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Formulating Rations for the Dairy Herd

Cooperative Extension South Dakota State University

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FS 770

Formulating rations for the dairy herd

Cooperative Extension Service
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Formulating balanced rations is an important objective of every dairyman who wants his herd to reach top performance. If he can determine the cheapest sources of the proper combination of nutrients he'll also be able to make a profit.

One method of accomplishing these goals is to use a computer. Computers can rapidly test all combinations of available feeds to find which provide the necessary nutrients at the lowest cost. Remote terminals such as AGNET, micro computers, and programmable calculators can do this.

This can also be done by following a step by step process described in this publication. A dairyman who formulates his own feed program can develop a better understanding of good nutrition.

DETERMINING FEED INTAKE

Feed intake varies considerably among cows, depending on animal size, level of production, and quality of the feed, particularly forages. A dry matter (DM) intake range of 2-4% of body weight is normal, 3% is average. Guidelines for estimating total dry matter intake for cows weighing between 880 and 1760 lb and producing from 22-99 lb of milk daily are shown in Table 1.

Table 1. Total dry matter intake guidelines.[1]

Pounds 4% fat-corrected milk	Pounds body weight				
	880	1100	1320	1540	1760
	Percentage of body weight				
22	2.5	2.3	2.2	2.1	2.0
33	2.8	2.5	2.4	2.3	2.2
44	3.1	2.8	2.7	2.6	2.4
55	3.4	3.1	3.0	2.8	2.6
66	3.7	3.4	3.2	3.0	2.8
77	4.0	3.6	3.4	3.2	3.0
88	—	3.8	3.6	3.4	3.2
99	—	4.0	3.8	3.6	3.4

[1]Nutrient Requirements of Dairy Cattle, Fifth revised edition, National Research Council, 1978.

The first step in balancing feed rations for dairy cattle is to accurately estimate how much forage each cow consumes each day. Be accurate. The amount of grain fed and its protein, energy, mineral, and vitamin content are based on this estimate.

If you don't have a large scale or feeder wagon with load cells, measure feed intake by any of the following methods. Weigh several bales and calculate average weight per bale. Or weigh the amount of silage unloaded from tower silos in a minute and multiply by the number of minutes the unloader is operated each day.

A third method is to fill a feed bunk with silage and weigh the amount in a 2-foot cross section of the bunk. Next, measure the length of the bunk and divide by 2. Multiply this value by the weight of silage in the 2-foot section. Another method, if you feed with a front-end loader, is to weigh the amount of material in one bucket or to dump several buckets on a truck bed and weigh it on a platform scale.

A final method is to assume a cow will consume 1.8-2.2% of her body weight in forage dry matter. For a 1,400-lb cow which consumes 2% of her body weight this would be 28 lb. This amount of dry matter could come from 31 lb of hay (90% DM), 80 lb of corn silage (35% DM), or a combination such as 15 lb of hay and 42 lb of corn silage.

Remember that feed intake is equal to the amount fed less the amount refused or wasted. Accurate estimates of feed intake are essential for successful ration balancing.

FEED COMPOSITION

Information on the average nutrient composition of South Dakota feedstuffs is listed in Table 2. Because these values are only averages, dairymen are encouraged to have all forages chemically analyzed.

For information on the nutritional needs of dairy cows see companion Fact Sheet 769 — Feeding the dairy herd.

Table 2. Average nutrient composition of feedstuffs on an as-fed basis.

	Dry matter %	Crude protein %	Net energy Mcal/lb	Calcium %	Phosphorus %
	As-fed				
Grains					
Barley	89	12.4	.76	.04	.33
Beet pulp	91	7.3	.74	.68	.10
Brewers grains	24	6.2	.16	.06	.12
Corn	89	8.9	.78	.02	.27
Ear corn	87	8.1	.73	.04	.23
Molasses, beet	77	6.7	.57	.16	.03
Molasses, cane	75	3.2	.56	.89	.08
Oats	89	12.4	.70	.06	.35
Sorghum, milo	90	11.2	.72	.04	.31
Wheat	89	12.8	.82	.04	.40
Dry forages					
Alfalfa, prebloom	89	20.8	.62	1.88	.27
Alfalfa, early bloom	90	15.4	.53	1.12	.21
Alfalfa, mid-bloom	89	14.2	.50	1.20	.20
Alfalfa, mature	91	12.2	.47	1.06	.15
Brome, early	88	9.2	.55	.26	.31
Brome, late	90	6.6	.49	.26	.31
Prairie hay	90	8.4	.33	.33	.12
Silages					
Alfalfa, prebloom	45	10.5	.31	.95	.14
Alfalfa, early bloom	45	7.7	.26	.56	.11
Alfalfa, mid-bloom	45	7.2	.25	.61	.10
Alfalfa, mature	45	6.0	.23	.52	.07
Barley, dough	68	5.9	.32	.20	.20
Corn	35	2.8	.25	.09	.07
Oats, milk	30	3.8	.19	.10	.03
Oats, dough	32	3.1	.19	.15	.11
Rye, dough	28	3.5	.15	.11	.09
Wheat, dough	32	3.8	.15	.09	.08
Protein supplements					
Linseed meal	91	35.1	.72	.39	.83
Soybeans	90	37.5	.89	.25	.59
Soybean meal (44%)	89	44.0	.75	.32	.67
Sunflower meal	93	37.0	.62	.37	1.02
Minerals					
Bone meal	95	12.1	.11	29.0	13.6
Dicalcium phosphate	96	—	—	22.8	18.1
Limestone	100	—	—	36.1	.02
Monosodium phosphate	87	—	—	—	22.6
Sodium tripolyphosphate	96	—	—	—	24.9

DETERMINING NUTRIENT REQUIREMENTS

Once nutrient intake and composition are known, the next step is to calculate daily nutrient needs. Nutrient requirements for maintenance, milk production, and maintenance plus pregnancy are shown in Table 3. Table 4 shows how to calculate the nutrient requirements of a 1,400-lb, nonpregnant cow producing 60 lb of milk containing 4.0% fat. Calculations shown are for determining crude protein and net energy requirements. Calcium and phosphorus needs may be determined by the same method.

Table 3. Daily nutrient needs of dairy cattle.[1]

	Crude protein (lb)	Net energy (Mcal)	Calcium (lb)	Phosphorus (lb)
A. For maintenance[2]				
800-lb cow	.77	6.6	.032	.026
1,000-lb cow	.89	7.9	.038	.030
1,200-lb cow	1.01	9.0	.043	.034
1,400-lb cow	1.12	10.12	.048	.039
1,600-lb cow	1.22	11.19	.053	.043
B. For milk production - add additional nutrients required per pound of milk to maintenance allowance				
% butterfat				
3.0	.077	.29	.0025	.0017
3.5	.082	.31	.0026	.0018
4.0	.087	.34	.0027	.0018
4.5	.092	.36	.0028	.0019
C. For maintenance plus pregnancy (last 2 months of gestation)				
800-lb cow	1.45	8.6	.053	.038
1,000-lb cow	1.69	10.2	.064	.045
1,200-lb cow	1.92	11.7	.075	.053
1,400-lb cow	2.13	13.2	.085	.060
1,600-lb cow	2.34	14.5	.095	.067

[2]To allow for growth of young lactating cows, increase allowances by 20% during first lactation and 10% during second lactation.

[1]Nutrient Requirements of Dairy Cattle, Fifth revised edition, National Research Council, 1978.

Table 4. Calculating daily nutrient requirements for protein and energy.

	Crude protein (lb)	Net energy (Mcal)
A. Daily requirements:		
1. For maintenance, 1,400-lb cow	1.12	10.12
2. For milk production,		
60 lb milk with 4.0% fat		
60 lb milk x .087 protein/lb milk =	5.22	
60 lb milk x .34 Mcal/lb milk =		20.40
Total requirements	6.34	30.52
B. Nutrients provided by ration:		
1. Forage[1]		
15 lb alfalfa hay @ 16% protein	2.40	
15 lb alfalfa hay @ .53 Mcal/lb		7.95
41 lb corn silage @ 2.8% protein	1.15	
41 lb corn silage @ .25 Mcal/lb		10.25
Total nutrients supplied by forage	3.55	18.20
Nutrients needed from grain	2.79	12.32
2. Grain mixture:		
20 lb that contain 14% protein	2.80	
20 lb that contain .70 Mcal/lb[2]		14.00
Total nutrients provided	6.35	32.30

[1]Assuming 2% forage dry matter intake, half from hay and half from corn silage.
[2]Most grain rations will contain .70 Mcals/lb. Therefore, this value is used in the energy calculation.

FORMULATING THE GRAIN MIX

After the desired level of protein is determined, the proper proportion of grains and protein supplement can be calculated. The following example shows how to formulate a grain mix of 14% protein using a mixture of 50% each of shelled corn and oats, plus soybean meal. Addition of salt, minerals, and vitamins dilutes the protein concentration; thus, the percentage of protein desired should be divided by 0.975 to increase accuracy.

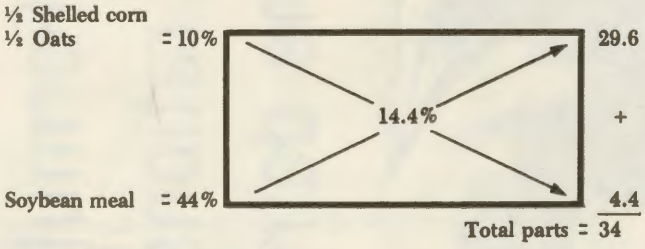

Figure 1. Proportions of grain and protein supplement can be calculated by following the step by step procedure illustrated by this box.

(1) First, draw a box like the one shown in Figure 1. Write the desired protein level in the middle of the box. Example: 14 ÷ .975 = 14.4%.

(2) Write the grains and protein supplement with their correct protein levels in the left corners of the square. The combination of corn and oats will equal about 10% protein. Example: 10% and 44%.

(3) Subtract diagonally (large minus small number) and write the differences in the appropriate corner. Example: 14.4 - 10 = 4.4 and 44 - 14.4 = 29.6. These numbers are parts or proportions to mix together.

(4) Read across (horizontally) to align the portions with the appropriate feed. Example: 29.6 parts of grain and 4.4 parts soybean meal.

(5) To convert to percentage figures, add all parts and divide total parts into each component, then multiply by 100. Example 29.6 + 4.4 = 34. The percentage of soybean meal in a batch would be (4.4 ÷ 34) x 100 = 13. The percentage of grain would be (29.6 ÷ 34) x 100 = 87.

(6) Multiply the size of the batch by these percentage figures to get the necessary pounds. Example: 2,000-lb batch x 13% soybean meal = 260 lb soybean per ton of grain mix. 2,000-lb batch x 87% grain would be 1,740 lb grain per ton.

In this example, a 1-ton batch would contain 260 lb of soybean meal, 870 lb of corn, and 870 lb of oats. In most cases, 30 lb of the proper mineral and 10-20 lb of trace mineral salt would be added per 1-ton batch.

Guidelines for determining the percentage of protein needed in a grain mix are shown in Table 5 for dairymen who don't go through the step by step process. These recommendations are based on providing 14% crude protein in the total ration (forage plus grain). They are not as accurate as detailed calculations.

Table 5. Crude protein needed in the grain ration with various qualities and quantities of forages.[1]

Forage	Percentage needed
Primarily legume[2]	
High quality (early bloom)	10-12
Medium quality (mid-bloom)	13-15
Low quality (full bloom)	16-18
Corn silage	20-22
Mostly corn silage	18-20
Corn silage plus 10 lb urea per ton[3]	16-18
Corn silage and legume (50%-50%)	14-16
Corn silage plus urea and legume (50%-50%)	12-14
Prairie hay	20-22
Oat silage	15-17
Pasture (mixed legume and grasses)	
Early spring	10-12
Mid-summer	13-15
Late summer	16-18

[1]Extremely poor forage requires more protein than indicated.
[2]Heated haylage will require more protein than indicated.
[3]No urea should be added to grain ration when urea is added to corn silage.

Table 6 lists guidelines for the amount of grain to feed with average quality forages. Following these grain feeding guidelines and feeding forage free choice should satisfy the energy needs of most cows.

With high producing cows, particularly in early lactation, extra grain should be fed to challenge the cows to higher production. For high producing cows to consume enough grain to meet needs, the amount of forage fed may need to be reduced. There is a limit to the amount of forage that can be replaced with grain, however. The forage fed should never be less than 1 lb of forage dry matter per 100 lb of body weight, or fat test may be reduced.

Table 6. Grain feeding according to forage quality.

Pounds milk per day	Forage quality: Good, % Milk fat 3.5	Good, % Milk fat 4.0	Average to poor, % Milk fat 3.5	Average to poor, % Milk fat 4.0
	Pounds grain			
20	0	1	11	12
30	4	5	16	17
40	8	10	20	21
50	13	15	24	26
60	17	19	28	31
70	21	24	32	35

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