HAY QUALITY EVALUATION

William C. Templeton, Jr.
Professor Emeritus
Department of Agronomy, University of Kentucky
and
Director (Retired) U.S. Regional Pasture Research Laboratory
USDA/ARS

During the last few years there have been several developments related to hay quality evaluation and marketing. In this presentation I shall briefly review these and indicate some of the implications for producers, vendors, purchasers and users of alfalfa hay.

History

Chemical analyses of forages were first accomplished approximately 175 years ago and chemical procedures developed in mid-nineteenth century were the only ones used world-wide for 100 years. The "artificial rumen" procedure for determining feed digestibility (1950s) and the Van Soest techniques for fiber analyses (1960s) have proved extremely helpful in evaluating forages as livestock feeds. Both these approaches require long periods of time in the laboratory to analyze a single sample, however, and are, therefore, relatively expensive.

Need for Improved Procedures

The official USDA hay standards were established over 50 years ago but for several years they have rarely been used in evaluating quality of market hays. Approximately 20% of the hay produced in the U.S. is sold once or more. The remaining 80% is used on the farms where it is produced. A very low percentage of the hay fed by those who produce it is ever evaluated chemically or objectively with respect to its nutritive properties or feeding value. Thus, the typical livestock producer who feeds hay to his animals has no information on its contribution to their nutritive requirements and, therefore, utilizes it inefficiently. Moreover, hay quality varies far more than does that of grains and most other feedstuffs.

Several procedures for determining nutritive properties of hays have been proposed and a few states have adopted procedures for use. For example, California has used a procedure (modified crude fiber) developed by animal scientists there some 25 years ago. But no other state has ever seen fit to use that procedure; thus, when hay has been shipped into or out of California, confusion has usually resulted because different measures of quality have been used by vendor and purchaser.

The same general situation has existed throughout the nation where hay has been traded with quality values stated. Mostly though, hay has been bought and sold with organoleptic descriptions expressed verbally and agreement somehow reached on price.
More than 10 years ago, the American Forage and Grassland Council (AFGC) established a hay marketing task force. Several scientists were surveyed to ascertain their views relative to quality-evaluation procedures. The majority felt that the neutral detergent fiber (NDF) and acid detergent fiber (ADF) analyses of Van Soest were the chemical assays of choice to estimate dry matter intake and in vivo dry matter digestibility, respectively.

Following a great deal of work the task force developed and proposed market hay grades for (1) legumes and legume mixtures and (2) grasses and grass-legume mixtures (Rohweder and Baylor, 1980). The proposed grades were widely discussed but never officially adopted.

Components of Hay Quality

The most important contribution of hay to the diets of ruminants and horses is energy, but hays also furnish protein, minerals and vitamins. They are valuable, also, owing to the fact that some fiber is essential for normal functioning of the digestive tracts of these animals. Crampton (1957) stressed almost 30 years ago that when forages are fed free-choice, as they often are, their voluntary consumption or intake by animals is the most important criterion of quality.

Later (Crampton et al., 1960) he and his colleagues established that intake accounts for approximately 70% of a forage's feeding value when it is fed as the sole diet. Digestibility accounts for 30%, less than half the importance of intake. In reality, the two are related, in that digestibility, especially its rate, markedly affects intake. When hay is to be fed free-choice any assessment of its quality has to take into account, then, both voluntary intake and digestibility. The concentration of crude protein, also, is an important factor in feeding and marketing. Information on mineral composition is desirable, especially with some classes of animals.

National Alfalfa Hay Quality Committee (NAHQC)

A group of agronomists, animal scientists, hay producers, and representatives of hay marketing organizations met in Anaheim, CA November 30 and December 1, 1982 to discuss the unsatisfactory state of affairs in hay quality evaluation and the general dissatisfaction with hay marketing matters. Those meetings resulted in formation of NAHQC and establishment of its goals of reaching agreement on procedures for expressing quality of alfalfa hay and of getting adoption of them throughout the U.S. Two additional meetings were held in 1983 to discuss relative merits of the procedures then in use and to reach agreement on the recommendations to be made.

Finally, a national workshop was held in Chicago March 22-23, 1984. Recommendations of the committee were presented and, with only minor dissent, they were very favorably received by those in
attendance (>150 people). The National Hay Association and AFGC have strongly supported NAHQC's efforts and several other organizations and groups have indicated approval of the approach being taken.

Details of the recommendations were published in the workshop proceedings (National Alfalfa Hay Quality Committee, undated). Among the items included were sampling procedures, laboratory procedures and certification of laboratories, visual appraisal, chemical information required for quality appraisal, analysis using near-infrared-reflectance spectroscopy, and the marketing and economic implications of nation-wide adoption of the recommendations.

Briefly, the recommendations are:

1. energy values are to be expressed as digestible dry matter (DDM)

2. DDM is to be calculated from ADF using the equation
   \[ DDM = 88.9 - 0.779 \times ADF\% \]

3. laboratory determinations are to include and be reported as percent dry matter, DM (as received basis); percent crude protein, CP (DM basis); and percent ADF (DM basis). DDM, calculated as in 2, above, will be reported as estimated DDM (EDDM)

4. DM, CP, and ADF may be determined by any method that gives results within the acceptable range established by a (to be agreed-upon) certifying agency, and

5. organoleptic and physical descriptions and other chemical values may be included optionally.

An integral part of the program is certification of laboratories for hay testing. Objectives of this program (Subcommittee on Laboratory Certification of the U.S. Alfalfa Hay Quality Committee, 1984) are to:

1. provide a voluntary mechanism for laboratories and hay testing facilities to certify the accuracy of their procedures

2. improve quality control of information coming from the laboratories and increase grower confidence in the information they receive

3. publish results of the certification procedure in national, regional, state and local hay grower publications

4. publish a list of certified participating laboratories on a quarterly basis, and
5. encourage and assist laboratories in improving their techniques.

Two further aspects of the organization's (now termed National Alfalfa Hay Testing Association) efforts are noteworthy:

1. the program is completely voluntary. This was a crucial factor in getting approval of most people and organizations that are now cooperating, and

2. changes in the recommendations will be made as new research/experience indicate a need for them.

Near-Infrared-Reflectance Spectroscopy (NIRS) and Hay Quality Evaluation

Norris et al. (1976) indicated that a relatively new procedure which had been used successfully for determining crude protein concentration in grains could be used for determining forage quality. Research in the area continued and in November 1978 a national NIRS project on forages was established, with six locations participating.

The project, still active and now with nine participating groups, has been highly successful in developing the technology for chemical analyses of forages. The initial findings of Norris et al. (1976) were confirmed, data bases on many kinds of forages were accumulated, and an extensive array of software was developed. A finely-ground, dried sample, consisting of 2 to 3 grams of material representative of the forage of interest, is used. Actual analysis requires less than 2 minutes per sample. After the NIRS analysis of a sample is completed the same computer, appropriately programmed, may be used for formulating a least-cost ration based on the nutritive properties of the forage.

NIRS analysis of forages is being adopted rapidly and widely in this country and in several others. The procedure not only is very rapid, it is highly accurate and repeatable if the analyses are conducted in accordance with the standardized methods (Marten et al., 1985). Most of the chemical characteristics of interest in utilizing hay, other forages and grains in livestock feeding can be determined by NIRS. DM, CP, heat-damaged protein, NDF, ADF, cellulose and lignin can be determined with a high degree of accuracy. Less accurate, but useful, information on calcium, phosphorus, potassium and magnesium can be obtained.

Implications for Producers, Vendors, Purchasers and Users of Hay

With the availability of NIRS analysis and ration-balancing programs which are available or in process of completion there is no longer any need to guess or use book values for composition of forages when feeding livestock. Feeding hay to dairy cows, for example, without knowing its chemical composition is almost certain
to result in either over- or under-supplementation if grain is fed. The extent of error will depend on the cows' nutritive requirements and the actual nutritive value of the hay.

The availability of NIRS technology in a mobile laboratory or van permits analysis of hays to be sold at auction very quickly after arrival at the market. Quality values can be placed on the lots of hay before sale so that both vendor and buyer can be aware of the hay's merits or deficiencies.

Favorable reaction to the National Alfalfa Hay Testing Association's recommendations suggest that increasing amounts of market hays will be sold on the basis of a chemical test. Indeed, some dairymen have been demanding tests on hay they purchase for some time now.

The full effects of these recent developments will not be known for some time. It appears, however, that with NIRS analysis and a uniform method of expressing the nutritive value of alfalfa hay throughout the U.S. the crop is likely to receive better management and be fed and traded with better understanding of its true worth as a feed.

References


