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Rick J. Grant
University of Nebraska - Lincoln

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During excessively wet or dry years, there is a wide range of forage quality with most dairy producers forced to feed at least some moderate to poor quality forage. This NebGuide discusses basic alterations in the feeding strategy to help cope with minimal reductions in milk yield.

Rick Grant, Extension Dairy Specialist

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Table I. Annual Requirements for Dairy Cow Producing 20,000 pounds of Milk

Nutrient	Yearly total	Typical % from forage
Dry matter, lb	16,380	55
Crude protein, lb	2,800	49
NE_L, Mcal[1]	12,000	52
NDF, lb[2]	4,800	79
Chewing time, hr	4,700	90
Calcium, lb	155	51
Potassium, lb	150	97

Adapted from M.E. McCullough, 1992. Hoard's Dairyman.
[1]NE_L = net energy for lactation.
[2]NDF = neutral detergent fiber.

Milk Production Requirements and Forage Quality

Profitable dairy rations are formulated using high quality forage for top producers, and properly allocated

forage for the rest of the herd. *Table I* shows the percentage of the annual nutrient requirements for milk production that typically come from forage for a high-producing dairy cow.

Approximately 50 percent of the crude protein (CP) and net energy for lactation (NE_L) requirements is supplied by forage, and 80 to 90 percent of the fiber (NDF, neutral detergent fiber) requirements. Clearly, to successfully meet the requirements for high levels of milk production, high quality forage must be fed. When feeding poorer quality forages, expect lower milk production.

Table II shows that increased grain feeding cannot compensate fully for poor quality forage. In this classic Wisconsin research, cows fed high quality alfalfa hay (40 percent NDF) and 20 percent grain out performed those cows fed low quality alfalfa (60 percent NDF) and 70 percent grain. In other words, feeding excessively high levels of grain, even though it raises dietary energy level, will not match feeding high quality alfalfa with low to moderate grain levels.

Table II. Alfalfa Quality and Dairy Cow Performance (4% Fat-Corrected Milk Yield)

Hay NDF[1],%	% Grain in ration dry matter			
	71	54	37	20
	-----(milk, pounds)-----			
40	86.2	87.3	83.3	79.8
42	77.4	77.4	69.2	68.1
52	64.8	66.4	62.6	57.3
60	69.7	64.8	55.6	52.3
Kawas, J.R. et al. 1983. J. Dairy Sci. 66:181. [1]NDF = neutral detergent fiber. As NDF increases with advancing forage maturity, forage quality declines.				

Forage Quality and Grain Needs

Table III illustrates the effect of forage type (grass or legume) and maturity on composition and amount of grain mix needed for various levels of milk production. Note that as Relative Feed Value (RFV) of alfalfa falls from 160 (recommended quality for high milk production) to 80, the typical CP content falls from 21 percent or more to only 10 percent. At the same time, neutral and acid detergent fiber (ADF) increase, thereby dramatically reducing the forage energy content. Similar trends exist for grass hay or silage of poor, good, or excellent quality.

Table III. Effect of Forage Quality on Dietary Composition and Grain Needs

	Alfalfa RFV					Grass		
	80	**100**	**120**	**140**	**160**	**Poor**	**Good**	**Excellent**
Composition, % of DM								
CP	10	13	16	18	21	8	11	17
ADF	48	42	38	31	30	45	40	33
NDF	60	52	46	43	38	72	63	53
NE_L, Mcal/lb	.51	.57	.60	.66	.68	.55	.60	.65
Forage Intake, lb/d (free-choice)	18	22	30	31	33	21	26	28
Dietary Ingredients, % of DM[1]								
Forage	27	32	36	43	50	28	34	42
Corn, shelled	50	48	47	43	41	48	44	43
SBM, 44% CP	20	17	14	11	6	21	19	12
Mineral-vitamins	3	3	3	3	3	3	3	3
Dietary Composition, % of DM								
CP	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5
NE_L, Mcal/lb	.78	.78	.78	.78	.78	.78	.78	.78
NDF	23.6	25.3	25.0	26.1	26.0	29.2	29.7	28.3
NDF/R[2]	70	71	73	77	81	69	72	79
Grain Fed, lb/d								
80 lb milk	40*	38*	36*	32	28	37*	33	31
65 lb milk	31	28	26	19	16	28	26	24
50 lb milk	26	22	18	13	11	21	19	17

*Diets containing 80 to 120 RFV alfalfa and poor quality grass hay cannot support 80+ pounds of milk production without danger of acidosis and related metabolic disorders due to overfeeding grain.

[1]Dietary ingredients needed to formulate a 17.5% crude protein diet with .78 Mcal/lb net energy of lactation.

[2]NDF/R = percentage of NDF coming from a coarse roughage such as hay or coarsely chopped silage.

With advancing forage maturity (decreasing RFV), free-choice forage intake declines. This fact must be kept in mind when dairy cows are fed grain separately from forage (as in a parlor), and forage is offered free-choice. If forage intake is substantially less than expected, the total daily ration consumed by the cow will be seriously unbalanced in terms of forage to concentrate ratio, and cows may become acidotic leading to lower milk production and more herd health problems.

As forage quality declines, the amount of corn and soybean meal (or other appropriate energy and CP sources) needed in the ration must increase. In *Table III*, dietary ingredients for a 17.5 percent CP and .78

Mcal NE_L/pound of dry matter ration (i.e. a high production ration) are shown. Note that as forage quality decreases, rations formulated for high levels of milk production became dangerously deficient in NDF (should be 26% of dry matter, minimum) and the percentage of NDF from coarse roughage (should be 75+%). **In fact, diets containing solely 80 to 120 RFV alfalfa and poor quality grass hay cannot support 80+ pounds of milk production without danger of ruminal acidosis, off-feed problems, and related metabolic disorders due to overfeeding grain.** Often, a dairy producer will overcompensate for poor quality forage by overfeeding starchy grains, and end up with low and erratic feed intake patterns, low milk production, low rumination activity, poor body condition, and even laminitis.

Table IV illustrates the relationship between forage energy content, milk production level, and grain allocation. Again, note that as forage NE_L content declines, the ability disappears to safely feed adequate amounts of grain to support high levels of milk production. In fact, a forage or forage mixture containing .46 Mcal NE_L/pound of dry matter can only support 60 to 65 pounds of milk production daily. A dairy producer cannot successfully feed an early lactation, high producing cow with this quality of forage.

Table IV. Grain Feeding Schedules for Different Quality of Forages

	--------Milk (lb/day)--------														
Schedule[1]	*25*	*30*	*35*	*40*	*45*	*50*	*55*	*60*	*65*	*70*	*75*	*80*	*85*	*90*	*95*
Forage NE_L	-------- (Grain to feed daily, lb.)[2,3] --------														
72	6	6	6	6	8	10	13	16	18	21	23	26	28	31	33
70	6	6	6	8	10	12	15	18	20	23	25	28	30	32	**
67	6	6	8	10	12	14	17	20	22	25	27	30	32	**	**
65	7	8	10	12	14	17	19	22	24	27	29	31	33	**	**
63	8	10	11	13	15	18	20	23	25	28	30	32	34	**	**
61	9	11	12	14	16	19	21	24	26	29	31	33	**	**	**
57	10	12	13	15	17	20	22	25	27	30	32	**	**	**	**
55	11	13	14	16	18	21	23	26	28	31	33	**	**	**	**
54	12	14	15	17	19	22	24	27	29	32	**	**	**	**	**
50	14	15	16	18	20	23	26	28	30	33	**	**	**	**	**
46	15	17	18	20	22	25	27	30	32	**	**	**	**	**	**

[1]Use the schedule which represents the energy level of the forage being fed, or the weighted average value, if more than one is fed. Energy is expressed as NE_L in Mcal per 100 lb, dry basis. The grain levels presented are based on feeding of forage to the limit of appetite.

[2]Add 2-4 lb daily to rations of first or second calf heifers and to older cows in the last half of lactation which need to improve body condition.

[3]Add about 1 lb of grain for each .3% unit over 3.6% fat test.

**Above these levels of grain, care must be exercised to assure that the cow stays on feed and consumes adequate roughage. At high levels the grain mixture should be fed in three or more portions daily and, if possible, should contain high fiber, high energy ingredients such as oats, wheat bran, barley, corn and cob meal, soyhulls or beet pulp.

Feeding with Limited High Quality Forage

Rainy weather and poor harvesting/drying conditions result in a large supply of moderate to poor quality forage and limited supplies of high quality forages. The fundamental problem with feeding poor quality forage to dairy cows is the upper limit to intake in early lactation. This occurs at about 32 to 34 percent dietary NDF or at 1.3 percent of body weight as NDF intake. Above these levels of dietary NDF, intake decreases which results in less milk production, poor body condition, and difficulty in breeding cows. Feeding strategies to cope with poor quality forage include:

1. feeding more grain,
2. altering grain composition,
3. feeding supplemental fat,
4. using high-fiber byproducts as starch replacements or forage extenders,
5. feeding more corn silage, and
6. properly allocating forages based on quality.

Grain Feeding. To partially compensate for lower quality forage, feed more grain. The trick is to avoid acidosis. Often, when producers feed more grain, they end up with a ration containing insufficient fiber and related acidosis problems. When dietary NDF falls below 25 to 26 percent of ration dry matter, or the forage is finely chopped, the following problems will likely occur:

1. reduced rumination,
2. less saliva production,
3. ruminal acidosis,
4. low milk fat test,
5. laminitis, sore feet,
6. chronic intake fluctuations,
7. reduced milk production, and
8. thin cows during early lactation.

To avoid these problems, limit grain intake to 7 to 8 pounds per feeding, or 50 to 60 percent of ration dry matter.

When feeding high levels of grain, consider adding high fiber, high energy byproducts to the grain mix such as: ear corn, corn gluten feed, hominy, beet pulp, or soyhulls. These feeds often reduce the incidence of acidosis and related off-feed problems. *Table V* gives the maximum intake of some common fibrous byproducts.

Table V. Maximum Intake of Fibrous Byproducts[1]

Feed	Amount/day
Soyhulls	5-6 pounds (fed alone)
	8-10 pounds (in TMR)
Corn gluten feed	10-20 pounds
Brewers' grains	15 pounds
Wheat midds	6 to 10 pounds

From: Kubik, D. and R. Stock. 1990. Byproduct feeds for beef and dairy cattle. NebGuide G90-978.
[1]If combinations of byproducts are fed, be sure to keep total to less than 25-30% of ration dry matter.

Table VI gives an example ration that uses fibrous by-products (soyhulls, ground ear corn) and some high

quality alfalfa to compensate for poor quality forage. Using these fibrous byproducts allows more grain to be fed with less incidence of ruminal acidosis. For more detailed information concerning handling, storage, physical characteristics, and feeding limits of common byproduct feeds, consult NebGuide *G90-918, "Byproduct Feedstuffs for Beef and Dairy Cattle.*"

Table VI. Use of Fibrous Byproducts and Limited High Quality Forage to Compensate for Poor Forage Quality

Ingredient	As-Fed	DM	NE_L	CP	NDF
	(lb)	(lb)	(Mcal/lb)	(%)	(%)
Alfalfa-high quality	10.2	9.0	.68	21.0	38.0
Alfalfa-poor	10.2	9.0	.51	10.0	60.0
Corn, shelled	17.9	16.0	.93	10.0	9.0
SBM, 44% CP	8.1	7.3	.88	49.9	14.0
Soyhulls	3.3	3.0	.83	12.1	70.0
Corn, ground ear	5.8	5.0	.88	9.3	28.0
Mineral-Vitamin	1.3	1.3	0	0	0
Total in Diet[1]	56.9	50.6	.78	17.5	29.1
[1]Meets requirements for high-producing dairy cow.					

High Fiber Byproducts as Forage Extenders. Many byproducts can be used successfully as forage extenders at 15 to 20 percent of ration dry matter. These include soyhulls, oat mill byproducts, cottonseed hulls, corn cobs, and beet pulp. When using these fibrous byproducts as a forage substitute to extend limited quantities of high quality forage, maintain minimum effective fiber levels:

- 19 to 21 percent acid detergent fiber (ADF)
- 26 to 27 percent NDF
- 60 to 75 percent of NDF from coarse roughage, and
- 40 to 50 percent forage in total ration dry matter.

Recent research at the University of Wisconsin shows that whole cottonseed is equally as effective as alfalfa haylage at maintaining milk fat test. In general, whole cottonseed works best when fed with either alfalfa, or a mixture of alfalfa and corn silages, but not corn silage alone.

Feed More Corn Silage. Two-thirds to three-quarters of the forage mix can be corn silage. It is often recommended to keep 5 to 7 pounds of hay or haylage per cow in the ration to help prevent fat cow problems resulting from overfeeding corn silage. When feeding corn silage, keep in mind the need for more protein supplements, especially from soybean and animal sources. Use high-fiber, low-starch byproducts and cottonseed to stimulate rumination and lower the potential for acidosis. Generally, adding a buffer and increased feeding frequency will also promote better dairy cow performance when feeding high corn silage diets.

Feed Supplemental Fat. Proper supplementation of diets containing low quality forage with fat can boost the energy content and avoid the risk of acidosis from overfeeding grain.

Suggested general guidelines for feeding fat are:

Source	Amount
Forages, grains	3% of dry matter
Natural fats	2-4% of dry matter
- whole oilseeds	1 pound
- tallow (blends)	1 pound
Protected (inert) fats	2% (1 pound)
Total	7-8% of ration dry matter maximum!

A good rule of thumb is: Pounds of fat in ration equals pounds of butterfat produced.

Example: 100 lbs

milk @ 4% fat = 4 pounds milk fat

= 4 pounds fat in ration

Suggested maximum levels of common fat sources are:

- Whole raw soybeans, Max = 5 pounds/day
- Whole roasted soybeans, Max = 5 to 10 pounds/day
- Extruded soybeans, Max = 3 to 4 pounds/day
- Whole cottonseed, Max = 6 to 7 pounds/day
- Sunflower seeds, Max = 2 to 3 pounds/day (ground)
  = 4 to 5 pounds (whole)

Table VII gives an example ration in which supplemental fat is used as an energy source when feeding poor quality forages. For more information on feeding supplemental fat to dairy cattle, read NebGuide *G90-961, Supplemental Fat for High Producing Dairy Cows.*

Table VII. Use of Fat to Compensate for Poor Quality Forage when Formulating a High Production Ration

Ingredient	As-Fed (lb)	DM (lb)	NE_L (Mcal/lb)	CP (%)	NDF (%)
Alfalfa	25.0	22.0	.51	10.0	60.0
Corn, shelled	16.9	15.0	.93	10.0	9.0
SBM, 44% CP	11.6	10.4	.88	49.9	14.0
Fat					
Oilseed	1.0	.99	2.69	0	0
Animal	1.0	.99	2.69	0	0
Mineral-Vitamin	1.3	1.3	0	0	0
Total in Diet[1]	56.7	50.7	.78	17.5	31.6

[1]Meets requirements for high levels of milk production.

Properly Allocate Forages. The components of a successful, profitable forage allocation system include

maintaining an accurate forage inventory, knowing the projected needs of calves, heifers, and cows, and continuously adjusting forage harvesting and purchasing plans as the year progresses. When faced with limited quantities of high quality forage, and some poor quality forage, proper allocation to the various classes of livestock can greatly improve the profitability of the feeding program. A two-year Dairy Herd Demonstration program in Nebraska showed that producers with the highest net income not only produced more milk, they fed less forage and grain per cwt. of milk -- i.e. they allocated their feed supply more effectively. As the harvest season progresses, compare your forage inventory to your projected needs, and adjust forage harvesting and purchasing plans accordingly. NebGuide *G92-1118-A, Forage Allocation System for Dairy Producers - Using a Forage Inventory and Allocation Worksheet,* can help to organize forage inventories and properly allocate forages.

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