Forage Quality

What It Is and Why It Is Important

Forage crops are those grown primarily for livestock feed and harvested to be fed later, or harvested directly by grazing animals. Included are all plants grazed by animals or harvested for hay or silage.

Since forages are consumed by animals, the product fed must be acceptable to the animal. Forages are marketed primarily in the form of animal products, that is, meat, milk, or wool, so the animal must be considered in the development of a sound forage feeding program. A high quality forage has a high feeding value per unit and is also more readily consumed.

What is forage quality?

The term quality, as applied to forages, generally means the same as feeding value and may be defined as the ability of a forage to supply animal nutrient requirements for a specific production function (meat, milk, or wool). The equation for quality may be written:

$$\text{Quality} = \begin{matrix}\text{Available nutrients} \\ \text{per unit of forage}\end{matrix} \times \text{Rate of intake}$$

The value of forage for the production of meat, milk, or wool, therefore, depends on the availability of the nutrients consumed and the quantity of forages voluntarily consumed. When the daily intake of forage, the chemical composition, and the digestibility are known, the daily intake of nutrients can be calculated.

Meeting animal requirements

A simple approach to the determination of the energy needs of an animal—or the need for any nutrient—is:

$$\begin{matrix}\text{Energy to be} \\ \text{supplied by ration}\end{matrix} = \begin{matrix}\text{Energy required} \\ \text{by animal}\end{matrix} = \begin{matrix}\text{Energy for} \\ \text{maintenance}\end{matrix} + \begin{matrix}\text{Energy for} \\ \text{production}\end{matrix}$$

For example, using this approach and standards established through the years, a dairy cow weighing 1,000 pounds and producing 60 pounds of 4 percent fat corrected milk would need approximately 27.2 pounds of total digestible nutrients (TDN) daily to meet the requirements for production and maintenance (Figure 1). This represents the energy contained in 36.2 pounds of grain or 49.4 pounds of average hay. Most 1,000-pound cows cannot eat 49 pounds of hay. The hay intake is not likely to exceed about 30 to 35 pounds. As shown in Figure 1, the energy supplied from forages decreases as the quality decreases; consequently, the energy supplied from grain must be increased if production levels are to be maintained.

Although the TDN requirements are different for dairy cattle, beef cattle, sheep, and horses, the principle shown in Figure 1 is the same for all types of livestock.

The effect of forage quality on forage dry matter intake, dry matter digestibility, and the milk potential of the forage is presented in Figure 2. As forage quality decreases, forage intake and nutrients supplied by the forage also decrease, and the milk production potential will approach zero, as is indicated for poor quality forage in Figure 2.

Considering the poor quality of the forage used on many farms, it becomes evident why dairy producers and beef cattle feeders depend heavily on grain to produce milk and meat. On most farms, a material saving in the cost of producing livestock and livestock products could be made by feeding more high quality hay and less grain per animal unit. If the fullest use is to be made of an animal's capacity for utilizing forage, this forage should be palatable and nutritious, for a ton of high quality forage supplies more digestible nutrients than a ton of low quality forage of the same kind. An animal's appetite may be satisfied with low quality forage before it gets enough nutrients from the forage portion of the ration to fulfill its requirements.

Determining the quality of forage

There are two principal methods that you can use to determine forage quality. One is to sample

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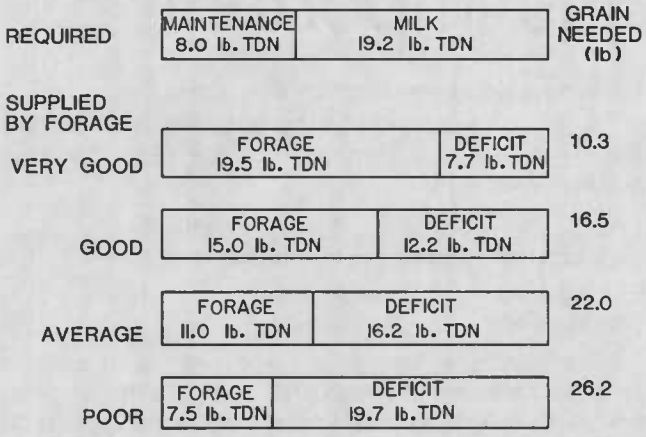
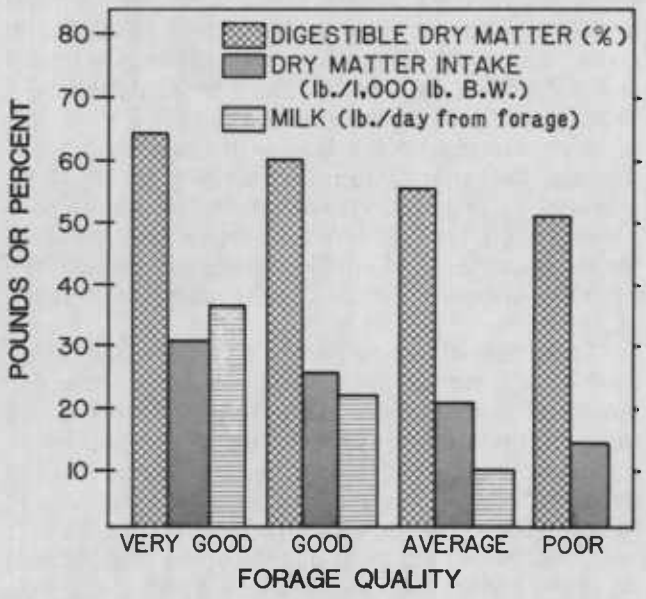
Figure 1. Forage quality and grain required (1,000-pound cow producing 60 pound 4 percent fat corrected milk).



Source: Adapted from Forage to the Front. Ag. Ammonia News, May-June, 1964.

Figure 2. Effect of forage quality on digestibility, dry matter intake, and milk production from forage.



Source: Adapted from Forage to the Front. Ag. Ammonia News, May-June, 1964.

the hay and/or silage to be fed and have it chemically analyzed. This analysis can be obtained from the Forage Analytical Service at Oregon State University or at any of a number of commercial laboratories in Oregon and surrounding states. Your county Extension agent has sampling instructions as well as the appropriate forms to be used when submitting samples to the OSU Forage Analytical Service. Your Extension agent can also help you locate other testing laboratories, and is available for assistance in interpretation of the analysis and in planning more efficient rations.

The second method is visual and one you can do on the farm. It requires judgment based on certain physical characteristics of the forage.

How do we estimate forage quality visually?

Visual estimates of forage quality are based on factors known to influence hay and silage quality, and animal performance. These factors are stage of maturity, leafiness, color, foreign material, and the odor and condition. Let's examine each one of these factors in some detail.

Stage of maturity. This refers to the growth stage of a plant at the time it is harvested. This is an important factor in determining the maximum feed value obtainable from an acre of forage. Early cut hay is high in feed value. For example, more than twice as many pounds of alfalfa hay cut in the seed stage is required to produce 100 pounds of gain in steers than alfalfa cut in the bud stage (Figure 3). This is because animals eat less of the poorer quality hay per day and will take longer to gain weight.

Total digestible nutrients (TDN), which includes protein, are higher in early cut hay (Figure 4) as are phosphorus and carotene (the compound from which vitamin A is formed). Note in Figure 4 that alfalfa in the bud stage may have in excess of 20 percent crude protein while at full bloom the protein content may only be 10 to 12 percent. Alfalfa hay cut at the late bud to very early bloom stage has a potential as high as 65 percent digestible nutrients (Figure 5). The same crop cut at full bloom usually has dropped to 55 percent digestible or less. Thus, late cut hay is low in feed nutrients.

Comparable figures for grasses are 65 percent TDN and 12 to 15 percent crude protein at the boot stage (head emerging from the leaf roll) and 50 percent or less TDN and 4 to 8 percent crude protein when the bloom is on the grass heads. There is less protein in a hundred pounds of either grass or legume as maturity advances (as the crop becomes older).

The time of cutting also makes a great difference in the palatability of hay or silage. As with digestibility, palatability also decreases as the crop becomes older (Figure 5). This is largely a result of the increasing amounts of fiber found in plants as the crop matures. Figure 6 shows that the average percent crude fiber of alfalfa in the bud stage is 20 percent, while at full bloom the percentage has increased to 35.

A common fault in forage harvest is to delay cutting too long. The quality of many excellent crops of grasses, alfalfa, and red clover is virtually sacrificed because they are not cut early enough. It is impossible to make high quality hay or silage from late-cut grass, alfalfa, and red clover, even with perfect curing weather.

The loss in quality with delayed cutting is not as serious with trefoils (lotus), white clover, and subterranean clover since their quality does not decline as rapidly with advancing maturity as happens with alfalfa, red clover, and the grasses. Trefoils and white and subterranean clovers do not drop the lower leaves as maturity advances, and their stems are finer and softer; thus they do not become as stemmy and unpalatable with maturity.

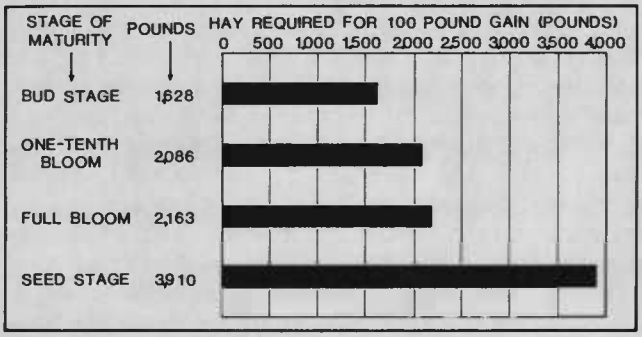
On a yearly basis, early-cut hay yields as much feed (digestible dry matter) per acre as later-cut hay and provides better livestock performance. Early-cut hays make desirable feed because they contain more digestible material. And because early-cut hays are more palatable, they are eaten in larger quantities by livestock and require less supplementation with grain than later-cut hays.

Leafiness. The amount of leaves in relation to stems is a more critical factor with legumes than with grasses because leaf loss during curing and handling is much greater with legumes. Leaves are higher in overall feed value than stems, as indicated by higher TDN, protein, and carotene contents, and a lower fiber content. On the average, alfalfa leaves contain about 24 percent crude protein and 14 percent crude fiber while the stems contain only 10 to 11 percent crude protein and 38 percent crude fiber. In other words, the leaves of alfalfa have about 2½ times as much protein as the stems and are very important in determining feed value. The protein in the leaves is also more digestible than that in the stems.

Since leaves are high in protein and low in fiber, highest quality hay is cut in the bud to early bloom stage when plants have a high proportion of leaves. As the plants mature the stems become larger, lower leaves fall from the plant, and the proportion of leaves decreases (Figure 4), resulting in a decline in protein and an increase in fiber.

The amount of leaves is an important indicator of both feed value and yield in hay.

Figure 3. Gains in weight of steers affected by the maturity of the alfalfa fed.



Source: Hay Quality: Relation to Production and Feed Value. USDA Miscellaneous Publication No. 363.

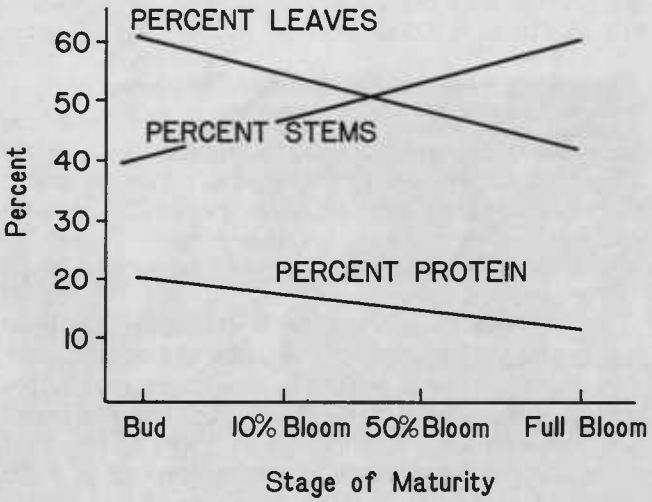
Color. This indicator is associated with the nutrient content, especially carotene. Color also indicates how well the hay is cured. The most desirable color approaches that of the bright green, immature crop in the field. This is usually associated with early cutting, good curing, pleasant aroma (odor), high palatability, freedom from must or mold, and a relatively high carotene content.

Any change in color indicates a reason for loss in feed value:

- Yellowing usually indicates more mature hays.
- A light golden yellow or bleached appearance may be a result of bleaching by the sun or it may indicate that rain has leached (washed) out some of the most digestible nutrients.
- Brown indicates heating caused by storage of high moisture hay. Brown hay usually has a distinctive odor and the baled hay is usually caked.
- Blackening indicates excessive rain damage —spoilage of plant tissues after curing.

Brown or black hay is an indicator of considerable losses in dry matter, vitamins, and digestibility (especially digestibility of protein). The presence

Figure 4. Effect of stage of maturity on average percent leaves, stems, and alfalfa protein.



Source: Management of Irrigated Forages in Nevada. Nev. Agr. Exp. Sta. Bull. B29.

of the dull gray of mildews and molds indicates that the hay was stored at too high a moisture content. Such hay has also lost dry matter and quality.

Foreign material. Hay can contain non-injurious and injurious material. Non-injurious foreign material describes all kinds of matter that is commonly wasted in feeding operations, but that is not harmful to livestock if eaten. This includes weeds, so-called wiregrasses, overripe grain hay, grain straw, cornstalks, stubble, chaff, sticks, certain grasses if mature, and any other objectionable matter that might occur in the hay. Some of the grasses that are considered as foreign material when mature are wild rye, most annual bromegrasses such as cheat and chess, pigeon grass (sometimes called foxtail or wild millet), broomsedge, and needlegrasses from which the needles have fallen.

Material that will cause injury or that is poisonous when eaten by livestock is considered injurious foreign material. This includes sandburs, poisonous plants such as tansy ragwort, harsh or rough bearded grasses like mature foxtail, wild barley, 3-awn grass, or ripgut brome, and grasses that have a sharp point at the base of the seed (matured needle grasses with the needles attached). It also includes any other matter such as wire or nails.

Hay containing weeds or other foreign material is discriminated against on the market because weeds represent waste and give the hay a bad appearance. Weeds are objectionable for feeding purposes because the weed seeds usually pass through the animal undigested and when the manure is spread on the land, it becomes a source of weed infestation. Many noxious weeds are spread in this way.

Odor and condition. The aroma of new mown hay is the standard with which all odor comparisons should be made. Any other odor, such as mildewy, musty, or putrified (rotten), indicates lowered quality. Storage at too high moisture, or weather damage cause odor problems and result in lowered acceptability to livestock.

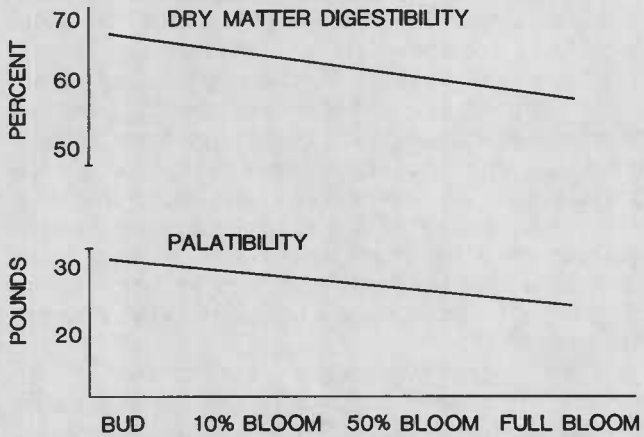
Attention should also be given to the condition of the hay. It should be free from must and mold, as well as free from insect and disease damage. It also should not be dusty.

Combining chemical and visual analyses

A visual evaluation supported by chemical analysis is the most reliable indication of quality. Chemical analysis gives a reliable measure of the items determined, but a visual estimation reveals quality factors such as spoilage, foreign material, and leaf shattering or loss. Chemical estimates do not show these factors.

Visual examination alone, while being very useful, creates problems for livestock producers, particularly those who purchase their forage requirements and desire a consistently high quality product. For example, a sampling of 5 lots of hay that appeared to be almost identical showed a wide range of quality as determined by chemical analysis. The percent crude protein in these lots was 19.7, 17.7, 15.3, 11.7, and 13.7. Whenever possible, chemical analysis should be combined with visual estimation.

Figure 5. Effect of stage of maturity of alfalfa on average dry matter digestibility and palatibility (pounds of hay consumed per 1,000 pounds body weight).



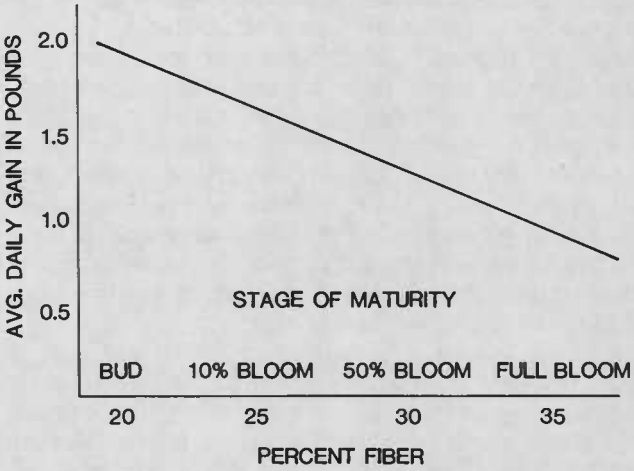
Source: Management of Irrigeted Forages In Neveda. Nev. Agr. Exp. Ste. Bull. B29.

Summary

Forage quality generally means feed value and is dependent upon the availability of nutrients (chemical composition) and the amount of forage consumed (rate of intake). A number of factors are known to influence forage quality and animal performance, the most important of which is *stage of maturity*. Top quality forages are cut early. Alfalfa should be cut in the late-bud to early-bloom stage; clovers, 25 to 50 percent bloom; and grasses, in the boot to early heading stage. Treat alfalfa-grass mixtures as alfalfa, and clover-grass mixtures as grass. Top quality forages are also leafy, bright green in color, and free irom weeds, mold, or mustiness. They are high in protein, energy, digestibility, carotene, and minerals, and low in fiber.

Forage varies more in quality than any other harvested feed crop grown on American farms. There is a wide variation in forage quality, even within a single species grown in almost identical conditions. This variation is due largely to a lack of understanding of the fundamentals of good haymaking and to a tendency among farmers to give less attention to their hay crop than to their livestock or to crops such as wheat and potatoes.

Figure 6. Effect of maturity stage of alfalfa on average percent crude fiber and estimated daily gains of a 500-pound calf on full feed.



Source: Menegement of Irrigated Foreges in Nevede. Nev. Agr. Exp. Sta. Bull. B29.

Characteristics of high quality forage have been emphasized throughout this discussion; however, this does not mean that all livestock should be fed only the highest quality forage. A substantial portion of the ration for maintenance of dry beef and dairy cows, dry ewes, and mature horses can consist of low and medium quality forages. These animals can make the best use of lower quality forages. Young, growing animals and high-producing milk cows have higher nutrient requirements and should receive the higher quality forage.

Knowing the nutrient requirements of the livestock to be fed and the nutrient contents of the forage available for feeding ,the livestock producer can formulate balanced rations using combinations of forages with varying quality levels or combinations of forages and protein and/or energy supplements. Low quality hay can often be supplemented with several pounds of high quality hay, saving the cost of concentrate feeds. Hay buyers will frequently find both excellent and poor quality hays are offered at the same price. Knowing the higher quality feed can also save you money.

The quality of forage fed to livestock determines how far you can cut expensive concentrates to minimize costs and maximize profits. Livestock feeders seeking profits consider good quality forage as the basis of any livestock ration; low quality forage, lacking in essential nutrients, must be supplemented with expensive concentrates. Substantial savings in the cost of producing livestock and livestock products could be made on many farms by feeding more high quality hay and less grain per animal unit.

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