Balancing Rations for Dairy Cows Using Commercial Supplements

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Taking time to balance the milking herd ration helps insure that the nutritional needs of the cows are met while minimizing feed costs. Table 1 shows the effects of balancing rations several times a year. In both studies, milk production increased when rations were balanced.

Table 1. Balancing rations increases milk production	
Ration balanced	**Milk production increase per year (lb/cow)**
Minnesota - 5 herds monthly	1100
Virginia - 4 herds/group	
7 times/year	+ 780
5 times/year	+ 486
none	- 86
Source: L. H. Kilmer. Dairy Profit Series: Nutrition Iowa State University Extension Publication DY-S-3023	

Forage testing is an essential starting point to balancing rations that are profitable and nutritionally sound. Table 2 shows the normal variation in the nutrient content of forages fed to dairy cows in Kentucky. Forages vary in nutrient content from year to year and thus should be tested yearly. Underestimating forage quality will result in unnecessary grain being fed and increased feed costs. Overestimating forage quality will result in cows receiving less nutrients than they need. As a consequence, milk production may be lower than expected.

Table 2. Nutrient composition of various forage fed in Kentucky						
	Dry Matter (%)		**Energy (NE_L) (Mcal/lb)**		**Crude Protein (%)**	
Forage	**Average**	**Range**	**Average**	**Range**	**Average**	**Range**
			Dry Matter Basis			
Corn Silage	37	23 - 69	0.63	0.54 - 0.73	8.3	5 - 10
Alfalfa hay	87	70 - 98	0.61	0.40 - 0.73	18.7	13 - 25
Grass hay	89	70 - 98	0.44	0.30 - 0.64	9.0	6 - 20
Kentucky Forage Testing Program						

Forages are the foundation upon which a balanced ration is built. Grain mixes are used to complement these forages and provide a more concentrated source of nutrients to meet the high nutritional needs of

these cows. Guidelines on the amount of grain mix and percent protein needed in the grain mix should be used as a starting point when feeding dairy cows.

The amount and percent protein needed in the grain mix depends on many factors. These include:

- Type of forages fed. When corn silage is the primary forage fed, a higher percent protein is needed in the grain mix compared to when alfalfa hay is the primary forage fed.
- Amount of each forage consumed. Forage intake should be measured to more closely estimate forage consumption.
- Quality of forages fed.
- Size of cow being fed.
- Amount of milk and butterfat test of the cow or group of cows.
- Stage of lactation and body condition of each cow or group of cows.
- The amount of body condition or fat expected to be lost or the amount of gain desired.
- Age of the cow being fed. First- and second-calf heifers are still growing and must be fed some additional nutrients to allow for this growth.

Calculating the Amount of a Commercial Grain Mix To Feed

This example shows the steps needed to calculate the amount and protein percentage of the grain mix fed to the average cow in a herd. Please pay attention to the assumptions made because they affect the amount and kind of commercial grain mix fed.

Step 1:

Gather information about the average cow in the herd (or individual cow). This information includes:

1. Body weight
2. Milk production
3. Milk butterfat test
4. Average age of the cow
5. Does the cow need to gain weight to be in proper body condition when she is dried off?

For this example, we will be using a 1300 lb mature Holstein cow producing 65 lb of milk at 3.5% butterfat and we want her to gain 1 lb body weight per day.

Step 2:

Gather information about the forages the cows are consuming. This information includes the nutrient analysis of the forages fed (from your forage analysis sheets) and the amounts of each forage the average cow consumes.

For this example, the average mature Holstein cow consumes:
55 lb corn silage
5 lb alfalfa-grass hay

The nutrient content of these forages on an as fed basis is listed in Table 3.

Table 3. Intake and nutrient composition of forages used in the example

	Intake (lb)	**Energy (NE_L) (Mcal/lb)**	**Crude Protein (%)**	**ADF[1] (%)**	**Calcium (%)**	**Phosphorus (%)**
	as fed basis					
Corn silage	55	0.26	2.7	9.8	.11	.07
Alfalfa hay	5	0.55	14.1	29.0	1.26	.22

[1] ADF = Acid Detergent Fiber

How to convert from dry matter basis to as fed:

Nutrient composition (dry matter basis) X % dry matter

Remember that the nutrient composition expressed on a dry matter basis is a larger number than when expressed on an as fed basis.

Step 3:

Calculate the average cow's requirements for energy (NE_L), protein (crude protein), calcium and phosphorus.

Table 4. Calculations for example (Step 3)

	Energy (NE_L) (Mcal/day)	**Crude Protein (lb/day)**	**Calcium (lb/day)**	**Phosphorus (lb/day)**
Maintenance	9.57	0.892	0.053	0.037
Milk Production	20.15	5.460	0.195	0.117

Growth	0.00	0.000	0.000	0.000
(none because mature cow)				
	_____	_____	_____	_____
Subtotal	29.72	6.352	0.248	0.154
1 lb weight gain	2.32	0.320	- - - - -	- - - - -
	_____	_____	_____	_____
Total	32.04	6.672	0.248	0.154

The amount of energy and crude protein needed for maintenance is obtained from Table 5 using the section labeled "Maintenance Requirements of Mature Milk Cows." To calculate the amount of nutrients needed for production, multiply amount of the nutrient needed per pound of milk at a particular fat percentage (use Table 5) by the pounds of milk.

For this example: to calculate the amount of energy needed for 65 lb of milk at 3.5% fat test

(0.31 Mcal NE_L/lb milk) x 65 = 20.15 Mcal NE_L.

First and second-lactation cows need additional nutrients to grow. To calculate the amount of energy, protein, calcium, and phosphorus needed for growth of first-calf heifers, take 20% of the maintenance requirement for each nutrient. For second-lactation cows, the growth requirement is calculated by taking 10% of the maintenance requirement for each nutrient.

Table 5. Daily nutrient requirements for milking dairy cows.

Live Weight (lb)	Energy (NE_L) (Mcal)	Crude Protein (lb)	Calcium (lb)	Phosphorus (lb)
Maintenance Requirements of Mature Milk Cows[1]				
700	6.02	0.613	0.028	0.020
800	6.65	0.661	0.032	0.023
900	7.27	0.708	0.036	0.026
1000	7.86	0.755	0.041	0.029
1100	8.45	0.801	0.045	0.031
1200	9.02	0.846	0.049	0.034
1300	9.57	0.892	0.053	0.037
1400	10.12	0.932	0.057	0.040
1500	10.66	0.973	0.061	0.043

Nutrients Needed for Each Pound of Milk at Different Fat Percentages				
Fat %				
3.0	0.29	0.078	0.0027	0.0017
3.5	0.31	0.084	0.0030	0.0018
4.0	0.33	0.090	0.0032	0.0020
4.5	0.36	0.096	0.0035	0.0021
5.0	0.38	0.101	0.0037	0.0023
5.5	0.40	0.107	0.0039	0.0024
Estimated Nutrient Needs for Each Pound of Weight Change				
1 lb weight loss	-2.23	-0.320	-----	-----
1 lb weight gain	2.32	0.320	-----	-----
Source: Nutrient Requirements of Dairy Cattle. 6th revised edition, 1989. National Academy Press. [1]To allow for growth, increase maintenance allowances for protein, energy, calcium and phosphorus by 20% for first-calf heifers and 10% for second lactation cows, (referred to as growth in Table 4. Step 3).				

Step 4:

Calculate the amount of energy, protein, calcium and phosphorus provided by the forages. Make sure you use the nutrient analysis on an as fed basis.

Table 6. Calculation for the example (Step 4)				
	Energy (NE_L) (Mcal/day)	**Crude Protein (lb/day)**	**Calcium (lb/day)**	**Phosphorus (lb/day)**
Cow's needs	32.04	6.672	0.248	0.154
From forages:				
55 lb corn silage[1]	14.30	1.485	0.060	0.038
5 lb hay	2.75	0.705	0.064	0.011
	_____	_____	_____ _____	
Total from forage	17.05	2.190	0.124	0.049
Needed from grain:[2]	14.99	4.482	0.124	0.105
[1] Use as fed nutrient analysis to calculate: Example for corn silage (0.26 Mcal NE_L/lb c.s. x 55 lb c.s.) = 14.30 Mcal NE_L				

[2] Calculated by subtracting nutrient provided by forages from the total amount of that nutrient needed by the cow.

To calculate the amount of energy (NE_L) obtained from corn silage, multiply the concentration of energy (NE_L) on an as fed basis by the amount of corn silage fed (See Table 3, Step 2).

For example:
55 lb corn silage x 0.26 Mcal NE_L/lb = 14.30 Mcal NE_L

Step 5:

Subtract the amount of energy, protein, calcium and phosphorus provided by the forages from the total amount of energy, protein, calcium and phosphorus needed by the cow. This is the amount of energy, protein, calcium and phosphorus that must be supplied by the grain mix. (For the calculations, see Table 6 in Step 4.)

For this example: The cow needs 32.04 Mcal NE_L and 17.05 Mcal NE_L is provided by the forage. Thus, 14.99 Mcal NE_L (32.04 - 17.05 Mcal NE_L) must come from the grain mix in order to meet the cow's energy needs.

Step 6:

Calculate the amount of grain mix and the percentage of protein needed in the grain mix.

A. To calculate the amount of grain to feed, use the following equations.

Mcal NE_L needed in the grain mix/Mcal NE_L in one pound of grain mix

The amount of energy (NE_L) found in commercial grain mixes can vary (range = 0.60-0.80 Mcal NE_L on an as fed basis). Ask your feed company representative for the amount of NE_L in the grain mix you are purchasing.

For example: If the grain mix contains 0.73 Mcal NE_L per pound of grain mix (as fed basis), then:
(14.99 Mcal NE_L needed in grain mix/0.73 Mcal NE_L/lb grain mix) = 20.5 lb grain mix

Therefore, you would need to feed this cow 21 lb of grain mix to meet her energy needs.

Make sure you know whether the NE_L value provided by your feed company representative is on an as fed or dry matter basis. If the NE_L value is on a dry matter basis, convert to as fed by using the following equation.

_____ Mcal NE_L (Dry matter basis) x 0.89

For example:
0.82 Mcal NE_L (Dry matter basis) x 0.89 = 0.73 Mcal NE_L

B. To calculate the percent protein needed, use the following equation.

(Pounds protein needed from grain mix/pounds of grain needed) X 100

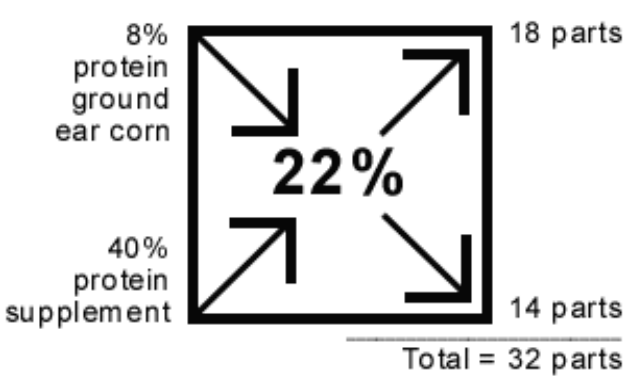
For this example:
(4.482 lb protein needed/21 lb grain mix) x 100 = 21.3% protein in grain mix

In this example, a 22% protein grain mix would have to be fed to meet her protein needs. (Always round up on the percent protein needed in the grain mix.)

If a 22% grain mix is unavailable from your feed company, you will need to feed a 20% protein grain mix and at the same time feed more pounds of this grain mix to meet the cow's protein needs. To calculate how much grain mix to feed if the highest protein grain mix available is 20% protein use the following equation;
(lb protein needed in grain mix/% protein in grain mix) X 100

In this example:
(4.482 lb protein needed in grain mix/20% protein in grain mix) X 100 = 22.4 lb grain

C. Determine mixture of concentrates to feed



The "Pearson's Square" method is one way of determining the mixture of grain and protein supplement needed to obtain a desired protein percentage. The desired protein percent of the grain mix is placed in the center of the square. Percent of protein in the grain and protein supplement are placed in the two left corners. By taking the difference (diagonally) between the desired protein percent and the percentage of protein in the grain or protein supplement, it is possible to determine the pounds of each to use.

Here, a 25% protein grain mix is made using ground ear corn and a 40% protein commercial supplement.

In this example, 18 parts (40 - 22) out of a total 32 parts would come from ground ear corn, or 56% of the grain mix is ground ear corn.

18 parts = 18/32 x 100 = 56% of mix is ground ear corn

The remaining 14 parts (2208), or 44% of the mix, is 40% commercial protein supplement.

14 parts = 14/32 x 100 = 44% of the mix 40% commercial protein supplement

Thus, a ton batch of this grain mix will contain 1120 lb ground ear corn (56% x 2000) and 880 lb 40% protein commercial protein supplement (44% x 2000).

Step 7:

Check to make sure adequate amounts of calcium, phosphorus, energy and protein are provided by the grain mix.

For example if 21 lb of a 22% protein grain mix is fed, the energy, protein, calcium and phosphorus needs of the cow would be met.

Table 7: Calculation for example (Step 7).
In this example, 21 lb of a 22% protein grain mix is fed.

	Energy (NE_L) (Mcal/day)	**Crude Protein (lb/day)**	**Calcium (lb/day)**	**Phosphorus (lb/day)**
Needed from grain mix (Step 5)	14.99	4.482	0.124	0.105
Amounts provided in 21 lb 22% protein grain mix[1](Step 6)	15.33	4.620	0.200	0.141

[1] In this example, the grain mix contains 0.73 Mcal NE_L lb, 22% crude protein, 0.95% calcium and 0.67% phosphorus on an as fed basis.

Worksheet for Calculating Amount of Commercial Grain Mix To Feed Milking Cows.

Step 1: Collect information about cow.

_____ Average body weight of cow

_____ Age of the cow

_____ Average milk production

_____ Average fat test

_____ Average number of days in milk

_____ How much weight should the cow gain?

Step 2: Collect information about forages fed.					
Forage	**Amount fed per cow per day**	**Energy Content (NE_L) (Mcal/lb)**	**Crude Protein %**	**Calcium %**	**Phosphorus %**
	As Fed Basis				

Steps 3, 4, and 5: Calculating the amount of nutrients needed from the commercial grain mix.				
	Energy (NE_L) (Mcal/lb)	**Crude Protein (lb/day)**	**Calcium (lb/day)**	**Phosphorus (lb/day)**
Step 3: Calculate cow's needs				
Maintenance				
Milk Production				
Growth				
Weight Gain				
TOTAL (A)				
Step 4: Amount of nutrients from forage				
TOTAL (B)				
Step 5:				
Amount needed from grain (subtract total A from B)				

Step 6:

A: Calculate amount of grain to feed

Mcal NE_L needed in grain mix/Mcal NE_L in one pound of grain mix as fed =

B: Calculate percent protein needed.

lb protein needed from grain/lb grain needed (step 6 part A) =

Step 7:

	Energy Content (NE_L) (Mcal/day)	**Crude Protein (lb/day)**	**Calcium (lb/day)**	**Phosphorus (lb/day)**
Needed from concentrate (step 5)				
Amounts provided in _____lbs _____% protein grain mix				
Difference				

Equal opportunity statement