March 2001

Dairy Lines

Volume 7, Number 3

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Managing Milk Composition: Maximizing Rumen Function

This article is part of a fact sheet series produced by extension dairy specialists from Oklahoma, Texas and New Mexico.

Various feeding management practices affect the levels of milk fat and protein concentration in raw milk. Feeding strategies that optimize rumen function also maximize milk production, milk component percentages and yield. Producers can use several strategies to enhance rumen function and the resulting milk components. Producers who use records, such as those provided by DHIA (Dairy Herd Improvement Association), can critically evaluate their nutrition and feeding management programs.

Feed Intake: Feed provides the nutrients that are the precursors, either directly or indirectly, of the principal milk solids. So an increase in feed intake usually results in the production of a greater volume of milk. In general, the proportional increases in fat, protein and lactose yields are approximately the same as the proportional increase in milk volume. Milk composition changes little.

It is critical to maximize feed intake of cattle so that negative energy balance is minimized during early lactation. As cows consume more energy than they use, body weight is regained, losses in body condition are minimized, and cows produce milk of normal fat and protein content. Increasing feed intake, and the resulting overall increase in energy, can increase milk protein content by 0.2 to 0.3 percent.

High-producing cows should eat 3.5 to 4.0 percent of their body weight daily as dry matter. If a herd is consuming less than this, production of solids-corrected milk may be limited. Major factors that can affect feed intake include:

- Feed bunk management (Keep feed bunks clean, not empty.)
- Feeding frequency
- Feed sequencing
- Ration moisture between 25 and 50 percent to optimize dry matter intake
- Social interactions and grouping strategy of the herd
- Abrupt ration changes
- Physical facilities
- Environmental temperature.

Increased feeding frequency of low-fiber, high-grain diets increases milk fat levels. The greatest increase occurs in diets of less than 45 percent forage and when grain is fed separately, as in parlor feeding. When diets are fed as a total mixed ration, feeding frequency becomes less important as long as the feed remains palatable and is fed and mixed a minimum of once a day. During hot weather, more frequent feeding helps keep feed fresh and palatable.

Forage to Concentrate Ratio: On a DM (dry matter) basis, the minimum ratio of forage to concentrate required to maintain normal milk fat percentage is approximately 40-to-60. This ratio should serve only as a guide; other dietary factors influence the general effects that a decreased ratio has upon rumen fermentation. These effects include decreased rumen pH, increased propionic acid production, and reduced fiber digestion. Obviously, type and physical form of ingredients that contribute to the forage or concentrate portion of this ratio must be considered.

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Grain Feeding: The proper feeding of concentrates involves maintaining proper forage-to-concentrate ratios and nonfiber carbohydrate levels. Feeding appropriate nonfiber carbohydrate levels can improve both milk fat and protein levels, while over-feeding leads to milk fat depression of one unit or more and often increases milk protein percent by 0.2 to 0.3 units.

Nonfiber carbohydrates include starch, sugars and pectin. The percentage of nonfiber carbohydrate is calculated as NFC = 100 - (% Protein + % NDF + % Fat + % Ash). Depending on the digestibility of the neutral detergent fiber (NDF) present, nonfiber carbohydrates should range from 34 to 40 percent of the total ration dry matter. In most instances, a nonfiber carbohydrate level between 36 to 38 percent is considered ideal. This level is typical of diets with less than 60 percent forage. Diets with greater than 60 percent forage may be deficient in nonfiber carbohydrates.

When feeding for component changes, limit the amount of grain consumed during one feeding to 5 to 7 pounds to avoid rumen acidosis and off-feed problems that result in reduced fat content of milk. Grain feeding guidelines to maximize milk fat and protein production are provided in Table 1. Limit grain consumption to a maximum of 30 to 35 pounds per cow daily.

Table 1. Grain feeding guidelines.

Breed	Milk Production	Grain Feeding Guideline
Holstein and Brown Swiss	Less than 40 lbs.	1 lb. per 4 lbs. of milk
	40 to 70 lbs.	1 lb. per 3 lbs. of milk
	Greater than 70 lbs.	1 lb. per 2.5 lbs. of milk
Jersey, Ayrshire and Guernsey	Less than 30 lbs.	1 lb. per 3 lbs. of milk
	30 to 60 lbs.	1 lb. per 2.5 lbs. of milk
	Greater than 60 lbs.	1 lb. per 2 lbs. of milk

Adapted from B. Mahanna. 1995. Hoard's Dairyman. Vol. 140, No. 15., p. 617.

Manure containing large amounts of undigested corn or with a pH less than 6.0 can indicate too much grain or an imbalance of nonfiber carbohydrates in the diet. Fibrous byproducts such as soybean hulls can replace starchy grain and reduce the severity of milk fat depression in rations high in nonfiber carbohydrate.

Grain Processing: The type of grain and processing method can have a significant impact on the site and extent of starch digestion of a particular diet and resulting milk component composition and yield (Table 2). Generally, ground, rolled, heated, steam flaked or pelletized grain increases starch digestibilities and propionic acid production in the rumen. Steam-flaked corn or sorghum compared to steam-rolled corn or dry-rolled corn or sorghum consistently improves milk production and milk protein yield. In six comparisons, steam-flaked corn increased milk protein percentage and yield, and decreased milk fat percentage compared to steam-rolled corn. Milk fat yield remained unchanged in these trials. Twenty-four (24) comparisons of dry-rolled and steam-flaked sorghum have produced similar results. These results are attributed to increased total tract starch digestibility, increased recycling of urea to the intestinal tract and increased microbial protein flow to the small intestine.

Table 2. Rate of rumen starch digestion as impacted by grain type and processing method.

Rate	Grain Type/Processing Method
Fast	Dry rolled wheat
	Dry rolled barley
	High moisture corn (ground)
Intermediate	Steam flaked corn
	High moisture corn (whole)
	Steam flaked sorghum
	Dry rolled corn
	Whole corn
Slow	Dry rolled sorghum

Extensive use of grains, such as wheat, that consist of a rapidly fermentable carbohydrate and over-processing of grains can result in severe milk fat depression, off-feed problems and reduced milk yield. It is important to match carbohydrate and protein sources and to carefully monitor nonfiber carbohydrate levels in the diet to ensure proper fermentation patterns and to maximize milk component content and yield.

Ration Fiber Levels: The level of fiber feeding and the physical size of fiber particles contribute to the effectiveness of a fiber source for stimulating rumination (cud chewing), buffer production (salivation) and maintenance of normal milk fat and protein composition. Feeding of finely ground forages inadequately stimulates rumination and lowers saliva production. This results in a rumen fermentation pattern that produces a higher proportion of propionic acid and, in turn, reduces milk fat percentage. In most situations, forage comprising no less than 40 to 50 percent of the total ration dry matter should be included in the diet at no less than 1.40 percent of body weight. Each day cows should receive a minimum of 5 pounds of roughage (fiber) that is at least 1.5 inches long.

Cows require a minimum acid detergent fiber (ADF) level of 19 to 21 percent in the ration dry matter. Maintain total neutral detergent fiber (NDF) intake above 26 percent of the total ration dry matter. Provide 75 percent of the NDF as forage. Below these levels, cows are at an increased risk for acidosis, feed intake fluctuations, laminitis and rapid and extensive body condition loss, especially in early lactation.

Protein Feeding Guidelines: Generally, dietary crude protein level affects milk yield but not milk protein percent, unless the diet is deficient in crude protein. Normal changes in dietary protein ranges do not consistently affect milk fat percentage. Theoretically, insufficient amounts of rumen-degradable protein might result in decreased milk fat percentage if the concentration of ammonia in the rumen does not support the optimal digestion of fiber and microbial growth.

The crude protein requirement for a 1,350-pound cow producing 3.6 percent milk fat ranges from 14.0 percent of total dry matter (TDM) for 50 pounds of milk to 18.0 percent TDM for

Heart of America Dairy Herd Improvement Summary (Jan)

	Quartiles 1	2	3	4	Your Herd
Ayrshire					
Rolling Herd Average	16,635	13,898	13,466	11,604.50	
Summit Milk Yield 1st	56.0	46.0	50.0	21.50	
Summit Milk Yield 2nd	74.0	57.0	61.0	24.0	
Summit Milk Yield 3rd	78.0	67.0	64.0	29.0	
Summit Milk Yield Avg.	70.0	57.0	59.0	27.0	
Income/Feed Cost	913.0	1064.0	352.0	775.0	
SCC Average	516.0	561.0	331.0	117.0	
Days to 1st Service	91.0	70.0	149.0	64.0	
Days Open	156.0	127.0	200.0	85.0	
Projected Calving Interval	14.30	13.40	15.80	7.40	
Brown Swiss					
Rolling Herd Average	18,226.50	16,253.83	15,266.5	13,034	
Summit Milk Yield 1st	60.17	53.67	50.17	44.86	
Summit Milk Yield 2nd	68.17	65.33	66.67	56.86	
Summit Milk Yield 3rd	80.83	60.17	67.83	64.57	
Summit Milk Yield Avg.	68.50	63.50	61.50	54.71	
Income/Feed Cost	1501.33	1117.80	1002.0	835.50	
SCC Average	343.0	382.83	367.60	408.0	
Days to 1st Service	75.50	66.33	90.50	65.43	
Days Open	159.83	60.67	154.83	214.43	
Projected Calving Interval	14.48	15.10	14.28	16.29	
Guernsey					
Rolling Herd Average	—	15,655	15,629	12,610	
Summit Milk Yield 1st	—	55.0	55.0	48.0	
Summit Milk Yield 2nd	—	68.0	70.0	54.0	
Summit Milk Yield 3rd	—	68.0	68.0	59.0	
Summit Milk Yield Avg.	—	64.0	63.0	55.0	
Income/Feed Cost	—	1046.0	11090.0	1078.0	
SCC Average	—	342.0	1178.0	535.0	
Days to 1st Service	—	96.0	104.0	109.0	
Days Open	—	147.0	172.0	249.0	
Projected Calving Interval	—	14.10	14.90	17.40	
Holstein					
Rolling Herd Average	23,361	20,378.73	18,315	14,977.76	
Summit Milk Yield 1st	73.44	66.57	61.10	53.16	
Summit Milk Yield 2nd	93.35	83.12	75.99	63.64	
Summit Milk Yield 3rd	98.35	88.79	81.77	69.40	
Summit Milk Yield Avg.	86.98	79.27	73.26	63.30	
Income/Feed Cost	1640.77	1353.35	1191.36	887.33	
SCC Average	369.85	393.98	432.49	532.38	
Days to 1st Service	90.98	90.47	93.96	90.67	
Days Open	161.75	167.02	173.58	202.15	
Projected Calving Interval	14.53	14.70	14.92	15.86	
Jersey					
Rolling Herd Average	16,826.86	14,813.63	13,528	11,516	
Summit Milk Yield 1st	55.14	48.88	44.63	42.75	
Summit Milk Yield 2nd	66.29	59.75	60.50	51.50	
Summit Milk Yield 3rd	69.43	66.0	58.38	51.25	
Summit Milk Yield Avg.	62.71	59.25	53.75	48.13	
Income/Feed Cost	1517.50	1329.14	1097.40	817.86	
SCC Average	298.71	301.88	361.25	494.0	
Days to 1st Service	79.0	74.38	89.25	120.50	
Days Open	138.43	152.38	136.13	154.38	
Projected Calving Interval	13.76	14.20	13.70	14.30	
Milking Shorthorn					
Rolling Herd Average	17,324.0	14,975	14,138	11806.50	
Summit Milk Yield 1st	50.0	55.50	45.0	54.0	
Summit Milk Yield 2nd	66.0	72.0	58.0	30.0	
Summit Milk Yield 3rd	72.0	75.0	65.0	64.0	
Summit Milk Yield Avg.	68.0	68.50	59.0	60.50	
Income/Feed Cost	—	1191.0	1030.0	959.0	
SCC Average	248.0	244.0	373.0	198.0	
Days to 1st Service	—	45.50	81.0	41.50	
Days Open	183.0	212.50	177.0	132.0	
Projected Calving Interval	15.20	16.20	15.0	13.55	

Hay Prices*—Kansas

	Location	*Quality*	*Price ($/ton)*
Alfalfa	Southwestern Kansas	Supreme	120-125
Alfalfa	Southwestern Kansas	Premium	110
Alfalfa	Southwestern Kansas	Good	—
Alfalfa	South Central Kansas	Supreme	100-110
Alfalfa	South Central Kansas	Premium	100
Alfalfa	South Central Kansas	Good	—
Alfalfa	Southeastern Kansas	Supreme	—
Alfalfa	Southeastern Kansas	Premium	90-105
Alfalfa	Southeastern Kansas	Good	—
Alfalfa	Northwestern Kansas	Supreme	100-105
Alfalfa	Northwestern Kansas	Premium	95-100
Alfalfa	Northwestern Kansas	Good	—
Alfalfa	North Central/East Kansas	Supreme	110-120
Alfalfa	North Central/East Kansas	Premium	100-120
Alfalfa	North Central/East Kansas	Good	—

Supreme = over 180 RFV (less than 27 ADF)
Premium = 150–180 RFV (27–30 ADF)
Good = 125–150 RFV (30–32 ADF)

Source: USDA Kansas Hay Market Report, *March 16, 2001.*

Hay Prices—Oklahoma

	Location	*Quality*	*Price ($/ton)*
Alfalfa	Central/Western, OK	Premium	100-125
Alfalfa	Central/Western, OK	Good	90-110
Alfalfa	Panhandle, OK	Premium	100-125
Alfalfa	Panhandle, OK	Good	90-110

Source: Oklahoma Department of Agriculture, *March 15, 2001*

Feed Stuffs Prices

	Location	**Price ($/ton)**
Blood Meal	Central US	412-415
Canola Meal		125-135
Corn Gluten Feed	Kansas City	60-70
Corn Gluten Meal	Kansas City	250-265
Corn Hominy	Kansas City	54-66
Cotton Seed Meal	Kansas City	150-158
Whole Cotton Seed	Memphis	106
Distillers Grains	Central Illinois	93-110
Pork—Meat and Bone Meal	Texas Panhandle	165
SBM 48%	Kansas City	153-160
Sunflower Meal		110
Wheat Middlings	Kansas City	44-49

Source: USDA Feedstuff Market Review, *February 7, 2001*

Continued from page 2

100 pounds of milk. Depending on the stage and level of production, the recommended level of undegradable protein ranges from 32 to 38 percent of crude protein. Keep soluble protein between 30 to 32 percent of crude protein, or about half of the degradable protein intake level.

It is essential to meet the cow's requirement for both crude protein and rumen undegradable protein to avoid a negative impact on dry matter intake and fiber digestibility. Studies of diets containing no supplemental fat show that each 1 percent increase in dietary protein, within the range of 9 to 17 percent, results in a 0.02 percentage unit increase in milk protein. The additional synthesis of protein by mammary tissue likely is linked to limiting amino acids.

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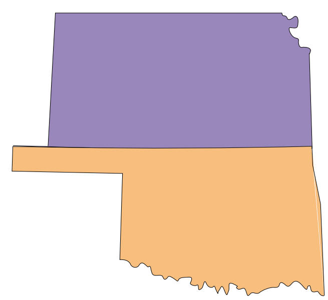
Dairy Lines is jointly published for dairy producers by the Department of Animal Sciences and Industry, K-State Research and Extension, and the Department of Animal Science, Oklahoma Cooperative Extension Service. For more information or questions, please contact 785.532.5654 (K-State) or 405.744.6058 (OSU).



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