service in ACTION

Colorado State University Cooperative Extension

no. .704

Recommendations for alfalfa hay quality evaluation

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Quick Facts

- Forage quality evaluation is a vital component of forage management and feeding systems.
- Obtaining a representative sample of an identifiable lot of hay is critical for valid forage quality analysis.
- Laboratory estimates of oven-dry moisture, crude protein and acid detergent fiber are the most useful measures of overall forage quality.
- Visual appraisals of hay also should supplement laboratory analysis.

Forage quality evaluation is a vital component of forage management and feeding systems. Quality measures based on sensory evaluation (appearance, odor, etc.) are inadequate because they are subjective. Laboratory methods of determining quality can provide a basis for objective evaluations that can be used in orderly marketing and efficient utilization of forages.

Unfortunately, the existing hay grading standards recognized by the Federal Grain Inspection Service are based on sensory characteristics. These standards are largely ignored by producers and buyers of hay and have proven inadequate in ration formulation. Sampling procedures and sample handling are other factors to be considered in hay testing. However, adequate guidelines for sampling have not been widely publicized.

The U.S. Alfalfa Hay Quality Committee was established in 1982 to address issues involving alfalfa hay quality testing. This committee, which is composed of industry, university and USDA representatives from throughout the United States, recently presented recommendations in 1980 for establishing uniform alfalfa hay sampling and testing procedures. The committee has also established a national laboratory certification program to promote uniformity in the analytical methods used by laboratories.

Standardized terminology for visual appraisal of hays was also proposed. These recommendations apply specifically to all forms of unground alfalfa hay, but they can also be used for ranking grass hays if the analytical values from these hays are not directly compared to those from alfalfa. These recommendations offer unique opportunities for more efficient marketing and utilization of alfalfa hay, both in Colorado and throughout the United States. This report provides an overview of the recommendations.

Table 1: Representative analytical values and estimated digestible dry matter (DDM) and digestible energy (DE) values for alfalfa hays harvested at various maturity stages.

Stage of maturity	Crude protein	Acid detergent fiber	DDM	DE
	% of Dry Matter			Mcal/kg
Pre-bloom	> 19	< 31	> 65	> 2.76
Early bloom	17-19	31-35	62-65	2.61-2.76
Mid-bloom	12-16	36-40	58-61	2.46-2.60
Full bloom	< 12	> 40	< 58	< 2.46

Hay Sampling Methods and Equipment

Laboratory analytical values are useful only if the sample analyzed is representative of an identifiable quantity of hay that is relatively uniform in quality. Therefore, the first step in sam-

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pling is to identify and define this hay. Hay is generally grouped into units called lots. Although there can never be a single definition that would cover all the possible exceptions, the committee did provide specific guidelines for grouping hay into separate lots. An individual lot can be designated as all the hay harvested from a given location or field at one cutting provided that stage of maturity is uniform and the duration of cutting or packaging (baling) does not exceed 48 hours.

Using this definition, the size of a lot could range from one to several hundred tons. Ideally, a single lot should not consist of more than 100 tons of hay. In some cases, buyers may specify an optimum size for each lot. Whatever the size, producers are responsible for separating and identifying lots to insure uniformity. This requires being observant of any factors, even within a field, that could cause the forage quality of one group of hay to differ from another.

One sample for each individual lot of hay should be collected for laboratory analysis. The sample should be taken from the final packaged product and consist of several subsamples selected at random from throughout the lot. After a lot has been sampled, all subsamples should be combined and placed in a durable plastic bag or some other sealed container to prevent moisture loss.

The method of sampling will vary with the type of hay package produced. Cube sampling is accomplished by selecting individual whole cubes. Bales and compressed loaf-type stacks should be sampled using a coring device with an internal diameter of at least ⅜" that is long enough to be inserted at least 12 inches into a bale. Excellent home-made core samplers have been constructed from items such as ski poles and golf club shafts. In addition, commercial core samplers can be obtained from the following sources:

Nasco West
1524 Princeton Ave.
Modesto, CA 95352
209/529-6957

Techni-Serv, Inc.
P.O. Box 848
Madras, OR 97741
503/475-2209

Oakfield Apparatus Inc.
P.O. Box 65
Oakfield, WI 53065
414/583-4114

Forageurs Corp.
8500 210th St. West
Lakeville, MN 55044
612/469-2596

Information on methods of collecting subsamples and the number required for a "true" representative sample is not yet complete. However, the committee did provide tentative recommendations for immediate use while further research on this subject is being conducted. At least 20 whole cubes should be randomly selected from an entire lot. For compressed bales, cores (subsamples) should be taken from each of 20 to 25 randomly selected bales.

Individual cores should be taken from the center of compressed ends of rectangular and square bales by inserting the coring device horizontally. For round bales, the cores should be obtained from around the circumference of the bale with the coring device directed toward the center of the bale. Loaf-type packages can be sampled from any side with cores taken at a slight angle (either up or down) rather than horizontally.

After the sample has been sealed in an airtight bag, it should be labelled to identify the lot represented by the sample and the grower's name, address and phone number. Some laboratories provide bags with labels on which the approprite information can be supplied. Sealed and labelled samples should be promptly submitted to a laboratory along with a written statement of the analyses being requested.

Hay sampling is as important in the hay evaluation process as the laboratory analyses used. If the techniques used in sampling and identifying lots are poor, the potential benefits from the analytical results will not be realized.

Laboratory Analysis and Data Interpretation

Forage quality and nutritive value are terms used to describe how well a forage will satisfy an animal's requirements for various nutrients. A complete list of nutrient requirements would include components such as vitamins, minerals, protein and energy. Laboratory estimates of crude protein and digestible energy are the most useful measures of overall forage quality, because these nutrients are required in the greatest quantities by livestock.

The presence of undesirable components such as toxins is an additional factor affecting quality. Laboratory analysis can also be used to detect these problem components when their presence is suspected.

Measurements of protein content in forages are obtained by determining total nitrogen and converting the values obtained to an expression of crude protein content. Energy availability, which can be expressed as digestible energy or total digestible nutrients (TDN), is indirectly evaluated under laboratory conditions by determining fiber content. Laboratory determination of crude protein is relatively straightforward, and the results from different labs are usually consistent. Unfortunately, laboratory methods for estimating fiber content vary greatly among laboratories.

In addition, the conversion systems used to predict energy availability from fiber content are not uniform. The purpose of the committee's recommendations on laboratory testing was to promote uniformity in hay testing procedures and to provide information for producers, buyers, feeders and laboratories rather than to impose a set of arbitrary standards on the hay industry.

The committee concluded that the best information on hay quality for marketing purposes can be obtained by requesting laboratory analyses for oven-dry moisture, crude protein, and

acid detergent fiber content. The procedures recommended for moisture and protein analysis are already used by most laboratories.

With respect to fiber analysis, however, the committee's recommendations differ from what is currently practiced in many labs. Acid detergent fiber analysis was judged superior to commonly used crude fiber methods as the best measure of fiber content. Although the Committee only issued recommendations on analyses to be used primarily for hay marketing purposes, other analytical data, such as mineral or nitrate content, may be useful.

Because fiber content and forage quality are negatively related, a conversion equation was also provided to calculate digestible dry matter, which is positively correlated with quality, from acid detergent fiber. An additional conversion equation was furnished for calculating digestible energy values. The equations are as follows:

$$\% \text{ DDM} = 88.9 - 0.779 (\% \text{ ADF})$$
$$\text{DE} = -0.027 + 0.0428 (\% \text{ DDM})$$

where:

DDM = estimated digestible dry matter,
ADF = acid detergent fiber, and
DE = estimated digestible energy expressed as Mcal/kg.

Representative analytical values and estimated DDM and DE values for typical alfalfa hays harvested at various stages of maturity are presented in Table 1.

Marketing strategies based on hay quality can be devised using individual analytical values or combinations of these values. The estimates of moisture and crude protein content and DE can also be used directly in ration formulation. Although widely applicable, the recommended evaluation system does have some limitations. Analytical and predicted values for crude protein and digestible energy are not reliable if the hay has undergone heat damage.

If black or brown discoloration is obvious upon sampling, this should be noted on the description sheet (see next section on visual appraisal). Extreme discoloration may indicate that lab analysis is unnecessary as a marketing tool because the hay would be classed as "sample grade" regardless of the analytical results.

In some instances, an analysis of the extent of heat damage can be conducted by determining the quantity of nitrogen present in the acid detergent fiber. Not all laboratories offer heat damage analysis as a routine service, so one should check with the lab before submitting samples suspected of heat damage.

Another limitation is that the estimated digestible energy values should not be used to determine comparative market values of alfalfa and grass hays. The estimates are valid for both types of hays, but they do not account for differences in intake; therefore, market values of alfalfa and grass hays should be established separately.

Even when common procedures are used, analytical results can vary among different laboratories. This variation would eventually render a program of uniform testing recommendations useless. To encourage uniformity in hay testing and aid laboratories in becoming familiar with the recommended procedures, the committee established a lab certification program.

Certification consists of sending standard hay samples to laboratories several times each year, comparing the results from all labs, and publishing the names of those that produce values considered within a normal range of accuracy. Lists of certified laboratories will be distributed as they become available from the Laboratory Certification Subcommittee.

Visual Appraisals of Hay

Laboratory testing is the most accurate and objective tool for evaluating hay quality, but visual appraisal also serves a useful purpose. In some instances, buyers may be more familiar with sensory measures of quality such as color and odor than with analytical values. More important, heat damage and the presence of foreign material or injurious foreign material cannot be detected directly by laboratory analysis. However, the informal terminology normally used to visually appraise hay is not standardized.

The committee carefully evaluated the role of visual appraisals and proposed a standardized system of evaluation that should be conducted by the seller or someone designated by the seller or buyer for each lot of hay.

The primary consideration in completing the visual appraisal sheet is the buyer's satisfaction. Maintaining good records during all phases of haymaking will help in providing accurate information. Most of the categories under "hay description" can be completed by observing core samples obtained from chemical analysis. Foreign material estimates can be obtained from cores and field observations prior to cutting and after windrowing.

Some hay inspectors use a device similar in shape to a crochet hook to obtain interior samples from a bale for visual inspection. Descriptions for hay cubes will usually be based on windrow observations. A brief guide for completing the appraisal form and suggested appraisal form are provided below.

Lab information: Enter name of lab that conducted the analysis and the number assigned by the lab.
Name and address: Give for individual performing the appraisal.
Date: Date the appraisal was made.

Lot Identification

Farm: Farm name (or owner's name) and town.
Harvest Date: Date the hay was stacked.
Lot code: Code used by seller to identify lot.
Field Location: Field number or other means of describing the field. (Could be same as lot code.)

Maturity: Pre-bloom—no plants blooming; early bloom—flowers present on less than 50% of plants; late bloom—flowers present on more than 50% of plants.
Cutting number: Cutting number for current year's production.

Lot Description

Quantity: Estimated tonnage of the entire lot.
Storage: Uncovered, tarped, straw-covered, open shed, enclosed barn, etc.
Bale type and size: Type (round, square, rectangular, or cubes), number of wires or strings, and dimensions.

Hay Description

Chemical treatment: If used, indicate type (preservative or drying agent), brand name and amount applied.
Color: Estimate color ranging from dark green to bleached. If brown or black, add "heat damaged" to color description.
Odor: Score as fresh, dull, light musty, moderate musty, moldy.
Foreign material: Estimate total amount of all foreign material, then name the type of noninjurious foreign material such as straw, grasses, weeds, etc.
Injurious foreign material: Same as above for only injurious material. Examples include noxious weeds, blister beetle, hardware or rocks. Presence of excessive pesticide should also be noted. Describe to the extent possible any substance that would make the hay undesirable.
Leaf attachment: Approximate percentage of leaves still attached to stem.
Leaf retention: Proportion of leaves originally on plants retained in bale (Excellent = high retention, Poor = low).
Visible mold: If mold present, indicate degree of discoloration from "light cure discoloration" to "obvious white mold." If mold present, reappraise color for heat damage.
Stem texture: Give size and hardness of stems. Size should range from coarse to fine. For hardness, use palm of hand to break over cut ends of stems at bale edges. Hard, tough stems will be painful to the palm of hand.
Potential weather damage: Estimate amount of precipitation during curing and storage and approximate time during curing when rainfall occurred.
Other comments: Include any additional comments that would help a buyer to visualize the status of the hay.

Alfalfa Hay Visual Appraisal Form

Lab Information: Date _____

Lab Name _____ Sample Number _____

Name _____ Address _____

Lot Identification

Farm _____ Maturity _____

Harvest Date _____ Lot Code _____ Cutting Number _____

Field Location _____

Lot Description

Quantity _____ Storage _____

Bale Type and Size _____

Hay Description

Chemical Treatment _____

Color _____ Odor _____

Foreign Material _____

Injurious Foreign Material _____

Leaf Attachment _____ Leaf Retention _____

Visible Mold _____ Stem Texture _____

Potential Weather Damage _____

_____

Other Descriptive Comments _____

_____

Hay Inspected by _____
(Signature)