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AGRICULTURE

Alfalfa Hay Quality Testing

by Dennis Cash and Howard F. Bowman*

Alfalfa is the most productive and highest quality forage species. Over one million acres of alfalfa have been harvested each year in Montana since 1960. Yield and forage quality of alfalfa vary widely across environments and operations. Currently there is much interest in targeting specialized hay markets. Most Montana producers can consistently produce alfalfa that is of fair to good quality. However, hay marketing is becoming more quality-oriented. This MontGuide provides growers with proper hay sampling methods, explanation of laboratory results and recommended practices for achieving high-quality alfalfa hay.

Alfalfa Hay Quality

Alfalfa supplies five major classes of nutrients to livestock: energy, protein, minerals, vitamins and water. Dairy producers have long recognized the importance of high-quality alfalfa hay or haylage in their rations. (Haylage is grasses or legumes mowed and field-wilted to a lower moisture level than regular silage.) In cow-calf beef operations, premium quality hay is often sacrificed to obtain higher yields by harvesting at later stages of maturity. High-quality horse hay is visually described as being soft and leafy with dark green color and free of foreign material such as weeds, dust and mold. Obviously there are many different definitions and opinions of hay quality.

Many hay markets throughout the U.S. now rely on forage quality testing for equitable pricing. The hay industry will likely become more progressive as uniform hay standards are adopted, and cash hay producers should routinely test hay. Recent studies with beef cattle published in a Certified Alfalfa Seed Council publication indicate that high-quality alfalfa resulted in higher average daily gains than were obtained from average or poor-quality alfalfa in rations for growing animals. The high quality alfalfa was considered comparable to corn silage in finishing rations. For this reason, alfalfa hay quality testing is appropriate for assisting producers in ration balancing for more efficient use of feeds.

High-quality alfalfa must be both palatable and nutritious. It should be preserved in a manner that will retain palatability and nutritive value as close to the original condition as possible, whether it is fed as hay, greenchop or silage.

Many factors affect the nutritive value of alfalfa hay:

Variety selection. An appropriate variety should have adequate winter hardiness, multiple pest resistance and yield potential. New multi-foliolate and "high-quality" alfalfa varieties have been released, and these are being

*Extension Crop Specialist and Extension Agronomist, respectively, Plant and Soil Science Department, MSU, Bozeman, MT 59717.

widely tested in Montana to determine if they consistently result in better chemical quality. (See the MontGuide MT 9303 "Alfalfa Variety Section" for further discussion.

Optimum stand density is very important for high-quality alfalfa, and this is achieved by seeding rate and weed control. Progressive growers use pre-plant herbicides and many plant above the recommended seeding rate to guarantee successful and pure alfalfa stands. Fertility, post-emergent weeds and insects are managed for optimum alfalfa growth and stand density (greater than 10 plants per square foot).

Table 1. Forage quality of Montana alfalfa cut at varied stages of plant maturity

Growth Stage	% Leaves	% CP	% ADF	% NDF	RFV
Bud	>40[a]	>18[b]	<30[c]	<40[d]	>140[e]
Early bloom	30-40	16-18	30-35	40-45	124-140
Mid bloom	20-30	13-16	35-40	45-50	100
Full bloom	<20	<12	>40	>50	<100

[a] % Leaves = percentage of total dry matter comprised by leaves.
[b] % CP = percent crude protein on a dry matter basis.
[c] % ADF = percent acid detergent fiber on a dry matter basis.
[d] % NDF = percent neutral detergent fiber on a dry matter basis.
[e] RFV = relative feed value.

(Adapted from Stivers, J., B. R.Moss and L. Welty. 1983. New trends in forage analysis. MSU Research Report 202:61-70.)

Harvest frequency. The most critical and manageable factor influencing hay quality is the stage of maturity. As alfalfa plants advance from the vegetative stage to the reproductive stage, fiber content increases, while protein content and digestibility decrease. In Montana, alfalfa cut at an early stage resulted in better nutritive value (Table 1).

Regrowth repeatedly cut at an early stage rapidly loses vigor, and stands become thin. Therefore, the optimum harvest time is a compromise between maintaining healthy stands and forage yield, while harvesting for high quality forage. In established stands, high quality hay is obtained by harvesting at the mid- to late-bud stage (weather permitting), followed by cutting every 30-40 days at early (less than10 percent) bloom. Allowing the hay to reach early (10 percent) bloom at least one cutting during the summer will help maintain good stands. In Montana the last cutting must allow for at least 30 days of regrowth prior to average first frost date in the fall.

Harvest management. After a high-quality, standing alfalfa crop has been produced, it is extremely important to properly cut, condition, cure, bale, transport and store the hay. The simple objective is to capture and retain the leaves, which comprise 70 percent of the nutritive value. The primary advantage of silage or haylage operations is that leaf losses are less than 20 percent. A good haying operation can generally lose up to 40 percent of the leaves from normal shatter. In a study in California, severe losses occurred as a result of improper haying (Table 2).

Hay that is rained on and requires turning may result in over 60 percent leaf loss. Progressive growers now utilize conditioners on their swathers to reduce drying times, and many apply propionic acid or other preservatives to allow baling at higher moisture content. Windrows should not be moved at less than 30 percent moisture, and baling can begin when moisture content is near 20 percent. Baled hay should then be stored immediately to maintain its high quality.

Quality alfalfa hay should have good leafiness, bright green color, pleasant aroma, fine and pliable stems, and be free of foreign material and mold. Although these parameters are helpful, they are subjective and not definitive for hay marketing or balancing animal rations. The bottom line criteria are to make an objective assessment of chemical analyses related to animal performance.

Table 2. Losses associated with baling and raking dry hay.

	Raked & Baled Properly (lb/A)	Losses (lb/A) Raked Too Dry	Baled Too Dry	Raked & Baled Too Dry	Total losses (%)
Dry matter	2900	-700	-100	-1000	34
Crude protein	660	-210	- 60	- 290	44
TDN[a]	1710	-480	- 90	- 680	40

[a]TDN = total digestible nutrients.

Hay Sampling Techniques

Hay sampling is best accomplished with a hollow core probe (see resource list in references). This device consists of a stainless-steel tube with a sharp cutting end. Push probes are simply pushed through the bale. Rotary probes have teeth on one end, and a fitting for a manual brace or an electric drill on the opposite end. The manual brace may be difficult to use when sampling tightly packed bales, and an electric drill is useful.

One core should be sampled from at least 20 randomly selected bales from a lot of hay. A lot of hay is defined as hay harvested from a field of uniform maturity within a 48-hour period. Generally, a lot should not exceed 200 tons of hay. Square bales should be sampled by inserting the core sampler near the center of the butt end of the bale. Occasionally with loosely packed bales, the corer will collect little hay, hitting air pockets within the bale. When this occurs, the bale should be reprobed from a slightly different angle. The collected cores (at least one-half pound) should then be composited, well mixed and sealed in a plastic bag to retain the moisture level.

Accurate and meaningful laboratory results are possible only if the test sample truly represents the lot sampled. Samples obtained from hand-sampling flakes from a bale, very small core samplers, or hand-mixed samples should not be used for analysis. Poor sampling techniques and an inadequate number of subsamples (less than 20) are the largest sources of error in hay testing.

The samples should be kept air-tight in a cool place until they can be submitted to a laboratory for analysis. Forage quality samples can be analyzed in Montana by shipping to the Chemistry Station Analytical Laboratory, McCall Hall, MSU, Bozeman, MT 59717. The National Forage Testing Association has identified over 100 laboratories which are voluntarily evaluated and certified annually. Producers are encouraged to contact their County MSU Extension Agents or the laboratories directly for fees and specific handling procedures.

Chemical Analyses

Many parameters have been used to estimate forage quality. Presently the most useful factors for predicting animal performance are crude protein concentration, acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrients and relative feed value. ADF and NDF are important for evaluating forages because they are correlated with digestibility and intake, respectively. The NDF fraction is insoluble in neutral detergent and is the cell wall structure of the forage that is partially available to animals. Low NDF values are desirable and are associated with increased animal intake. ADF is insoluble in acid detergent and is the percentage of highly indigestible plant material in the forage (silica, lignin, etc.). Low ADF values are desirable because they correlate with increased digestibility. NDF values from a sample are always higher than ADF values because the ADF fraction is also insoluble in neutral detergent.

The newest technology for evaluating forage quality is by near infrared spectroscopy (NIRS). NIRS is an accurate procedure that rapidly estimates numerous "wet chemistry" parameters of forage quality. Many of

Table 3. Hay quality standards and value of hay in California markets.

Standard	% CP[a]	% ADF[b]	% NDF[c]	% TDN[d]	RFV[e]	Prices[f]
Supreme	>22	<27	<34	>62	>185	$141
Premium	20-22	27-29	34-36	60-62	170-185	$130
Good	18-20	29-32	36-40	58-60	150-170	$118
Fair	16-18	32-35	40-44	56-58	130-150	$95
Utility	<16	>35	>44	<56	<130	--

[a] CP is crude protein.
[b] ADF is acid detergent fiber.
[c] NDF is neutral detergent fiber.
[d] TDN is total digestible nutrients using the Western (California) formula on a 100% dry matter basis: TDN = 82.38 – (0.7515 x ADF).
[e] RFV is calculated by the Wisconsin formula: RFV = (DDM X DMI)/1.29, where DDM is dry matter digestibility (%) and DMI is voluntary dry matter intake (% of body weight). DDM = 88.9 – (0.779 x ADF). DMI = 120/NDF.
[f] Source: National Forage Testing Association at http://foragetesting.org.

the certified forage quality testing laboratories are equipped with NIRS instruments, and this procedure has greatly improved the speed and numbers of routine analyses available to growers. A uniform system of grading hay based on forage quality was proposed by the American Forage and Grassland Conference (Table 3).

Complete understanding of these equations is not important. However, Montana alfalfa producers should consider the following points:

1. In hay auctions where alfalfa is marketed on a quality basis, there is a significant premium for high-quality hay. For the period 1983-1991, the average price differential between hays of adjacent grades (Prime vs. 1, 1 vs. 2, etc.) was $15 per ton.
2. Milk production for dairy cattle, and average daily gains of beef cattle and sheep have been highly correlated to the level of alfalfa forage quality.

Summary

Alfalfa is an important crop in Montana. Producers desiring to target specialized hay markets should use all the available cultural practices to maximize both alfalfa yield and quality. Routine hay quality testing is inexpensive, and is recommended for both cash hay producers for marketing purposes, and feeders for ration formulation.

References

Lacefield, G., D. Ball, H. White and T. Johnson. 1989. *Alfalfa hay quality*. Certified Alfalfa Seed Council Publication. 8 pp.

National Forage Testing Association, P.O. Box 37115, Omaha, NE 68137. (402) 333-7485.

Rohweder, D. 1992. "Feeding beef cattle alfalfa—economically advantageous". *Montana Farmer-Stockman*. Oct. p. 8-9.

Stivers, J., B.R. Moss and L. Welty. 1983. "New trends in forage analysis." *MSU Research Report* 202:61-70.

Resource List for Hay Probes*

E-Z Probe
E-Z Probe Corp.
P.O. Box 848
Madras, OR 97741
(503) 475-2209

Forageurs Hay Probe
Forageurs Corp.
20788 Holyoke Ave., W.
P.O. Box 564
Lakeville, MN 55044
(612) 469-2596

Hay Chec Sampler
Hodge Products Inc.
P.O. Box 1326
El Cajon, CA 92022
(619) 444-3147

Oakfield Probe
Oakfield Apparatus Inc.
P.O. Box 65
Oakfield, WI 53065
(414) 583-4114

Penn State Forage Probe
Nasco
901 Janesville Ave.
P.O. Box 901
Fort Atkinson, WI 53538-0901
(414) 563-2446

Utah Hay Sampler
P.O. Box 1141
Delta, UT 84624
(801) 846-3207

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