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Balancing Rations for Sheep and Goats

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To achieve the best production from your flock or herd of sheep or goats, you must provide them with optimum nutrition throughout the production cycle. Unfortunately, some of the most critical periods in the production cycle are also those during which pastures are not available or are not at their peak. This means you will have to feed your animals to maintain their productivity. But feed costs are high, and overfeeding your sheep and goats will not only waste feed and money, but it can cause problems, especially at or around the time of birth. How do you meet the needs of your animals without spending more than you have to? Balance a ration!

To balance a ration you will need to know how much your animals weigh, their stage of the production cycle and the nutrient contents of your available feeds. You will also need to be familiar with a few terms that are commonly used in nutrition.

You need to know your animals' weights because feed requirements are higher for larger animals than they are for smaller ones. Ruminants tend to eat 2.5% to 3% of their body weight in dry matter (DM) each day. So, a 100-lb doe or ewe will eat about 2.5 to 3 lbs of DM per day on average, and a 150-lb doe or ewe will eat about 3 to 4.5 lbs of DM per day.

What is dry matter? Feeds are made up of proteins, carbohydrates, fats, minerals, vitamins and water. The amount of water in a feed alters how much of the feed an animal will have to consume to meet its needs. For example, silage averages 34% DM, meaning that about two-thirds of the silage is just water. The animals will drink less because they are getting water from their feed, but they will have to eat many more pounds of silage than they will of hay, which tends to be about 88% dry matter. If our 100-lb doe could get all of her nutrients from silage or hay, she would have to consume 7.5 to 9 lbs of silage to meet her needs. She would only have to eat 2.8 to 3.4 lbs of 88% DM hay to do the same thing.

The stage of the production cycle is critical to know because animals have different needs depending upon what you are asking their bodies to do. For example, during late summer ewes and does are not usually still producing milk and they have not yet been bred. Their nutritional needs are at the lowest point of the year, and good pasture should meet or exceed all of their needs. During late pregnancy their nutrient requirements nearly double to meet the needs of the rapidly growing fetuses. Once they kid or lamb, their needs will be triple their late summer levels to meet the demands of milk production for their growing kids or lambs. Growing kids and lambs need roughly the same amount of energy and protein as their dams, yet they are only half as big. The National Research Council (NRC) has developed tables you can use to estimate the nutrient needs of your animals depending upon their size and stage of production.

Finally, you need to know the nutrient content of the feeds you are offering. It is not uncommon for goats and sheep to nibble on straw bedding or wood shavings, but they have little nutritional value. You can make a reasonable guess about nutrient quality by using values established by the NRC if you want to formulate a ration before you buy any feeds; a wise thing to do.

If you already have the feed, you can look at the guaranteed analysis on the feed tag. The Arkansas Feed Law (Act 726 of 1997) requires feed mills to provide basic nutrient information on all livestock feeds sold in Arkansas. Nutrient information required by Arkansas includes:

1. Minimum percentage of Crude Protein.
2. Maximum percentage of equivalent crude protein from Non-Protein Nitrogen (NPN) when added.
3. Minimum percentage of Crude Fat.
4. Maximum percentage of Crude Fiber.
5. Minimum and maximum percentage of Calcium.
6. Minimum percentage of Phosphorus.
7. Minimum and maximum percentage of Salt (if added).
8. Minimum and maximum percentage of total Sodium shall be guaranteed only when total Sodium exceeds that furnished by the maximum salt guarantee.
9. Minimum and maximum Copper in parts per million (ppm) (if added, or if total copper exceeds 20 ppm).
10. Minimum Selenium in parts per million (ppm).
11. Minimum Vitamin A, other than precursors of Vitamin A, in International Units per pound (if added).

Information about energy content of the feed is **not** required to be on the label.

In the case of hays, silages or pastures, you can collect a sample and take it to your county Extension agent. Your agent will send the sample in for analysis for $18 in Arkansas at the time of this writing. Once you have this information, you are ready to create a ration for your sheep or goats.

Usually your lowest cost feed will be a forage, either pasture or hay. You want your forage source to provide as many of your animals' needs as possible. Typically the nutrients that forages lack most are energy, followed by protein. Energy supplements are usually but not always cheaper than protein supplements. This is why, when you balance a ration, you usually start by balancing the DM needs, then energy, then protein.

Energy is commonly measured in one of two ways: TDN or DE. TDN stands for Total Digestible Nutrients, and it is measured as a percent of the DM in the feed. TDN is an approximation of the energy value of all of the carbohydrates, proteins and fats in the feed. Because neither TDN nor DE are required to be on the feed label, you may have to calculate the TDN.

% TDN = % crude protein + % crude fiber + (% crude fat x 2.25)

A pound of feed that is 50% DM and 80% TDN would have 0.4 lb of TDN (1 lb x 50% x 80% = 0.4 lb). Ruminants like sheep and goats convert excess protein into energy in the rumen. DE is Digestible Energy, a measure of the difference between the gross energy in the feed and the gross energy left in the manure. DE is often reported in megacalories per kilogram (Mcal/kg) or per pound (Mcal/lb).

Most sheep and goat producers use TDN because it is easier to work with. But the requirements of sheep and goats are often listed using DE. To convert DE to TDN, use:

% TDN = Mcal/kg DE ÷ 4.4
OR
% TDN = Mcal/lb ÷ 2

For example, a feed containing 2.42 Mcal/kg DE would contain 1.1 Mcal/lb DE, which would be equivalent to 55% TDN.

55% TDN = 2.42 Mcal/kg DE ÷ 4.4
OR
55% TDN = 1.1 Mcal/lb ÷ 2

Crude protein (CP) is a measure of the amount of nitrogen in a feed. Nitrogen is the key element in protein. Nitrogen is easy to measure and is used as a substitute for actual protein. Labels on feeds in Arkansas must state how much CP and how much non-protein nitrogen (NPN) is in the feed. Ruminants have the ability to convert cheap NPN into protein because of the bacteria in the rumen. You should avoid feeding too much NPN though, because it can cause digestive upset. CP is what you will use to develop your ration.

Mineral deficiencies can crop up when you are balancing a ration. Most sheep and goat producers provide free choice trace mineralized salt to prevent them. Be careful to avoid feeding goat or cow mineral to sheep. It usually contains too much copper, which can be toxic to sheep. The ratio of calcium to phosphorus (Ca:P ratio) should remain near 2:1 and should not drop below 1:1. Grains and by-product feeds often have extremely low levels of Ca and often fairly high levels of P. So, if your supplement exceeds 1% of the body weight of your animals, you may have problems like milk fever or urinary calculi develop in your flock or herd. For example, if you feed a 100-lb goat 1.5 lbs of grain or by-product feed, you are feeding 1.5% of the animal's weight and may run into a problem. Vitamin deficiencies are extremely rare in ruminants.

Let's try an example. Suppose it is January and you are feeding a small flock of ewes bred to lamb in March. They are entering late pregnancy at this time and may need some additional feed to lamb successfully and produce milk. They weigh, on average, 110 lbs. What do you need to feed them? First, you need to know the ewes' nutrient requirements. Look in Table 2 below and find the requirements for a ewe, last trimester (110 lbs). She will need 3.2 lbs of DM containing 0.34 lb of CP, 2.1 lbs of TDN, 7.3 g Ca and 4.3 g P each day. In Arkansas, mixed bermudagrass hay is a commonly available winter forage. Look in Table 1 below for the nutrient values for the hay.

If your ewe eats 3.2 lbs of DM per day and bermudagrass hay is 87% DM, to find out how much hay she can consume, divide 3.2 by 87%:

3.2 lbs DM per day ÷ 87% = 3.7 lbs of bermudagrass hay per day

Your ewe needs 2.1 lbs of TDN and 0.34 lb of CP each day. Nutrients in feeds are calculated using DM, so you need to decide whether 3.2 lbs DM of bermudagrass hay will meet her needs. In Table 1, you can see that on average, bermudagrass hay

Table 1. Nutrient composition of selected feeds.

Feed	DM (%)	CP (%)	TDN (%)	DE (Mcal/lb)	Ca (%)	P (%)
Bermudagrass hay (AR)	87	12.3	58	1.04	0.51	0.27
Corn, ground grain	88	9.0	88	1.76	0.03	0.31
Whole cottonseed	92	24.4	90	1.80	0.17	0.62
Distillers dried grain	88	31.0	90	1.80	0.08	0.88

Table 2. Nutrient requirements of sheep.

Animal/ Production Stage	DM (lb)	CP (lb)	TDN (lb)	DE (Mcal/day)	Ca (g)	P (g)
Ewe, dry (110 lbs)	2.0	0.15	1.1	2.2	2.0	1.5
Ewe, dry (154 lbs)	2.6	0.20	1.4	2.8	2.4	2.0
Ewe, last trimester (110 lbs)	3.2	0.34	2.1	4.3	7.3	4.3
Ewe, lactating (110 lbs)	3.5	0.56	2.4	4.8	6.7	5.7
Ewe, flushing (110 lbs)	2.2	0.18	1.2	2.4	2.4	1.8
Lamb, growing (66 lbs)	2.3	0.29	1.8	3.7	4.2	3.4

Table 3. Nutrient requirements of goats.

Animal/ Production Stage	DM (lb)	CP (lb)	TDN (lb)	DE (Mcal/day)	Ca (g)	P (g)
Doe, dry (110 lbs)	2.2	0.16	1.2	2.4	1.9	1.5
Doe, dry (154 lbs)	2.8	0.20	1.5	3.0	2.3	1.9
Doe, last trimester (110 lbs)	2.9	0.18	2.0	4.0	5.9	3.3
Doe, lactating (110 lbs)	3.4	0.44	1.8	3.6	8.9	5.3
Doe, flushing (110 lbs)	2.4	0.17	1.3	2.6	2.0	1.6
Kid, growing (67 lbs)	2.0	0.33	1.3	2.7	5.4	2.8

contains 58% TDN and 12.3% CP. **But for the purposes of our example, we will assume a level of 52% TDN and 7% CP, which is not uncommon:**

3.2 lbs DM per day x 52% =
1.7 lbs of TDN per day

3.2 lbs DM per day x 7% =
0.22 lb of CP per day

There is not enough TDN or CP in the hay to meet all of your ewes' needs.

2.1 lbs TDN required – 1.7 lbs TDN provided =
0.4 lb TDN still needed

0.34 lb CP required – 0.22 lb CP provided =
0.12 lb CP still needed

This means you will have to substitute an energy feed for some of the hay. Keep in mind that the ewes will eat less hay to make room in their diet for the energy feed. The easiest way to calculate how much hay to replace with an energy feed without a computer is by using a Pearson's Square. You will use a worksheet like this one to develop the ration:

Worksheet 1

Hay **52**	TDN Requirement	
	Total	

In Table 1, you can see ground corn is **88%** TDN. You will have to convert the TDN and CP requirement in Table 2 from pounds per day to percent of the diet, but that can easily be done:

(2.1 lbs TDN required per day ÷
3.2 lbs DM required per day) x 100 = 65.6% TDN

(0.34 lb CP required per day ÷ 3.2 lbs DM
required per day) x 100 = 10.6% CP

Now you can fill in the boxes in the Pearson's Square below (Worksheet 2). You should always balance for energy first. Energy feeds are often less expensive than protein supplements, and ruminants often require extra energy, but not much extra protein.

In the upper left-hand box, put the percent TDN found in your hay (**52%**). In the lower left-hand box, put the TDN percent for the ground corn (**88%**). In the center box, put the percent TDN requirement for your animal (**65.6%**). Subtract the amount of TDN provided by each feed from the requirement in the center box to get the amount of hay and ground corn needed to meet your ewes' energy needs.

Worksheet 2

Hay **52**	TDN Requirement **65.6**	Hay (88 – 65.6) **22.4**
Ground corn **88**		Corn (65.6 – 52) **13.6**
	Total	**36**

Now divide the number you got for hay by the total and multiply by 100 to get the percent of the final ration that will be hay: (22.4 ÷ 36) x 100 = 62.2%. Do the same for the number you got for the corn: (13.6 ÷ 36) x 100 = 37.8%. You will know you did this correctly if the numbers add up to 100% (62.2% + 37.8% = 100%). This means in a ration with 3.2 lbs of DM per day, you will feed:

3.2 lbs DM x 62.2% hay =
1.99 lbs DM hay per day

3.2 lbs DM x 37.8% ground corn =
1.21 lbs DM ground corn per day

1.99 lbs hay per day +
1.21 lbs ground corn per day =
3.2 lbs DM per day

You have met your ewes' DM and energy requirements. Some energy feeds are low in protein, so you may have to add a protein supplement after you have removed some of the hay and added some energy feed. Feeds that are high in energy are most often corn and small grains. But they are often too high in P and too low in Ca. Let's see if you have also met your ewes' CP requirements.

(1.99 lbs hay per day x 7% CP) +
(1.21 lbs ground corn per day x 9% CP) =
0.14 + 0.11 = 0.25 lb CP per day in the ration

The ewes need 0.34 lb CP per day, so you are 0.09 lb short on CP each day. To increase your CP, you will have to add a protein supplement, but also reduce the amount of your new ration. Remember, the ewes can only eat so much feed in a day, so anything you add has to replace something you are already feeding. Let's continue with our example. We will use whole cottonseed (Table 1) as the protein supplement because it is usually readily available in Arkansas.

The % CP in your new ration is:

(0.25 lb CP per day in the ration ÷
3.2 lbs DM) x 100 = 7.8% CP

To set up a Pearson's Square for CP (Worksheet 3), you do the same thing you did for TDN. Just replace the numbers for TDN with the numbers for CP.

Worksheet 3

Hay/corn ration **7.8**	CP Requirement **10.6**	
	Total	

Whole cottonseed is **24.4%** CP (Table 1), so insert that number in the bottom left box below the **7.8%** CP for your hay/corn ration you made to balance TDN (Worksheet 4).

Worksheet 4

Hay/corn ration **7.8**	CP Requirement **10.6**	Hay/corn ration (24.4 – 10.6) **13.8**
Whole cottonseed **24.4**		Whole cottonseed (10.6 – 7.8) **2.8**
	Total	**16.6**

Divide the number you got for the hay/corn ration you made earlier by the total and multiply by 100 to get the percent of the final ration that will be hay: (13.8 ÷ 16.6) x 100 = 83.1%. Do the same for the number you got for the corn: (2.8 ÷ 16.6) x 100 = 16.9%. You will know you did this correctly if the numbers add up to 100% (83.1% + 16.9% = 100%). This means in a ration with 3.2 lbs of DM per day, you will feed:

3.2 lbs DM x 83.1% hay/corn ration =
2.66 lbs DM hay/corn ration per day

3.2 lbs DM x 16.9% whole cottonseed =
0.54 lb DM whole cottonseed per day

2.66 lbs hay/corn ration per day +
0.54 lb whole cottonseed per day =
3.2 lbs DM per day

Remember that your hay/corn ration is made up of 62.2% hay and 37.8% ground corn. Since your new ration is 2.66 lbs of the hay/corn ration, your final ration will be:

2.66 lbs hay/corn ration x 62.2% hay =
1.65 lbs DM hay per day

2.66 lbs hay/corn ration x 37.8% ground corn =
1 lb DM ground corn, and

0.54 lb DM whole cottonseed per day

1.65 lbs hay + 1 lb ground corn +
0.54 lb whole cottonseed = 3.19 lbs DM

You have met your ewes' DM needs and CP requirements. Let's make sure you are still meeting their TDN requirements.

(1.65 lbs hay x 52% TDN) +
(1 lb ground corn x 88% TDN) +
(0.54 lb whole cottonseed x 90% TDN) =
0.86 + 0.88 + 0.49 = 2.23 lbs TDN

Your ewes require 2.1 lbs of TDN per day, so you have still met their TDN needs.

All of this has been calculated on a DM basis, but you don't feed DM. You feed hay or ground corn or whole cottonseed, all of which have water in them. So, there is a final step you must take; you must convert your DM calculations to an "as-fed" basis. It's easy! Remember the hay is 87% DM, ground corn is 88% DM and whole cottonseed is 92% DM. Just divide the pounds of DM you will feed in your ration by the % DM:

1.65 lbs DM hay ÷ 87% =
1.9 lbs of bermudagrass hay as fed

1 lb DM ground corn ÷ 88% =
1.1 lbs of ground corn as fed

0.54 lb DM whole cottonseed ÷ 92% =
0.6 lb of whole cottonseed as fed

Congratulations! You've balanced your ration. If you like to play with numbers or are handy with a spreadsheet, you can include the costs of different feeds and create a low-cost ration based on inexpensive feeds that are available locally.

Summary

Sheep and goats have different nutritional needs depending upon size and stage of production. Feeds provide nutrients to meet these needs, but the nutrients in feeds can vary greatly from one source to another. Feeds, especially forages, should be tested to make sure you are feeding enough to meet the animals' needs. Begin by balancing your ration for how much they can eat, the DM energy (TDN or DE) and/or DM CP. Remember to convert the final results from DM to an as-fed basis. By balancing a ration, you will meet your livestock's needs while avoiding overfeeding, wasting feed and high feed bills.

References

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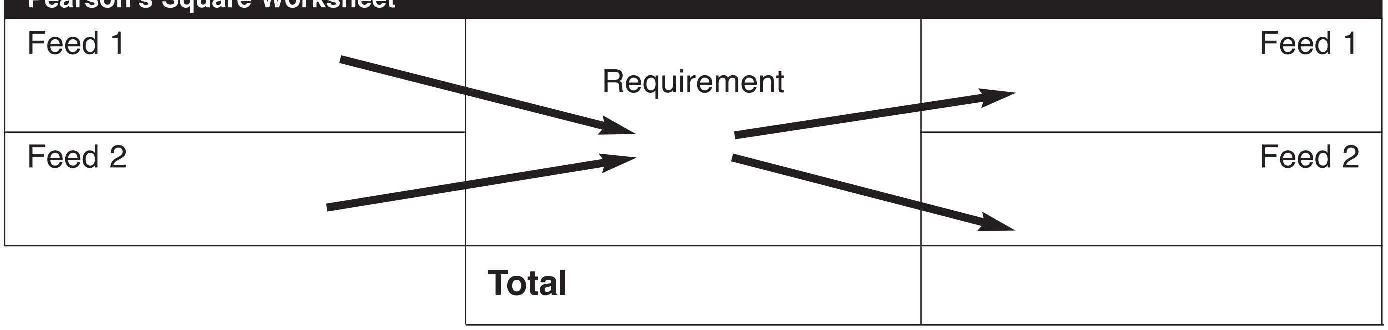
University of Arkansas Cooperative Extension Service. Arkansas Feedstuffs Database 20-Year Summary.

Pearson's Square Worksheet



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