ALFALFA HAY QUALITY: HOW MUCH IS IT WORTH TO DAIRYMEN?

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To most people, alfalfa hay is alfalfa hay. Whether it is cut at the bud stage or at full-bloom, it all looks pretty much the same after it is in bale or hay cube form. But the cow knows the difference and the amount of milk she produces or how much weight she gains is very dependent on the quality of hay she eats.

What do we mean when we talk about alfalfa quality? The most important factor is the maturity of the plant when it is harvested. There are other factors that affect quality also, such as leafiness, green color, harvesting conditions and contamination with foreign material. These factors can be controlled by good management practices on the part of the hay grower. When these factors are controlled, the palatability and digestibility of alfalfa hay is inversely related to its maturity. In other words, as the length of time between cuttings is increased, the value of the hay to cattle is decreased.

Hay is usually evaluated on the basis of a visual inspection, but with variable results. Research at the University of California has produced a chemical analysis, which, when used with visual inspection, greatly improves the accuracy of predicting the nutritive value of alfalfa hay. The chemical method, called the "Modified Crude Fiber" (MCF) analysis is based on the fact that the fiber content of alfalfa increases as it matures.

Since leaves are high in protein and low in fiber, highest quality hay is that cut in the prebud or early bud stage when the plants have a high proportion of leaves. As the plants mature the stems become larger, lower leaves fall from the plant, and the proportion of leaves decreases, resulting in protein decline and fiber increase. However, continuous cutting in the early bud stage shortens the life of the stand of alfalfa, reduces yields, and increases weediness of the alfalfa. Field tests show that quality, longevity, and weed population can be maintained in good balance by seasonal adjustment of cutting times. To accomplish this, the first two cuttings in the spring and the last cutting in the fall should be made at the one-tenth bloom stage. The summer cuttings should be made in the late bud stage.

Leafiness is important since two-thirds of the protein is found in the leaves. Leaf shatter during raking and baling can result in low quality. Alfalfa cut past the one-tenth bloom stage loses leaves rapidly as maturity increases. Alfalfa harvested in the spring and fall has a higher leaf percentage than summer-cut hay at the same stage of maturity. Natural green color is an indicator of proper curing, good palatability and aroma, freedom from mold, and relatively high carotene content.

Foreign material in hay refers to weeds, grain straw, hay stubble, dirt, and other material having little or no feeding value. Contamination with wire or other metal can even result in death of the cow from "hardware disease".

Harvesting conditions adversely affecting hay quality are excess handling of the hay when dry, causing leaf shatter, exposure to excessive dew or rain causing leaching of nutrients, or excessive dust which makes the hay unpalatable. Mold or spoilage occurs in hay baled at too high a moisture content, resulting in brown or even black hay.

The reliability of chemical analyses and visual inspection for evaluating these five quality factors is presented in the table on the following page.

It is clear that the most reliable judgment results from using both the chemical and visual methods. Alfalfa cut at the right stage of maturity can become low-quality hay by poor haymaking practices and conditions that only visual inspection can detect. Complete dependence on chemical analyses can be misleading because the following tables on nutritive values are correlated with the alfalfa plant only. Thus, large amounts of grasses and other weeds in the hay would destroy the validity of the chemical test. The effects of

mold, rain damage, and brittle character are not detected by chemical analysis, further emphasizing the need for visual inspection.

	Chemical Analyses	Visual Inspection
maturity	good	poor
leafiness	good	good
harvesting conditions	fair	good
green color	poor	good
foreign material	poor	good

The ultimate proof of alfalfa hay quality is measured by its palatability and by the production it generates. Many tests and observations have demonstrated a very dependable relationship between low-fiber alfalfa hay, good palatability and high milk production and rapid weight gains.

Analyses Required

Evaluation of the principal nutrients in alfalfa hay requires only two analyses: 1) a dry matter determination and 2) a modified crude fiber determination. University of California research has established relationships that reliably predict estimated net energy (ENE), digestible protein (DP), and total digestible nutrient (TDN) values for alfalfa hay from its dry matter and modified crude fiber contents.

It is important to use the modified crude fiber (MCF) analysis rather than the standard (AOAC) crude fiber analysis. MCF includes the silica (dirt) present in the hay sample. As crude fiber and dirt in a sample go up, energy and protein contents go down. The AOAC crude fiber analysis does not include silica and so is not as accurate as modified crude fiber in predicting the nutritional value of alfalfa hay. A complete description of the laboratory method for determining MCF is included in the University of California bulletin entitled "Alfalfa Hay Testing", AXT-290, available from all U.C. Agricultural Extension offices in California.

Interpreting and Using Alfalfa Hay Analyses

There are five major classes of nutrients needed by cattle (energy, protein, minerals, vitamins and water). Energy is the nutrient most often limiting milk production, so the energy content of hay deserves the greatest emphasis. High-energy alfalfa hay is also high in protein.

ENE and TDN are both measures of the energy content of feeds. TDN has been used extensively in the past but gradually is giving way to ENE because of the greater accuracy of ENE in comparing various classes of feeds. Estimated net energy (ENE), digestible protein (DP), and total digestible nutrients (TDN) for each MCF reading at 90% dry matter are listed in Table 1. Hay quality ratings also are assigned to ranges in MCF levels based on experience with cattle fed hay with varying MCF levels.

Table 1. Estimated Net Energy (ENE), Digestible Protein (DP) and Total Digestible Nutrients (TDN) in Alfalfa Hay Estimated From Modified Crude Fiber (MCF) Content. (All constituents expressed on a 90% dry matter basis)

MCF %	kilocalories/lb	DP %	TDN %	Quality Rating
17	494	18.4	58.4	Excellent
18	486	17.9	57.6	
19	477	17.3	56.7	
20	468	16.8	55.8	
21	460	16.2	55.0	
22	450	15.7	54.1	Good
23	440	15.2	53.3	
24	430	14.6	52.4	
25	420	14.1	51.6	
26	409	13.5	50.7	Fair
27	397	13.0	49.9	
28	385	12.5	49.0	
29	372	11.9	48.1	Poor
30	359	11.4	47.3	
31	345	10.8	46.4	
32	331	10.3	45.6	
33	317	9.8	44.7	

Alfalfa cube grades of Premium, No. 1, No. 2 and No. 3 have been developed by the California Grain and Feed Association which correspond to the "Quality Ratings" of Excellent, Good, Fair and Poor listed in Table 1. Complete information on cube grades and sampling procedures also is contained in the UCAES publication AXT-290, Alfalfa Hay Testing. The grades and standards established by the California Grain and Feed Association are shown in Table 2.

Table 2. Alfalfa Hay Cube Standards

	90% Dry Matter Basis		
Grade Name	Modified Crude Fiber* (Max %)	Crude Protein (Min %)	Moisture (Max %)
Premium	22	19	12
No. 1	25	17	12
No. 2	28	15	13
No. 3	above 28	below 15	14 or more

*Note: Univ. of Calif. method from AXT-290, Alfalfa Hay Testing

Modified crude fiber is the only analysis required to predict the nutritive value of alfalfa hay as far as energy is concerned. However, moisture content of hay is important from an economic standpoint. When hay is selling for $30 per ton, each percentage of moisture is costing the buyer $0.30 per ton. Most hay will standardize at about 90% dry matter (10% moisture) after being stored for a month or so in warm, dry weather. When hay is bought behind the baler, moisture levels of 15% to 18% are common. The buyer should consider the decreased value of hay high in moisture as well as the energy predicted from the MCF content.

Tables 3 and 4 were developed to estimate the relative dollar value of alfalfa hay at varying MCF and dry matter (DM) percentages. The tables are based upon a standard hay sample arbitrarily set at 25% MCF and 90% dry matter. This corresponds to hay with an ENE of 420 kilocalories per pound, which is the lower end of the "Good" category.

TABLE 3 Relative Alfalfa Hay Values at Various MCF Percentages. (90% DM basis)

	$/ton															
MCF	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
14	4.76	5.24	5.71	6.19	6.67	7.14	7.62	8.10	8.57	9.05	9.52	10.00	10.48	10.95	11.43	11.90
15	4.33	4.77	5.20	5.63	6.07	6.50	6.93	7.37	7.80	8.23	8.67	9.10	9.53	9.97	10.40	10.83
16	3.95	4.35	4.74	5.14	5.53	5.93	6.32	6.72	7.11	7.51	7.90	8.30	8.70	9.09	9.49	9.88
17	3.52	3.88	4.23	4.58	4.93	5.29	5.64	5.99	6.34	6.70	7.05	7.40	7.75	8.10	8.46	8.81
18	3.14	3.46	3.77	4.09	4.40	4.71	5.03	5.34	5.66	5.97	6.29	6.60	6.91	7.23	7.54	7.86
19	2.71	2.99	3.26	3.53	3.80	4.07	4.34	4.61	4.89	5.16	5.43	5.70	5.97	6.24	6.51	6.79
20	2.29	2.51	2.74	2.97	3.20	3.43	3.66	3.89	4.11	4.34	4.57	4.80	5.03	5.26	5.49	5.71
21	1.90	2.10	2.29	2.48	2.67	2.86	3.05	3.24	3.43	3.62	3.81	4.00	4.19	4.38	4.57	4.76
22	1.43	1.57	1.71	1.86	2.00	2.14	2.29	2.43	2.57	2.71	2.86	3.00	3.14	3.29	3.43	3.57
23	0.95	1.05	1.14	1.24	1.33	1.43	1.52	1.62	1.71	1.81	1.90	2.00	2.10	2.19	2.29	2.38
24	0.48	0.52	0.57	0.62	0.67	0.71	0.76	0.81	0.86	0.90	0.95	1.00	1.05	1.10	1.14	1.19
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	-0.52	-0.58	-0.63	-0.68	-0.73	-0.79	-0.84	-0.89	-0.94	-1.00	-1.05	-1.10	-1.15	-1.20	-1.26	-1.31
27	-1.10	-1.20	-1.31	-1.42	-1.53	-1.64	-1.75	-1.86	-1.97	-2.08	-2.19	-2.30	-2.41	-2.52	-2.63	-2.74
28	-1.67	-1.83	-2.00	-2.17	-2.33	-2.50	-2.67	-2.83	-3.00	-3.17	-3.33	-3.50	-3.67	-3.83	-4.00	-4.17
29	-2.29	-2.51	-2.74	-2.97	-3.20	-3.43	-3.66	-3.89	-4.11	-4.34	-4.57	-4.80	-5.03	-5.26	-5.49	-5.71
30	-2.90	-3.20	-3.49	-3.78	-4.07	-4.36	-4.65	-4.94	-5.23	-5.52	-5.81	-6.10	-6.39	-6.68	-6.97	-7.26
31	-3.57	-3.93	-4.29	-4.64	-5.00	-5.36	-5.71	-6.07	-6.43	-6.79	-7.14	-7.50	-7.86	-8.21	-8.57	-8.93
32	-4.24	-4.66	-5.09	-5.51	-5.93	-6.36	-6.78	-7.20	-7.63	-8.05	-8.48	-8.90	-9.32	-9.75	-10.17	-10.60
33	-4.90	-5.40	-5.89	-6.38	-6.87	-7.36	-7.85	-8.34	-8.83	-9.32	-9.81	-10.30	-10.79	-11.28	-11.77	-12.26

TABLE 4. Relative Alfalfa Hay Values at Various Dry Matter Percentages.

	$/ton															
DM	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
100	2.22	2.44	2.67	2.89	3.11	3.33	3.56	3.78	4.00	4.22	4.44	4.67	4.89	5.11	5.33	5.56
99	2.00	2.20	2.40	2.60	2.80	3.00	3.20	3.40	3.60	3.80	4.00	4.20	4.40	4.60	4.80	5.00
98	1.78	1.96	2.13	2.31	2.49	2.67	2.84	3.02	3.20	3.38	3.56	3.73	3.91	4.09	4.27	4.44
97	1.56	1.71	1.87	2.02	2.18	2.33	2.49	2.64	2.80	2.96	3.11	3.27	3.42	3.58	3.73	3.89
96	1.33	1.47	1.60	1.73	1.87	2.00	2.13	2.27	2.40	2.53	2.67	2.80	2.93	3.07	3.20	3.33
95	1.11	1.22	1.33	1.44	1.56	1.67	1.78	1.89	2.00	2.11	2.22	2.33	2.44	2.56	2.67	2.78
94	0.89	0.98	1.07	1.16	1.24	1.33	1.42	1.51	1.60	1.69	1.78	1.87	1.96	2.04	2.13	2.22
93	0.67	0.73	0.80	0.87	0.93	1.00	1.07	1.13	1.20	1.27	1.33	1.40	1.47	1.53	1.60	1.67
92	0.44	0.49	0.53	0.58	0.62	0.67	0.71	0.76	0.80	0.84	0.89	0.93	0.98	1.02	1.07	1.11
91	0.22	0.24	0.27	0.29	0.31	0.33	0.36	0.38	0.40	0.42	0.44	0.47	0.49	0.51	0.53	0.56
90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	-0.22	-0.24	-0.27	-0.29	-0.31	-0.33	-0.36	-0.38	-0.40	-0.42	-0.44	-0.47	-0.49	-0.51	-0.53	-0.56
88	-0.44	-0.49	-0.53	-0.58	-0.62	-0.67	-0.71	-0.76	-0.80	-0.84	-0.89	-0.93	-0.98	-1.02	-1.07	-1.11
87	-0.67	-0.73	-0.80	-0.87	-0.93	-1.00	-1.07	-1.13	-1.20	-1.27	-1.33	-1.40	-1.47	-1.53	-1.60	-1.67
86	-0.89	-0.98	-1.07	-1.16	-1.24	-1.33	-1.42	-1.51	-1.60	-1.69	-1.78	-1.87	-1.96	-2.04	-2.13	-2.22
85	-1.11	-1.22	-1.33	-1.44	-1.56	-1.67	-1.78	-1.89	-2.00	-2.11	-2.22	-2.33	-2.44	-2.56	-2.67	-2.78
84	-1.33	-1.47	-1.60	-1.73	-1.87	-2.00	-2.13	-2.26	-2.40	-2.53	-2.67	-2.80	-2.93	-3.07	-3.20	-3.33
83	-1.56	-1.71	-1.87	-2.02	-2.18	-2.33	-2.49	-2.64	-2.80	-2.96	-3.11	-3.27	-3.42	-3.58	-3.73	-3.89
82	-1.78	-1.96	-2.13	-2.31	-2.49	-2.67	-2.84	-3.02	-3.20	-3.38	-3.56	-3.73	-3.91	-4.09	-4.27	-4.44
81	-2.00	-2.20	-2.40	-2.60	-2.80	-3.00	-3.20	-3.40	-3.60	-3.80	-4.00	-4.20	-4.40	-4.60	-4.80	-5.00
80	-2.22	-2.44	-2.67	-2.89	-3.11	-3.33	-3.56	-3.78	-4.00	-4.22	-4.44	-4.67	-4.89	-5.11	-5.33	-5.56

After the determination of the MCF and dry matter of the sample hay, use of the tables is as follows:

1. From column 1 of table 3 find the MCF percent of the tested hay.
2. Read across that row to the column containing the dollar value closest to the price of standard hay (25% MCF at 90% dry matter).
3. The value in the box where these two intersect is the amount to add (or subtract if the number is minus) to the price of standard hay.
4. From column 1 of table 4 find the dry matter percent of the tested hay.
5. Read across that row to the column containing the dollar value closest to the price of the tested hay after it was corrected for its MCF content, as calculated in instruction 3.
6. The value in the box where the two intersect is the amount to add (or subtract if the number is minus) to the price of the tested hay after correction for MCF content. The number obtained is the comparative value of the tested hay in relation to the standard hay.

Example

What is the relative value of alfalfa hay with 23% MCF (90% DM basis) and 84% DM when standard hay (25% MCF at 90% DM) is selling for $33.50 per ton?

1. In table 3, column 1 find the row for 23% MCF.
2. Read across that row to the column nearest to $33.50 per ton; in this case, $34.00.
3. The value in the box where the two intersect is $1.62. Add $1.62 to $33.50, which equals $35.12.
4. In table 4, column 1 find the row for 84% DM.
5. Read across that row to the column nearest $35.12; in this case, $36.00.
6. The value in the box where the two intersect is -$2.40. Subtract $2.40 from $35.12, which equals $32.72. This is the value of the tested hay when the standard hay is selling for $33.50.

This method is not intended as a hay pricing guide. Prices are established by supply and demand. Rather, it is intended only for comparing the relative value of different hay lots whose sale prices have been stated.

For example, a dairyman is offered two lots of hay, each at $31 per ton. Good quality hay is selling for $32 on the open market. Lot A has 26% MCF at 90% DM and has a dry matter percentage of 88%. Lot B has 23% MCF at 90% DM and has 85% dry matter. Which is the better buy? Using tables 3 and 4, the following comparision will determine the relative value of the two lots.

	Lot A	Lot B
standard hay	$32.00	$32.00
MCF correction (table 3)	-0.84 (26%)	1.52 (23%)
MCF corrected value	31.16	33.52
DM correction (table 4)	-0.71 (88%)	-1.89 (85%)
DM and MCF corrected value	$30.45	$31.63

From the above calculations, it can be seen that Lot B is worth $1.18 ($31.63 minus $30.45 = $1.18) more per ton than Lot A. Therefore, the dairyman would do better to buy Lot B if both are priced at $31.00 per ton.

High-Quality Hay Costs More to Produce

Since maturity is a major determinant of quality, high-quality hay costs more to produce than does low-quality hay. This is because one or more extra cuttings are required during the growing season. Harvesting costs are increased and yield is decreased

by more frequent cutting. Also, a grower incurs greater costs in maintaining weed control. A measure of these influences is provided in table 5.

Table 5. Relationship of Several Factors to Stage of Alfalfa Maturity

	Percent of 1/2 bloom		
Maturity	dry wt.	crude protein production	weeds
1/2 bloom	100	100	100
1/10 bloom	99	108	100
bud	85	107	200
prebud	68	97	400

The relationships shown in table 5 explain why much of the alfalfa hay produced in California is cut in the 1/2-bloom stage, or later. If there is no economic incentive to produce more palatable, more nutritious hay, the grower profits most by producing hay of lesser quality. Dairymen must be willing to pay a premium for high-quality hay if enough is to be produced to fulfill their needs.

Pricing hay on the basis of its MCF content makes sense for both the hay grower and the dairyman. A higher price for better quality hay or cubes rewards the hay grower who is making a superior product. Conversely, it penalizes the hay grower whose only objective is to obtain maximum tonnage from his fields without regard for the nutritional value of the hay. Many dairymen have learned that they can afford to pay more for high-quality hay because of the greater milk flow it produces from dairy cows. The value of the extra nutrients can be estimated with reasonable accuracy from tables 3 and 4, as shown in the previous examples. Within a price range of $30-$40 per ton, the value of alfalfa hay increases $.75 to $1.00 per ton for each 1% decrease in MCF. The area of negotiation between hay grower and dairymen lies between the extra cost of producing high-quality hay and the value of the extra nutrients it contains. Prices will shift with supply and demand, as always. Chemical analyses can help identify the supply, and also strengthen the tone of demand, in both directions.

Very Low Fiber Rations and Milk Composition

Experience with the feeding of extremely low-fiber alfalfa hay both at experiment stations and under commercial conditions has shown that milk fat percentage can be reduced under these conditions. Milk flow and solids-not-fat (SNF) content usually are increased at the same time. In most cases, the drop in fat test is compensated for by the increased amount of milk, resulting in approximately the same amount of milk fat per cow. However, minimum standards must be maintained by milk processors, and low-fat milk must be standardized with milk fat from other sources. Therefore, production of low-fat milk is discouraged by some milk processors.

Factors other than fiber are involved in the production of low-fat milk. Additional research is necessary before firm recommendations can be made for the prevention of a low-fat test. Indications are that feeding rations with less than 15% crude fiber can be expected to result in lowered milk fat percentages. Maintaining this level of fiber in the total ration of cows fed high levels of concentrates requires alfalfa hay with 20% or more crude fiber. If cows eating high levels of grain (20 pounds or more per day) do not voluntarily eat hay at a level of at least 1.5% of their body weight per day, even hay with 20% crude fiber may not prevent a drop in fat test. Many times, however, the advantages of greater milk flow, higher SNF test and better body condition of cows eating low fiber hay with higher energy levels overshadow the disadvantages of lower fat tests.

Other Advantages of High-Quality Hay

In addition to a higher energy content for low-fiber alfalfa hay, large secondary benefits are obtained that substantially increase its value to dairymen.

Since low-fiber hay contains more protein (see table 1) the protein level of the concentrate mix can be lowered accordingly. Protein supplements are the most expensive item in a concentrate mix, so lower protein concentrate means a lower cost concentrate mix to the dairyman.

Alfalfa with a higher energy content can either replace an equal amount of additional energy fed as concentrates, or provide additional energy if the same quantity of concentrates are fed. Either procedure will benefit the hay user.

Low-fiber hay is usually more palatable than high-fiber hay, resulting in less wastage. Since low-fiber alfalfa is usually less mature, the stems are not as hard, and they are seldom rejected by livestock.

Hay Testing Is Done by Private Labs

Hay testing is done in all parts of the state by commercial laboratories. Their fee is nominal for the important information provided. Help with locations of laboratories offering the MCF analysis and assistance with interpretation of results can be obtained from your local University of California Agricultural Extension office.