

Evaluating Hay Quality

High quality hay has a high nutritive content (including crude protein and digestible energy) and a high intake and acceptability. It is low in cell walls and fiber and free of defects, such as dust, musty odor, mold, and excessive foreign material. Livestock and dairy producers seeking higher profit margins consider high quality forage the basis for any feed ration. Essential nutrients not supplied by the forage must be supplemented by concentrates, which add to the total feed bill. Thus, the higher the hay quality, the lower the amount of concentrates needed, and the lower the feed costs.

Hay varies in quality more than any other harvested feed crop grown on American farms. Hay quality can differ widely even within a single species grown in the same locality. The variation largely is due to a lack of understanding of good haymaking fundamentals and because farmers tend to give less attention to hay crops than to corn, soybeans, small grains, and other crops. Farms producing livestock and livestock products can save money by feeding more high quality hay and less grain per animal unit. Buyers frequently find both excellent and poor quality hays offered at the same price.



Research and farm experience show that physical inspection combined with chemical analysis (forage testing) gives a reliable indication of hay quality. Unfortunately, chemical analysis is not always feasible or cost effective. The cost of analysis may not be justified for livestock owners who use small quantities of hay. Also, routine chemical analysis does not reveal defects such as dust, musty odor, mold, foreign material, and leaf shattering. Thus, either in the absence of chemical analysis or to complement it, livestock owners must rely on their senses to reveal factors known to influence hay quality and ultimately animal performance.

Hay Quality Factors

Hay quality really means feed value and should be evaluated accordingly. The factors known to influence hay quality and animal performance include the following: 1) stage of maturity at harvest, 2) leafiness, 3) color, 4) foreign material, and 5) odor and condition. Let's examine each one of these factors.

Stage of Maturity

Stage of maturity refers to a plant's stage of development at the time it is harvested. Determining the maturity of legumes and grasses is easy before harvesting but becomes more difficult after cutting and baling. Weathering or sun bleaching after cutting or the delay of normal development of legume flowers due to cool, cloudy weather, especially with first cutting, further complicate the determination of maturity.

Alfalfa. To determine the stage of maturity at which alfalfa was cut, observe the buds or flowers and the texture and woodiness of the stems. Alfalfa cut in the bud stage has buds at the tips of the stems but no purple flower petals. Bud stage alfalfa is usually very leafy and the stems are relatively fine and pliable. Alfalfa cut in early bloom has some purple flower petals and stems that are larger than bud stage alfalfa. Under normal growing conditions, alfalfa cut after it has blossomed has a rather stemmy appearance, distinctly larger woody stems, and fewer leaves. Alfalfa cut after full bloom also may have seed pods.

It is important to note that the conditions under which alfalfa grows can affect its appearance and mask its physiological maturity. It should be recognized that age (days of growth) and physiological maturity of the plant are not identical, especially with alfalfa. Factors such as cool temperatures and cloudy weather that retard maturity promote higher quality at any given age. Temperature and daylength appear to be the main factors involved in maturation. Development rate is accelerated by increasing temperature and increasing daylength (photoperiod). Thus, development is faster in the summer than in spring or fall. So the first cutting of alfalfa at the first bloom stage is older physiologically than the first bloom stage of the second and third cuttings, which makes determining maturity through bud and blossom development somewhat difficult. Alfalfa grown under severe drought conditions usually has small, fine stems, even when producing seed. When determining alfalfa maturity, make sure you consider stem size and texture and the amount of leaves, in addition to bud or bloom development.

Clover. For top quality hay, clover should be cut at the 20 percent bloom stage. Determine clover maturity by observing the color and condition of its blooms and the maturity of its seeds. Clover cut no later than full bloom and not weathered while being cured has numerous red or purplish-red blossoms (red clover) or pinkish-white or white blossoms (white clover). Clover cut in full bloom has no or only a few shrunken seeds. Brown clover heads and yellowish-brown seeds indicate the stage between full bloom and full maturity. Dark brown heads and plump, mature seeds indicate full maturity. However, hay that does not have seeds but does have other late cut characteristics still may be fully mature—first cutting clover often does not produce seed.

Grasses. You can easily determine the stage at which grasses were cut by examining the heads or inflorescences. First cutting orchardgrass, reed canarygrass, and tall fescue should be harvested in the boot to early heading stage. First cutting timothy and smooth brome grass should be cut in the fully headed to early bloom stage. If these grasses are cut before full bloom, there will be no visible ripe

seeds or flower parts. Plump brown seeds that shell out easily from dry, whitish glumes or chaff indicate full maturity. Color of grass hays is also related to stage of maturity. Even if not weather damaged, grasses with fully ripe seeds usually have yellowish-brown stems and heads and many brown leaves.

Another method for determining the quality of grass hay is to examine the basal area of the internode below the head. Pull the inflorescence from the nodal area and look at the base of the internode. Black or another dark color indicates high quality. If the basal area of the internode is pale, the plant was more mature when harvested. Grass hay with pale nodal bases has more fiber and less crude protein, energy, and digestibility than grass with dark bases.

Alfalfa-grass mixtures should be cut according to the maturity of the alfalfa; that is, when the alfalfa is in the late bud to early bloom stage; clover-grass mixtures should be cut according to the maturity of the grass.

Leafiness

Leafiness, the ratio of leaves to stems, is an excellent indicator of hay quality. Leafiness in legumes is particularly critical because

legumes lose their leaves during curing and handling more readily than grasses. Leafiness is extremely important to high quality feed given that about 60 percent of the total digestible nutrients (TDN), 70 percent of the protein, and 90 percent of the vitamins are found in the leaves. A high percentage of leaves also indicates good harvest and handling methods. In general, hay with a high leaf content has a higher percentage of minerals and vitamins and a greater energy value than hay with few leaves.

As legumes and first cutting grasses advance in maturity, the stem mass increases and the leaf-to-stem mass ratio decreases. This is a major factor contributing to the low quality of mature forage. As plants mature, the stems become larger, lower leaves fall from the plant, and the proportion of leaves decreases.

Leafiness in alfalfa hay varies from 65 or 70 percent for very leafy hay to only 10 or 15 percent for very stemmy hay. In a bale of very leafy alfalfa hay, the leaves are predominant and cling to stems that are soft and pliable; alfalfa hay with a low percentage of leaves appears very stemmy in the bale.



Leaf shatter during raking and baling reduces hay quality and becomes more prevalent as plants mature. The method of curing hay, the method of handling it from field to storage, and the weather conditions during curing and baling also influence leafiness. Leaves shattered from the stems and loose in the bales may be wasted when the hay is fed. To preserve leafiness, hay must be cut early and carefully cured and handled.

Color

The most desirable hay color is the bright green of the immature crop in the field. This color usually indicates that the hay was rapidly and properly cured, with no damage from rain, molds, or overheating during storage. A fresh aroma, freedom from must or mold, and a relatively high carotene content add to its palatability and feed value.

A hay's bright green color may be lost by sun bleaching, rain during curing, fermentation in the bale, stack, or mow, or because the plants were too mature when cut. The appearance of off-color hay tells much about the cutting and handling methods.

However, color can be deceiving. Often, an early cut, rain damaged hay that is off-color will have a higher nutritive value than bright green, late cut hay. Also, color is not a good indicator of digestibility. Humans tend to emphasize it, but color itself is unimportant to ungulates because they are colorblind and cannot distinguish green from brown.

Bleaching. Sun-bleached hay is a light golden yellow and should not be discriminated against as seriously as hay that has been rained on or heated in storage. Only material on the outside of the windrow or only the sides of the bale exposed to the direct sunlight should be bleached; the other material should be a bright green. Sun bleaching reduces palatability and carotene content. In general, the amount of carotene in a hay is directly proportional to its degree of greenness. Green hay is rich in carotene; straw-colored or brown hay is very poor in it.

Yellowing, especially in grass hay, usually indicates that the plants were over-mature when cut. Grasses with fully ripe seeds usually have yellowish-brown stems and heads and many brown leaves. Yellowing due to

maturing can be distinguished from sun bleaching because all of the plants, rather than just those on the outside, have the same yellowish color.

Rain damage. Hay that has been exposed to rain or to heavy dews or fog has a characteristic dark brown or black appearance. Rain falling on hay between the time of cutting and baling can leach out soluble nutrients and reactivate plant respiration. Hard rain can also shatter leaves, especially if the rain occurs when the hay is nearly dry. The stems of hay that has been sun-bleached or discolored by rain are usually harsh and brittle. Avoiding rain damage is a goal in haymaking but delayed cutting must be balanced against the lower feeding value of late cut hay.

Heating damage. Brown hay indicates heating from microbial (mold) growth because the hay was not sufficiently dry when it was baled. This hay has a distinctive musty, moldy odor and when the bale is opened the flakes are often caked and show visible mold. Molds consume nutrients in the hay, particularly sugars and starches, producing carbon dioxide and water. Extensive heating, as with brown hay, results in considerable loss of dry matter, digestible protein, and energy and destroys much of the carotene and other vitamins.

Slight discoloration from sun bleaching, dew, or moderate fermentation is not as serious as the loss of green from maturity, rain damage, or excessive fermentation.

Foreign Materials

Foreign materials can be divided into injurious and noninjurious categories. Injurious foreign material is material that will harm the animal if eaten. This includes poisonous plants and matter such as wire or nails. Noninjurious foreign material is matter that is commonly wasted in feeding operations but is not harmful to livestock if eaten. This includes weeds, grain straw, cornstalks, stubble, chaff, and sticks.

Weeds are the most common noninjurious foreign material found in hay. Livestock do not relish most weeds and if they are eaten they usually have little or no feed value. Hay containing weeds is discriminated against because weeds represent waste and give hay

Hay Evaluation Guidelines

The score sheet below is a guideline for evaluating hay. The sheet indicates the amount of importance to place upon each quality factor. Note that maturity, at 30 points, is the most important factor. Leafiness, color, and odor and condition each receive a possible 20 points. Foreign material has a possible 10 points.

Sample Score Sheet

	Possible score	Score given
<p>Maturity Alfalfa should be cut in the late bud or early bloom stage, clovers at 20 percent bloom. Most grasses should be cut in the boot to early heading stage. These stages of maturity score highest (25 to 30 points). Alfalfa and clover cut at full bloom and grasses cut between late heading and full bloom score low (1 to 10 points) because they have lower feed value.</p>	30	_____
<p>Leafiness Hay with a high ratio of leaves to stems and a substantial portion of the leaves attached to stems scores high (5 to 20 points). Stemmy hay and hay with shattered leaves score low (0 to 5 points).</p>	20	_____
<p>Color Hay with a bright green color scores high (15 to 20 points). Golden yellow to yellow hays score 5 to 15 points. Dark brown or black hays score 0 to 5 points.</p>	20	_____
<p>Odor and Condition Smell of new mown hay scores high (15 to 20 points). Hays with musty or other off-odors score 5 to 15 points. Moldy or unusually dusty hays score very low (0 to 5 points).</p>	20	_____
<p>Foreign Material Hay with noninjurious foreign material should receive a lower score than that without. Hay with injurious foreign material should not be fed to animals.</p>	10	_____
TOTAL	100	_____

a bad appearance. Weed seeds usually pass undigested through livestock and when the manure is spread on land it becomes a source of weed infestation.

Odor and Condition

The smell of new mown hay is the standard by which hay odor is judged. Mildew, mustiness, or a putrefied (rotten) odor result from weather damage or insufficient drying before baling and indicate lower quality hay. Odor problems usually result in lower acceptability by livestock. Hay should be free from must and mold and from insect and disease damage. It also should not be dusty.

Quality Characteristics

The physical characteristics described here show that hays vary widely in their potential feed value. Use these hay evaluation tips to estimate the quality of the hay you are feeding your livestock. You may find that its quality is better than you thought, and you can reduce the amount of concentrates fed. On the other hand, you may find that the quality of the hay is poorer than you thought, and you need to increase the amount of concentrates.

Excellent quality. Legumes cut in the late bud to early bloom stage for alfalfa or 20 percent bloom stage for clovers; grasses cut in the boot stage. Hay is bright green, leafy, and free from mold or mustiness. This feed is high in carotene, protein, minerals, and energy and low in fiber.

Good quality. Legumes cut by half bloom; grasses cut in the early heading stage. Good quality hay is leafy, has good green color and is free from mold or mustiness. Hay that was rained on after partial curing can fall into this category if it was cut early. The nutritional value is not as high as excellent quality hay but good results can be obtained if it is properly supplemented.

Fair quality. Legumes or grasses cut at full bloom. Fair quality hay lacks greenness and is stemmy and low in carotene, minerals, protein, and energy and high in fiber.

Poor quality. Any legume or grass cut after full bloom. Poor quality hay is stemmy and

lacks leaves. It may be severely weather damaged, bleached, musty, or moldy.

Comparing Hays of Various Qualities

Hays of different qualities can be compared and converted into measured amounts of good quality hay.

Conversion Chart			
Quality	Time cut	Description	Value
Excellent	Very early	Leafy, bright green	1.2
Good	Early	Leafy, green	1.0
Fair	Medium to late	No excessive damage or leaf loss	0.8
Poor	Late	Coarse, stemmy, unpalatable	0.6

Example: You have 60 tons of fair quality hay, 40 tons of good quality hay, and 20 tons of excellent quality hay. How many tons of hay do you have in equivalents of good quality hay?

$$60 \times 0.8 = 48$$

$$40 \times 1.0 = 40$$

$$20 \times 1.2 = 24$$

Total = 112 tons of good quality hay in terms of potential feeding value.

The 120 tons of hay you have represents only 112 tons of hay in terms of its potential feeding value (as good quality hay). In actual feeding, animals will eat less fair quality than good quality hay, therefore, the lower conversion factor. When fed excellent quality hay, animals may eat more of it. But even if they do not, the feed nutrients contained in the excellent quality hay will result in better animal production and performance than if the animal were fed lower quality hay.

Summary

Regardless of whether one is buying, selling, producing or feeding hay, quality should be a major consideration. Knowledge of the factors influencing quality, and an understanding of the impact of varying quality on animal performance, result in more efficient and economical feeding programs.



anthesis - Stage in floral development when anthers are extended and pollen is shed.

bleached hay - Hay with faded color and reduced feeding value, palatability, and digestibility because of excessive rain damage and/or sun exposure during curing.

- Sun-bleached hay has a light golden yellow color and need not be discriminated against as seriously as hay that has been rained on or has heated in the stack or mow. Only material on the outside of the windrow or only the sides of the bale exposed to the direct sunlight will be bleached. The other material should be a bright green.

- Hay which has been exposed to rain or to heavy fog and dews has a characteristic discolored dark brown or black appearance. The stems of hay that has been bleached too long in the sun, or that has been discolored by rain, are usually harsh and brittle.

- Brown-colored hay indicates heating and fermentation caused by baling and storage at too high moisture content. This hay usually has a distinctive musty odor and the bale is often caked.

- Yellowing, especially in grass hay, usually indicates that the plants were over-mature when cut. This can be distinguished from sun bleaching because all plants will have the same yellowish color.

- Slight discolorations from sun bleaching, dew, or moderate fermentation are not as serious as the loss of green color from maturity, rain damage, or excessive fermentation.

bloom - Plants in a state of flowering. In hay management, the term is generally associated with stages of flower development or maturity of legume plants, but it is sometimes associated with development of grasses. A familiar analogy is roses, (i.e., roses in the bud stage, early bloom, full bloom).

- prebloom** - Stage of plant growth just before flowers begin to bloom; also referred to as bud or late bud stage of growth of legumes.

- first bloom** - Stage of growth when the first blooms begin to appear.

- early bloom** - Legumes: stage of growth between initiation of bloom and $\frac{1}{10}$ of the plants in bloom; also referred to as first flower. Grasses: initial flowering (anthesis) in the uppermost portion of the inflorescence.

- 20 percent bloom** - Stage of growth when 20 percent of the plants have blooms.

- midbloom** - Stage of growth in which $\frac{1}{10}$ to $\frac{2}{3}$ of the plants are in bloom; also may be referred to as half bloom or 50 percent bloom.

- late bloom** - Stage in which $\frac{2}{3}$ or more of the plants are in bloom.

- full bloom** - Essentially all legume plants are in flower or the whole inflorescence of grasses in anthesis.

- gone-to-seed** - Stage at which seeds have developed.

boot stage - Growth stage when a grass inflorescence is enclosed by the sheath of the uppermost leaf—head not showing.

curing - The process of drying the forage after it has been cut so that it can be preserved for later feeding.

cutting - The numerical order of the harvests each year. For example, first cutting is the hay from the first harvest each year, which should occur in May and early June in most of Maryland; second cutting hay is from the second harvest of the year, typically four to six weeks after the first cutting; third cutting is from the third harvest, etc. Three to five cuttings are made per year. The quality of each cutting is primarily dependent upon the stage of maturity of the crop when it is harvested. First cutting is often harvested late due to inclement conditions for haymaking in May, therefore quality can be lower than that of second, third, or fourth cuttings.

early cut - Hay harvested at an early or

immature stage of growth—alfalfa in the late bud to early bloom stage, clovers at 20 percent bloom, grasses in the late boot to early heading stage. Early cut hay is relatively fine-stemmed and leafy, lower in fiber, higher in protein and energy, more palatable, and consumed in larger quantities by animals, than later cut hay. Early cut hay reduces the amount of supplements (grain or sweet feed) required.

flake - A thin piece of a rectangular bale of hay. Flakes are formed by a repeating cycle of compression and release of pressure. In the baling process, hay is picked up from the windrow and moved into the bale chamber where it is compressed and cut on one side (cut at the entry point into the chamber). During the compression release phase of the cycle, more hay is moved into the bale chamber and then compression occurs again. This repetitive cycle forms the hay into flakes.

grass - Any of a group of plants with long, narrow leaves, jointed stems and seed-like fruit. Examples are wheat, rye, oats, orchardgrass, timothy, and tall fescue.

green hay - Can have multiple meanings: 1) Uncured hay. 2) Hay that has not been sufficiently dried before baling and will become musty and/or moldy in storage. Often occurs as “green spots” or “green bunches” in bales due to uneven drying or curing in the field. 3) Hay that, on being cured, retains a green color.

heading stage - The stage of development of a grass plant between initial emergence of the inflorescence from the boot and the time the inflorescence is fully emerged.

inflorescence - Flowering part of a plant. The tassel of corn, the spike or head of wheat or timothy, and the panicle of the oat or bluegrass are examples of grass inflorescences.

internode - Part of plant stem between the joints or nodes.

late cut - Hay harvested at an advanced stage of growth—alfalfa and clovers cut at the full bloom stage, grasses between the late heading and full bloom stage. Late cut hay is coarse and stemmy, high in fiber and low in protein and energy.

legume - A family of plants, including many valuable food and forage species such as peas, beans, soybeans, peanuts, clovers, alfalfas, lespedezas, and vetches. With the aid of symbiotic bacteria they convert nitrogen from the air to nitrates in the soil through a process known as nitrogen fixation.

musty - Having the disagreeable odor of substances that have spoiled in close, muggy conditions; such as musty grain, clothing, or books.

node - Part of the stem where one or more leaves are attached.

stemmy - Hay with large coarse stems and a low leaf content or legume hay that has a high proportion of the leaves shattered (broken) from the stems.

windrow - A long row of cut hay raked up to dry and cure in the field before being baled.

Evaluating Hay Quality

by

Lester R. Vough

Forage Crops Extension Specialist

Department of Natural Resource Sciences and Landscape Architecture

University of Maryland, College Park

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, University of Maryland, College Park, and local governments. Thomas A. Fretz, Director of Maryland Cooperative Extension, University of Maryland.

The University of Maryland is equal opportunity. The University's policies, programs, and activities are in conformance with pertinent Federal and State laws and regulations on nondiscrimination regarding race, color, religion, age, national origin, sex, and disability. Inquiries regarding compliance with Title VI of the Civil Rights Act of 1964, as amended; Title IX of the Educational Amendments; Section 504 of the Rehabilitation Act of 1973; and the Americans With Disabilities Act of 1990; or related legal requirements should be directed to the Director of Personnel/Human Relations, Office of the Dean, College of Agriculture and Natural Resources, Symons Hall, College Park, MD 20742.

P97/R2000