PNW 223 / Revised April 1988

Testing the Quality of Alfalfa Hay

D.B. Hannaway and P.J. Ballerstedt

Hay is the principal cash crop for many Pacific Northwest farmers. Purchasing hay is the biggest cash expenditure for many livestock producers. Recognizing quality differences, and their causes, is important to both producers and buyers of hay.

Frequently, high-quality and low-quality hay are offered at the same price. In many sales, buyers evaluate hay only by what they can *see*. Farmers know from experience that selecting on a visual basis doesn't always indicate feed quality accurately. Research and experience show that combining visual inspection with chemical analysis greatly improves your accuracy when you predict the nutritive value of hay.

Visual evaluation

Base your visual evaluation of hay quality on five factors:

Stage of maturity

The stage of plant maturity at harvest influences quality more than variety, production location, soil fertility, or seasonal influences. Alfalfa hay harvested in the vegetative (prebud) stage of maturity will have the highest nutritive value for livestock.

Maturity at the time of cutting also makes a great difference in palatability and digestibility. Both the acceptability (palatability) and the feed value (digestibility) decrease as the crop matures (from vegetative to full bloom stages). You'll have to make some compromises, however, between highest quality and highest yield.

Early-cut hay (prebud stage) will not produce as much as late-cut hay (1/2 bloom stage), but early-cut hay will produce more digestible nutrients than late-cut. On a yearly basis, early-cut hay will yield as much digestible dry matter per acre as later-cut hay.

Early-cut hay makes a more desirable feed because it contains more digestible material, is more palatable, and is eaten in larger quantities by livestock. If you use early-cut hay, you'll need less supplementary protein and energy feeds than you will with later-cut hay.

Leafiness

Leaves contain highly digestible energy and at least two-thirds of the protein found in hay. Loss of leaves, because of plant maturity or leaf shatter during raking and baling, greatly reduces hay quality. Thus the percentage of leaves remaining in the bale is an important indicator of hay quality.

Color

Bright green color is a good indicator of proper curing, good palatability, and high carotene content (carotene is converted to vitamin A). Any change from a bright green color indicates a loss in feed value. However, hays that have been slightly sun-bleached or have had a small amount of rain damage will still make high-quality feed.

Foreign material

Weeds and straw have little or no feeding value. Wire can injure livestock when they swallow it. In general, foreign material reduces palatability, which means lower intake.

Odor and condition

The smell of hey-mown hay is your standard. Any other odor, such as musty or putrified (rotten), indicates lowered quality. The causes are excessively high moisture content, or weather damage. Odor problems generally mean lowered livestock acceptability.

Dustiness also detracts from the value of hay. Don't feed dusty or moldy hay to horses or dairy cows, but you might use it in maintenance rations for beef cows.

Chemical analysis

Sampling your hay

A chemical analysis is valid only to the extent that the sample truly represents the stack or lot of hay under consideration. Use a core sampler.

David B. Hannaway, associate professor of crop science, and Peter J. Ballerstedt, Extension forage specialist, Oregon State University, in consultation with Extension specialists at Washington State University and the University of Idaho.

A Pacific Northwest Extension Publication

Oregon • Idaho • Washington

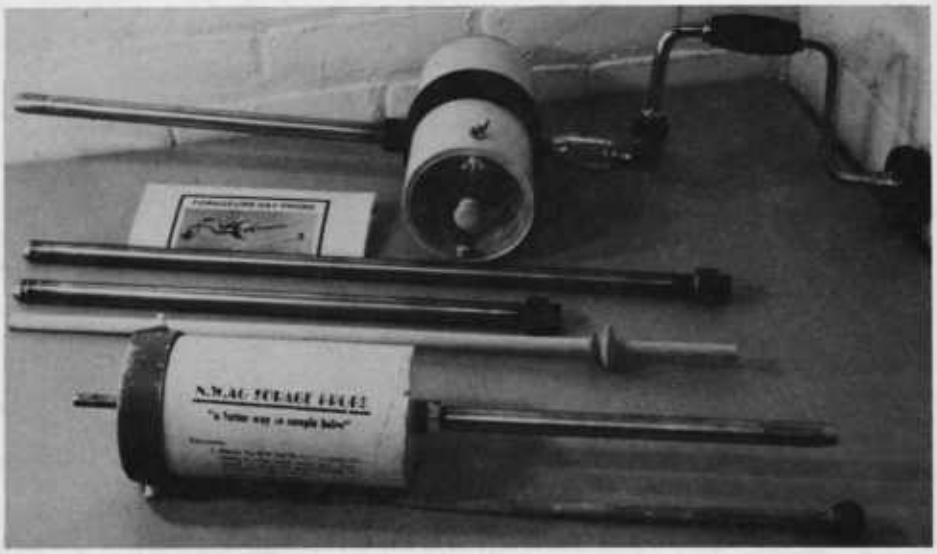

Figure 1.—Two types of hay care samplers: (abave) Forageurs Hay Prabe; (belaw) N.W. Ag Forage Probe.

Commercial forage samplers are available through farm supply sources. You can attach a core sampler to a brace or ½-inch drill for easy sampling (figure 1). Your county Extension agent can help you locate a supplier.

Sample a bale by centering the core sampler in the end of the bale and drilling horizontally (figure 2). Take at least 20 cores (1 per bale) for each lot you sample.

A lot of hay should represent hay harvested from the same field, the same cutting, and the same stage of maturity. If two lots of hay are in a stack, sample them separately.

Sampling plan

Bales within a lot of hay should be sampled at random. *Random* means that you have no preconceived reason for selecting or rejecting a specific bale to sample (location, color, leafiness, etc.).

Here are two ways to guard against preselection: (1) sample every fourth or fifth bale going around the stack (or truck) or down the row in the field; (2) take at least five random samples from each of the four sides of a stack.

To sample cubed hay, core 20 cubes at random from a lot of 200 tons or less.

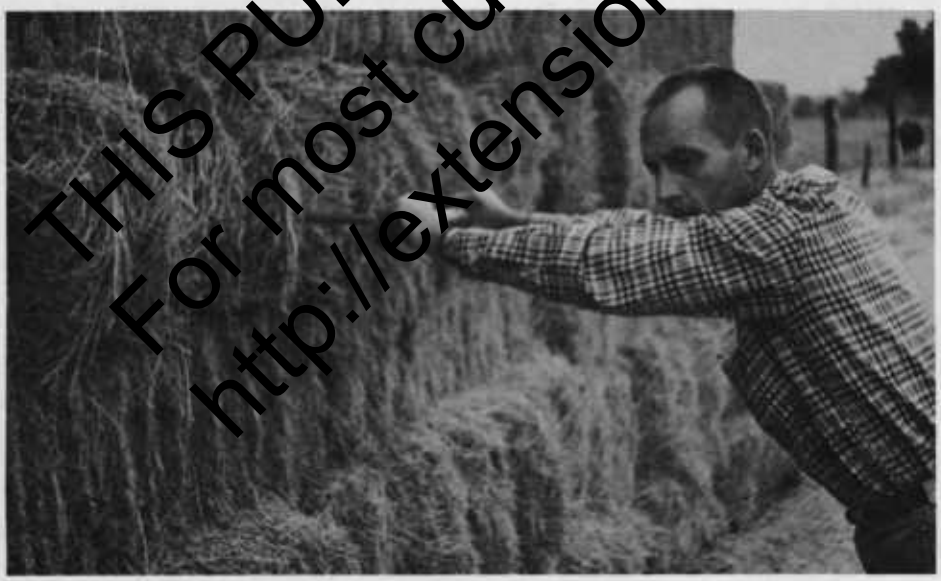

Figure 2.—Center the core sampler in the end of the bole ond probe horizantolly thraugh each of 20 bales.

Handling your sample

Twenty cores with a relatively harge-barreled probe will produce a large amount of sample. If you're tempted to divide it into smaller samples before you send it to the lab—*don't do it!* Stems and leaves will separate and settle. You can ruin a perfectly good sample by dividing it.

Place the whole sample in a polyethylene freezer bag and seal it tightly. If you package the sample in this manner, the laboratory report of dry matter "as received" will be close to the dry-matter content of the hay when you sampled it. Label your samples to show the lot and the location where you took the cores.

Standarized U.S. Alfalfa Hay Test

To promote common methods of hay testing and reporting, a standardized test has been developed for alfalfa hay. Several commercial and university service laboratories in the Pacific Northwest use this test to analyze hay. Your county Extension agent can help you locate the closest cooperating laboratory.

Laboratory analyses

The chemical analyses necessary for completing this standarized alfalfa hay test include dry matter, crude protein, and acid detergent fiber.

Dry matter (DM). At the time of baling, moisture content may range from 10 to 25% (90 to 75% dry matter). Moisture is usually lost from newly harvested hay; the total weight loss is generally 5% or more. During storage, hay can gain or lose moisture, depending on conditions.

The U.S. alfalfa hay test requires reporting chemical analyses on a 100% dry matter basis. This puts all hay on a common basis for comparing feed values. And this is important—stored hay or "as-fed" moisture varies according to conditions of storage.

Crude protein (CP). The quality of alfalfa and other legume hays is closely related to its crude protein content, since it's related to stage of maturity and leafiness. Hay high in protein allows the livestock producer to save money by reducing the need for high protein concentrates in the ration.

Acid detergent fiber (ADF). Hay quality is also related to its energy content. This test evaluates the available energy in alfalfa hay. ADF is the plant fiber that remains after an acid detergent removes part of the digestible cell wall material and the cell contents. ADF has a negative correlation with estimated digestible energy (DE)—that is, as ADF increases, digestible energy decreases.

Calculated values

The U.S. alfalfa hay test involves two calculated values, estimated digestible dry matter and digestible energy. The test uses them to estimate energy availablity of the forage. They're comparable to the calculated value TDN (total digestible nutrients, right-hand column).

The test uses these formulas to calculate these values:

Estimated digestible dry matter (EDDM). ADF is needed here:

$$EDDM\% = 88.9 - (0.779 \times ADF\%)$$

Digestible energy (DE). Now EDDM is needed:

$$DE\ (Mcal/kg) = -0.027 + (0.0428 \times EDDM\%)$$

The energy availability estimate (DE) from hay test results can be used to balance rations.

Laboratory certification

In November 1984, the American Forage and Grassland Council (AFGC) and the National Hay Association (NHA) launched the Hay Testing Laboratory Certification Program with the publication of a laboratory manual (see "For further reading," page 4).

This voluntary program has two objectives: to assist the alfalfa hay industry by identifying laboratories that perform with acceptable accuracy, and to help cooperating laboratories improve or maintain their performance standards.

To accomplish these objectives, the NHA (working in cooperation with regional, state, and local hay grower and marketing interests) accepted joint responsibility with the AFGC for conducting laboratory certification.

You can identify certified laboratories by the seal shown in figure 3 or by contacting your county Extension agent for a list of certified laboratories.

Other laboratory tests

Modified crude fiber (MCF). Some laboratories estimate total digestible nutrients (TDN) by a MCF test. This test was developed in California as a more rapid test than the crude fiber test. MCF has a negative correlation with animal digestibility (as MCF increases, digestibility decreases).

Neutral detergent fiber (NDF). This is the plant fiber that remains after a neutral detergent removes cell contents. NDF has a negative correlation with animal dry matter intake (as NDF increases, intake decreases).

Other calculated values

Total digestible nutrients (TDN). This has been the most extensively used measure of feed quality in the United States. It is the sum total of all digestible organic nutrients—proteins, nitrogen-free extract, fiber, and fat.

TDN has the approximate value of digestible energy, but the method has several drawbacks—the most important is that TDN overestimates the DE content of roughages. However, the existence of volumes of TDN data on various feeds and a long-standing tradition ensure its continued use for some time as the transition is made to other energy measures.

Since the determination of TDN values requires extensive laboratory procedures, TDN is often estimated from a single fiber test, such as ADF or MCF. These estimates are both termed TDN, but they are not comparable. For this reason, it's necessary to know which fiber test is used to estimate TDN.

Relative feed value (RFV). This estimate of overall forage quality is calculated from estimates of intake

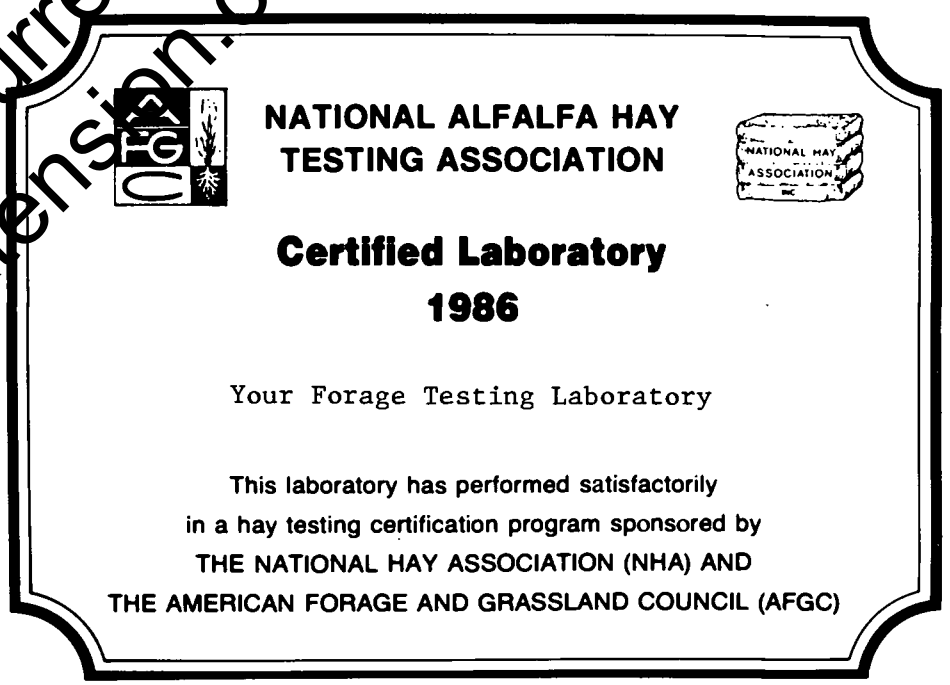

Figure 3.—U.S. Alfalfa Hay Test Laboratory Certificate.

(DMI, from NDF) and digestibility (DDM, from ADF) of forages on a dry-matter basis.

High-quality hay

Livestock producers recognize the value of early-cut, high-quality hay. Early-cut hay is higher in protein and digestible energy (table 1). When you use early-cut hay, you reduce the quantity of protein and energy supplement that you must feed. The increased palatability of early-cut hay also results in greater consumption and higher milk production.

It costs the hay grower more to produce high-quality hay, however, than it does to produce low-quality hay. If there's no economic incentive to produce a higher-quality product, the grower profits most by producing a larger volume of lower-quality hay.

Thus livestock feeders should expect to compensate those growers who are willing to produce high-quality hay—it's a more useful product for animal feeding operations.

Hay quality test codes used in this publication

ADF	Acid detergent fiber: % plant fiber remaining in test sample after acid-detergent treatment.
CP	Crude protein: % protein in test sample.
DDM	Digestible dry matter: derived from ADF.
DE	Digestible energy: Mcal/kg in test sample.
DM	Dry matter: % dry matter in test sample, related to 100% dry matter.
DMI	Dry matter intake: derived from NDF.
EDDM	Estimated digestible dry matter: % in test sample.
MCF	Modified crude fiber: faster than CF test.
NDF	Neutral detergent fiber: % fiber remaining in test sample after neutral-detergent treatment.
NE_l	Net energy of lactation.
RFV	Relative feed value: estimate of overall quality, derived from estimates (dry-matter basis) of intake and digestibility.
TDN	Total digestible nutrients: total of all digestible organic nutrients in test sample—proteins, nitrogen-free extract, fiber, and fat.

Table 1.—Relationship of the stage of alfalfa maturity at harvest to crude protein (CP), acid detergent fiber (ADF), estimated digestible dry matter (EDDM), digestible energy (DE), net energy of lactation (NE_l), and total digestible nutrients (TDN), all expressed on dry-matter basis[a]

Maturity	CP (%)	ADF (%)	EDDM (%)	DE (Mcal/kg)	NE_l (Mcal/kg)	TDN (%)
Prebud	21.7	31	64.8	2.74	1.47	65
Bud	19.9	34	62.4	2.64	1.40	62
1/10 Bloom	17.2	38	59.3	2.51	1.30	58
1/2 Bloom	16.0	40	57.7	2.44	1.25	56
Full Bloom	15.0	42	56.2	2.38	1.20	54
Mature	13.5	44	54.6	2.31	1.15	52

[a] Adapted from *Nutrient Requirements of Dairy Cattle,* 1978 (National Academy of Science, Publication 1349).

For further reading

Hannaway, David B. (ed.) *Hay Testing Laboratory Certification Manual* (U.S. Alfalfa Hay Quality Committee, Subcommittee on Laboratory Certification, Publication No. 2, reprinted 1980). Single copy $8.50; order from National Hay Association, P.O. Box 1050, Jackson, MI 49204.

National Academy of Science, *Nutrient Requirements of Dairy Cattle* (Publication 1349, 1978). Your county Extension agent will likely have a copy of the latest edition—or will know where to find one.

Trade-name products are mentioned or pictured as examples only. This does not mean that the participating Extension Services endorse these products or that they intend any discrimination against products not mentioned or pictured.

Published and distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914, by the Oregon State University Extension Service, O.E. Smith, director; Washington State University Cooperative Extension, F.L. Poston, director; the University of Idaho Cooperative Extension Service, H.R. Guenthner, director; and the U.S. Department of Agriculture cooperating.