = 32.8 \text{ parts Ground Corn}$$
$$32.8 / 33.8 = .97 \text{ or } 97\% \text{ Ground Corn}$$

32.8 parts Ground Corn + 1 part Soybean Seed = 33.8 total parts in ration

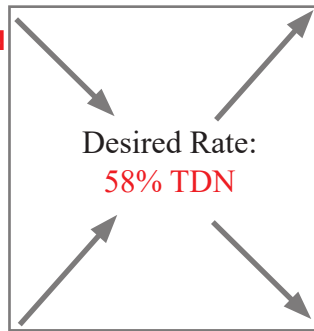
**Feed 2:**

$$10 - 9 = 1 \text{ part Soybean Seed}$$
$$1 / 33.8 = .029 \text{ or } 3\% \text{ Soybean Seed}$$

**Check your work:**  $97 (.09) + 3 (.428) = 10$

2. Balance a ration with a desired rate of 58% TDN using Corn Distillers Grain 86% TDN and Fescue Hay 48% TDN.

**Feed 1:**  
Corn Distillers Grain 86% TDN



**Feed 1:**

$$58 - 48 = 10 \text{ parts Corn Distillers Grain}$$
$$10 / 38 = .26 \text{ or } 26\% \text{ Corn Distillers Grain}$$

28 parts Fescue Hay + 10 parts Corn Distillers Grain = 38 total parts in ration

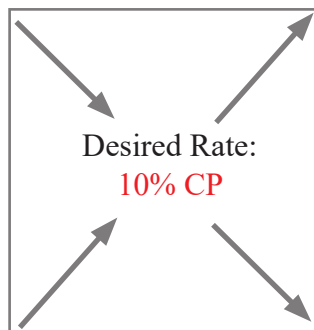
**Feed 2:**

$$86 - 58 = 28 \text{ parts Fescue Hay}$$
$$28 / 38 = .74 \text{ or } 74\% \text{ Fescue Hay}$$

**Check your work:**  $26 (.86) + 74 (.48) = 58$

3. Balance a ration with a desired rate of 10% CP using Soybean Seeds 42.8% CP and Fescue Hay 9.5% CP.

**Feed 1:**  
Soybean Seeds 42.8% CP



**Feed 1:**

$$10 - 9.5 = .5 \text{ parts Soybean Seeds}$$
$$.5 / 33.3 = .02 \text{ or } 2\% \text{ Soybean Seeds}$$

32.8 parts Fescue Hay + .5 parts Soybean Seeds = 33.3 total parts in ration

**Feed 2:**

$$42.8 - 10 = 32.8 \text{ parts Fescue Hay}$$
$$32.8 / 33.3 = .98 \text{ or } 98\% \text{ Fescue Hay}$$

**Check your work:**  $2 (.428) + 98 (.095) = 10$



## Part II: The Escape Box Ration Challenge - Answers for Group F

With your assigned group, read the scenario card provided by your teacher to determine your desired rate for the Pearson Square calculations. Each of the first three boxes contains a card for each group and feed examples, using the information on your group's card to create a Pearson Square and determine how much of each of the feeds listed on the box card would be required in a ration to reach your group's desired nutrient rate. After each group has finished their calculations for a box, you will use the answer the box card tells you to unlock the next locked box. The fourth and final box contains a delicious treat for your class to enjoy!

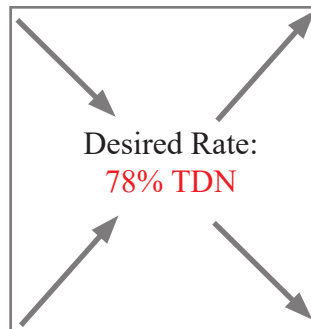
**Combination for Box 1 (Use the directions at the bottom of the scenario card to determine the last digit of the combination below.):**

<b>Lock #1</b>		
<b>6</b>	<b>1</b>	<b>8</b>

### Box 1

**Feed 1:**  
**Cottonseed 96% TDN**

**Feed 2:**  
**Alfalfa Hay 50% TDN**



**Feed 1:**  
 $78 - 50 = 28$  parts Cottonseed  
 $28 / 46 = .608$  or 61% Cottonseed

$28$  parts Cottonseed +  $18$  parts Alfalfa Hay =  $46$  total parts in ration

**Feed 2:**  
 $96 - 78 = 18$  parts Alfalfa Hay  
 $18 / 46 = .391$  or 39% Alfalfa Hay

**Check your work:**  $61 (.96) + 39 (.50) = 78$  or 78%

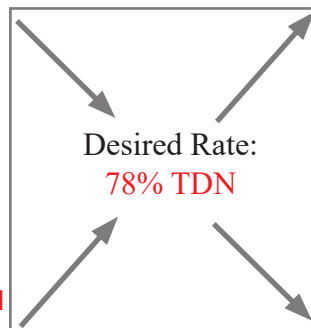
**Combination for Box 2 (Use the directions at the bottom of the card from box 1 to determine the last digit of the combination below.):**

<b>Lock #2</b>		
<b>6</b>	<b>2</b>	<b>3</b>

### Box 2

**Feed 1:**  
**Soybean Meal 84% TDN**

**Feed 2:**  
**Ground Corn 50% TDN**



**Feed 1:**  
 $78 - 50 = 28$  parts Soybean Meal  
 $28 / 34 = .823$  or 82% Soybean Meal

$28$  parts Soybean Meal +  $6$  parts Ground Corn =  $34$  total parts in ration

**Feed 2:**  
 $84 - 78 = 6$  parts Ground Corn  
 $6 / 34 = .176$  or 18% Ground Corn

**Check your work:**  $82 (.84) + 18 (.50) = .778$  or 78%

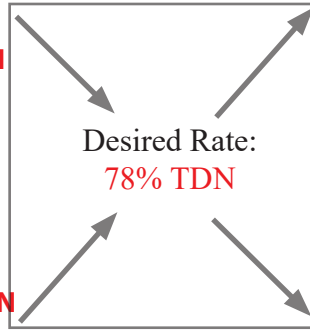
**Combination for Box 3 (Use the directions at the bottom of the card from box 2 to determine the last digit of the combination below.):**

<b>Lock #3</b>		
<b>6</b>	<b>3</b>	<b>8</b>

**Box 3**

**Feed 1:**  
**Dried Distillers Grain 79.5% TDN**

**Feed 2:**  
**Grass Hay 56.3% TDN**



**Feed 1:**  
 $78 - 56.3 = 21.7$  parts Dried Distillers Grain  
 $21.7 / 23.2 = .935$  or 94% Dried Distillers Grain

$21.7$  parts Dried Distillers Grain +  $1.5$  parts Grass Hay =  $23.2$  total parts in ration

**Feed 2:**  
 $79.5 - 78 = 1.5$  parts Grass Hay  
 $1.5 / 23.2 = .064$  or 6% Grass Hay

**Check your work:**  $6 (.563) + 94 (.795) = 78.10$

Combination for Box 4 (Use the directions at the bottom of the card from box 3 to determine the last digit of the combination below.):

<b>Lock #4</b>		
<b>6</b>	<b>4</b>	<b>0</b>

**Box 4**

Enjoy your treat!