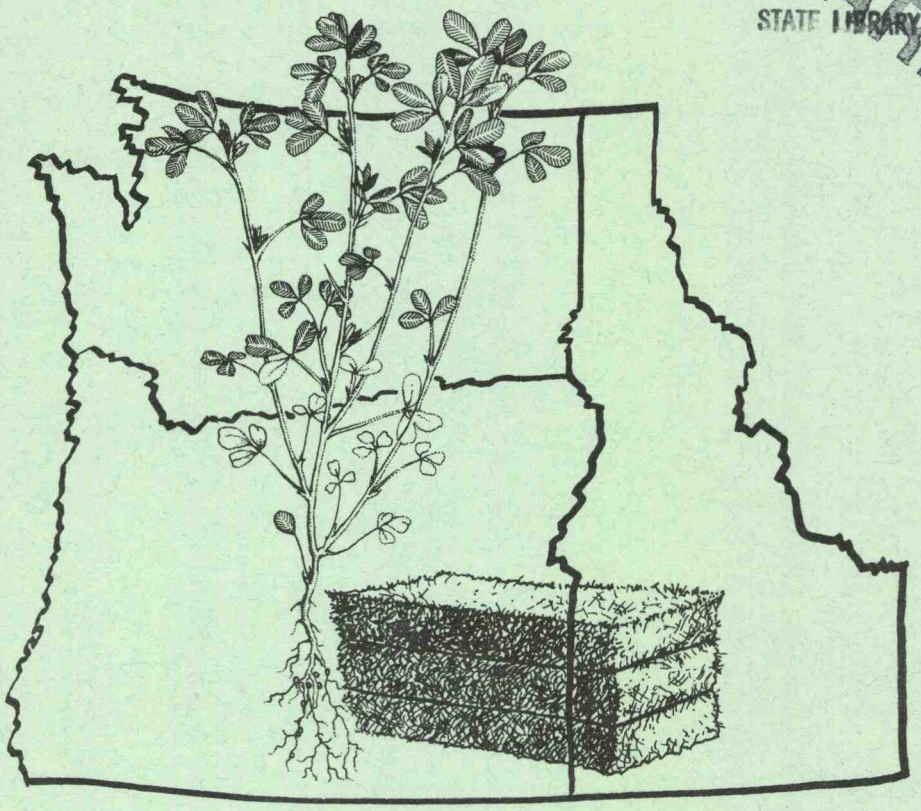
ALFALFA HAY
Quality and Testing

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

Alfalfa hay is a major forage for ruminant animals. Both hay growers and livestock feeders must realize that there is a wide variation in the quality of hay. Frequently, high-quality and low-quality hay are offered at the same price. In many sales hay is evaluated on a visual basis only, even though it is known that the selections made by experienced hay buyers do not always indicate feed quality accurately. Research and experience show that the combination of visual inspection and chemical analysis greatly improve the accuracy of the predicted nutritive value of hay.

Recognition of the factors that determine hay quality can lead the grower to improve production practices.



Quality Factors

• *Stage of maturity.* The stage of maturity at cutting influences quality more than variety, production location, soil fertility, or seasonal influences. Alfalfa hay harvested in the pre-bud or early bud stage will have the highest nutritive value for livestock. Maturity at the time of cutting also makes a great difference in the palatability and digestibility. Palatability and digestibility both decrease as the crop grows older. Some compromise has to be made, however, between quality and optimal yield and persistence of the alfalfa stand. *On a yearly basis, early cut hay* (late bud to very early flower on alfalfa) *yields as much feed* (digestible dry matter) *per acre as later-cut hay.* Early cut hay makes a more desirable feed because it contains more digestible material. Hay cut at this stage is more palatable and is eaten in larger quantities by livestock. This results in less need for supplementation with grain than later-cut hays.

• *Leafiness.* At least two-thirds of the protein is found in the leaves. Leaf shatter during raking and baling greatly reduces hay quality. The percentage of leaves remaining in the bale is an important indicator of hay quality.

• *Color.* Bright green color is an indication of proper curing, high carotene content, and good palatability. Any change from a bright green color indi-

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cates loss in feed value. However, hays which have been slightly sun-bleached or have had a small amount of rain damage will still make high-quality feed.

• *Foreign material.* This refers to weeds, straw, wire, or other material having little or no feeding value. Foreign material can be harmful, resulting in problems such as loss in palatability and lower consumption or possibly injury to livestock because of consumption of wire, nails, and similar foreign objects.

• *Odor and condition.* The smell of new mown hay is the standard with which all odor comparisons should be made. Any other odor, such as a musty or putrified (rotten) odor indicates lowered quality. The causes are storage at too high moisture, or weather damage. Odor problems are associated with lowered livestock acceptability. Dustiness also detracts from the value of hay. The presence of volcanic ash may cause serious respiratory problems, especially with horses. Dusty or moldy hay should not be fed to horses or dairy cows, but can be used for beef cows or heifers, which have lower nutritional needs.

Sampling and Testing Procedures

A chemical analysis is valid only to the extent that the sample represents the lot of hay under consideration. Commercial forage samplers, such as the "Penn State" forage sampler, are available through farm supply sources. These can be attached to a drill bit or ½-inch drill for easy sampling.

One 12- to 18-inch core sample taken diagonally from each of 25 bales selected at random constitutes a sufficiently representative sample of a lot of hay to predict its quality. The greater the number of bales sampled, the greater the validity of the test results. 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 procedure for cubed hay consists of selecting 40 cubes at random from a lot of 200 tons or less, and placing them in an airtight container for shipment to a laboratory. After grinding, the composite mixture of the 40 cubes is used for analysis.

Ideally, samples should be placed in double thickness polyethylene freezer bags and closed tightly with a rubber band. In this manner the percent dry matter reported will represent the dry matter content of the lot of hay when sampled.

Standardized Hay Test

There are several commercial and university service laboratories located in the tri-state area. A number of these laboratories participate in a standardized hay testing program coordinated by the Tri-State Alfalfa Coalition (Oregon, Idaho, and Washington). Your county Extension agent can help you locate a cooperating laboratory.

The chemical analyses necessary for completing this standardized alfalfa hay test include moisture, crude protein, and acid detergent fiber.

• *Moisture.* The moisture or water content of hay is important because moisture replaces the nutrients per pound of feed. Moisture is usually lost from newly harvested hay, with the absolute weight loss generally being 5 percent or more. Buyers and sellers should discount hay with over 12 percent moisture to allow for shrinkage due to drying.

• *Crude protein (CP).* The quality of alfalfa and other legume hays is closely related to its crude protein content, since it is related to stage of maturity. Hay high in protein allows the dairyman to save money by feeding a grain ration low in protein.

• *Acid detergent fiber (ADF).* This is the plant fiber that remains after removing part of the digestible cell wall material with an acid detergent. ADF has been highly correlated with animal digestible dry matter (DDM): as ADF increases, DDM decreases.

• *Total digestible nutrients (TDN).* This is the sum total of all digestible organic nutrients—that is, proteins, nitrogen-free extract, fiber, and fat. However, this is most often an estimated value and not a laboratory analysis. TDN is most often estimated from a single fiber test, such as ADF or MCF.

• *The laboratory report.* Since feeding requirements for dairy cows are based on percent dry matter, the forage analysis also should be expressed on this basis. Ration formulation can then be calculated on a least-cost basis.

Other Tests

• *ADF-bound protein (BP).* When hay is damaged by heating, the standard CP and ADF analyses do not accurately determine feeding value. The BP analysis determines the portion of CP that is not available to the animal. BP is then subtracted from the CP value to give the available protein (AP) value (AP = CP — BP).

• *Neutral detergent fiber (NDF).* This is the plant fiber that remains after removing cell contents by treatment with a neutral detergent. NDF has been highly correlated with animal dry matter intake (DMI): as NDF increases, DMI decreases.

• *Digestible protein.* This is a calculated value that is estimated from crude protein analysis.

• *Relative feed value (RFV).* RFV is an estimate of overall forage quality. It is calculated from estimates of intake (DMI, via NDF) and digestibility (DDM, via ADF) of forages on a dry-matter basis.

• *Net energy of lactation (NE_l).* This is the difference between metabolizable energy and heat increment, which includes the amount of energy used for maintenance and that required for milk production.

• *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 fiber test, which has been highly correlated with animal digestibility: as MCF increases, digestibility decreases. Formulas have been developed to relate RFV to TDN, but these are estimates. Further research is needed to refine these formulas and to make easier the job of marketing of hay between states.

• *Calcium.* Since most cereal grains are low in calcium, dairy cattle depend largely on forage for this mineral. Alfalfa hay is a good source of calcium.

Table 1. Relationship of the State of Alfalfa Maturity at Harvest to Crude Protein (CP), Acid Detergent Fiber (ADF), Net Energy of Lactation (NE_l), and Total Digestible Nutrients (TDN) (expressed on dry matter basis).

Maturity	CP	ADF	NE_l	TDN
	Percent	Percent	(Mcal/kg)	Percent
Prebud	21.7	31	1.47	65
Bud	19.9	34	1.40	62
1/10 Bloom	17.2	38	1.30	58
1/2 Bloom	16.0	40	1.25	56
Full Bloom	15.0	42	1.20	54
Mature	13.5	44	1.15	52

From: *Nutrient Requirements of Dairy Cattle,* 1978 (National Academy of Science, Publication 1349).

Table 2. Proposed Market Hay Grades for Alfalfa, Based on Chemical Composition—Crude Protein (CP), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF)—and the Calculated Relative Feed Value (RFV).

Grade	Stage of maturity	CP	NDF	ADF	RFV
1	bud	>19	<40	<31	>140
2	early bloom	17-19	40-45	31-35	124-140
3	mid bloom	13-16	46-51	36-41	101-123
4	full bloom	<13	>51	>41	<100

• *Phosphorus.* Most forages are poor sources of phosphorus and need to be supplemented. However, it is important to know the phosphorus content of the forage so that the phosphorus supplement will be used in the proper amount. Today, phosphorus supplements are both expensive and in short supply, so all livestock feeders should avoid overfeeding them. Since the Ca:P ratio is important in dairy rations, both Ca and P analyses should be requested.

Visual and Chemical Analyses

A combination of visual and chemical analysis of hay gives the most reliable indication of hay quality. Chemical analysis should be used to insure a reliable measure of the items determined, but a visual estimation reveals quality factors such as spoilage, foreign material, and leaf shattering or loss. Routine chemical estimates do not always reflect these factors. Of course, the ultimate measure of hay quality is its palatability and the milk or meat production it supports.

High-Quality Hay

Dairymen recognize the value of early cut, high-quality hay. Early cut hay is higher in protein and TDN (Table 1), which reduces the quantity of protein and grain supplement that must be fed. 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 is no economic incentive to produce a higher-quality product, the grower profits most by producing a larger volume of lower-quality hay. Livestock feeders must be willing to pay a premium for high-quality hay.

National Hay Grading Standards

In 1978, the American Forage and Grasslands Council and the Federal Grain Inspection Service proposed national hay standards. They used both chemical analyses (CP, NDF, and ADF) and organoleptic characteristics (sight, smell, and touch) to establish these proposed hay grades (Table 2.).

The different grades of hay should be selected for the particular function required. High-producing cows or beef in a feedlot should be fed hay from Grades 1 or 2. Dry dairy cows and dairy heifers would perform well with Grade 3 hay. Lactating beef cows or lactating ewes could be fed Grade 2 or 3 hay. Dry ewes or beef cattle on a maintenance ration could be fed Grade 4 alfalfa or a grass or cereal hay. Thus, all grades of hay have value if used in the proper feeding situation. Grade 1 alfalfa hay should not be considered the best hay to feed in all situations. Cost and relative performance required will determine what feed is best for your situation.

Regional Hay Grading Standards

Because of grass hay growers' opposition to the proposed national hay grading standards, no changes have been made in the official grading standards. Thus, the Tri-State Alfalfa Coalition was formed to promote standardization of laboratories for hay quality analysis and reporting.

Research in the area of near-infrared (NIR) spectroscopy techniques for analysis of hay will likely revolutionize hay testing. Until this technique is perfected, however, standardized testing and reporting is the only method available to improve our ability to predict animal response based upon chemical analysis.

Pacific Northwest cooperative Extension bulletins are joint publications of three Pacific Northwest states—Washington, Oregon, and Idaho. Similar crops, climate, and topography create a natural geographic unit that crosses state lines. Since 1949, the PNW program has published over 200 titles. Joint writing, editing, and production has prevented duplication of effort, broadened the availability of faculty specialists, and substantially reduced costs for the participating states.

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