Timing alfalfa harvest for high-quality dairy hay

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The quality of alfalfa hay is determined by its maturity at cutting, by environmental conditions before and during harvest, and by handling and storage processes. Because environmental conditions vary from year to year and from day to day, factors other than calendar date must be used as harvest criteria. In addition, preservation processes cannot bring back quality already lost.

Of all the quality factors the producer can control, timing of cutting is the most important. The University of Idaho Cooperative Extension System Alfalfa Quality Watch Program for southern Idaho has demonstrated that plant maturity at harvest greatly influences the nutritional quality of first-cutting alfalfa hay. This publication describes a method for deciding harvest timing of first-cutting alfalfa hay in southern Idaho based on field sampling of plant morphological growth stages.

Laboratory analyses determining the nutritional quality of standing alfalfa have been used in harvest scheduling in the past, but in the time it takes to get the results back (usually 2 to 3 days), the quality may deteriorate significantly. The Magic Valley Alfalfa Quality Watch Program in 1991 demonstrated an average weekly decline of 2.0 percentage units of crude protein (CP) and an increase of 3.8 percentage units of acid detergent fiber (ADF).

Why raise dairy-quality hay?

Alfalfa producers who raise dairy-quality hay (table 1) can expect higher returns per ton than producers who provide hay of lower quality. This is because higher quality hay increases returns over feed costs for dairy producers.

Cost comparisons developed by Bar Diamond, Inc., have shown that reducing ADF from 32 percent to 22 percent increased milk production by 4.68 pounds per head per day. This increase in milk production would more than offset any increased cost associated with feeding higher quality alfalfa hay.

Table 1. Approximate dairy hay quality standards.

Quality classification	Maximum ADF[a] (%)
Premium[b]	29
Good	32
Fair	37
Low	greater than 37

Source: USDA Agricultural Marketing Service and California Department of Food and Agriculture Market News Branch. 1993. Hay Market News 43(9). March.

[a]100 percent dry matter basis.

[b]Premium quality dairy hay should be free of odor and foreign material and contain more than 20 percent crude protein and less than 29 percent acid detergent fiber.

MSC and hay quality

Nutritional quality of alfalfa hay is closely tied to maturity defined in terms of morphological growth stage of the plant. Past characterizations of maturity were usually based on flower development, for example, "pre-bud," "bud," "1/10th bloom," and "early bloom." Although these terms were helpful, they did not precisely define maturity, and they created some confusion.

A new method of assigning numerical values to growth stages allows the mean morphological growth stage of growing alfalfa to be easily determined in the field. This method, called "mean morphological stage of growth by count," or MSC, uses the number of stems in each developmental stage to quantify maturity. When the MSC has been determined, forage quality parameters (such as ADF, CP, Digestible Dry Matter [DDM], and Total Digestible Nutrients [TDN]) can be quickly estimated.

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CIS 1003

MSC provides a quick way of estimating hay quality in a growing stand of alfalfa. MSC is a good indicator of quality at harvest and predictor of hay quality under ideal harvest conditions. It is not intended to be used as a substitute for standard laboratory analysis in buying and selling hay.

How to estimate hay quality using MSC

1. **Collect a sample**. Sample fields at weekly intervals when plants reach 8 to 12 inches in height. Take random grab samples (usually 8 to 10 handfuls are sufficient). Cut stems at mower height or at approximately 1 to 1½ inches above ground level. The composite sample should contain more than 40 alfalfa stems.

   All harvestable alfalfa stems must be counted, including those less than 6 inches tall. Discarding stems from a sample will cause inaccurate readings.

   Examine and sort samples immediately. Because results are based on pure stands of alfalfa, discard any weeds and dead material from alfalfa samples. (Weed populations can seriously affect alfalfa quality.)

2. **Stage the stems.** Separate the individual stems into stages of development. (Refer to table 2 and to Stages of Alfalfa Development.) In staging the stems, remember that each sample is composed of several different morphological growth stages.

3. **Determine mean morphological growth stage by count (MSC).** Determine MSC for each field by counting the number of stems in each growth stage and obtaining a weighted average (for an example, see table 3). Very seldom will growth stages greater than 6 be used when classifying quality forage.

Table 2. Morphological stages of development for individual alfalfa stems.

Growth stage number	Stage name	Stage definition
0	Early vegetative	Stem length less than 6 inches; no visible buds, flowers, or seed pods
1	Midvegetative	Stem length 6 to 12 inches; no visible buds, flowers, or seed pods
2	Late vegetative	Stem length greater than 12 inches; no visible buds, flowers, or seed pods
3	Early bud	One to two nodes with visible buds; no flowers or seed pods
4	Late bud	Three or more nodes with visible buds; no flowers or seed pods
5	Early flower	One node with one open flower; no seed pods
6	Late flower	Two or more nodes with open flowers; no seed pods
7	Early seed pod	One to three nodes with green seed pods
8	Late seed pod	Four or more nodes with green seed pods
9	Ripe seed pod	Nodes with mostly brown, mature seed pods

Source: Kalu, B. A., and G. W. Fick. 1983. Morphological stage of development as a predictor of alfalfa herbage quality. Crop Science 23:1,167-1,172.

Table 3. Example of calculations used in computing MSC.

Growth stage	Number of stems	Product of columns 1 and 2
0	13	0
1	15	15
2	19	38
3	10	30
4	8	32
Total	65	115

MSC = 115/65 = 1.77

4. **Estimate alfalfa hay quality based on MSC.** Use table 4 to estimate ADF, CP, DDM, TDN, and hay quality in first-cutting standing alfalfa. As the alfalfa plant matures, ADF increases while CP, DDM, and TDN decrease.

   For instance, in the example in table 3, MSC was calculated to be 1.77. Using table 4, the estimated analyses for this hay would be ADF = 28.9, CP = 23.4, DDM = 66.4, and TDN = 63.3. Using the criterion of less than 29.0 percent ADF as premium dairy hay (table 1), the hay grower would need to harvest this field now to produce premium dairy hay.

   Caution: *Table 4 is based on the first cutting of a pure stand of irrigated alfalfa in southern Idaho and relates to plants actively growing.* The data would not apply to grass-alfalfa, weed-alfalfa mixtures, or alfalfa grown in areas where climatic conditions may severely stress the plant.

Stages of alfalfa development[1]

Vegetative stages

At early stages of development, reproductive structures are not visible on alfalfa stems. Leaf and stem formation characterize vegetative growth.

Stage 0: Early vegetative. Stem length less than or equal to 15 cm (6 inches). No visible buds, flowers, or seed pods.

The junction between the main stem and a leaf or branch is called the axil. An axillary bud is present in each leaf axil; however, they are so small at this stage that they are not easily seen.

[1]*Source*: Fick, G. W., and S. C. Mueller. 1989. Alfalfa quality, maturity, and mean stage of development. Information Bulletin 217. Ithaca, New York: Cornell University Department of Agronomy, College of Agriculture and Life Sciences.

Table 4. Using MSC to estimate hay quality in first-cutting irrigated alfalfa in southern Idaho.

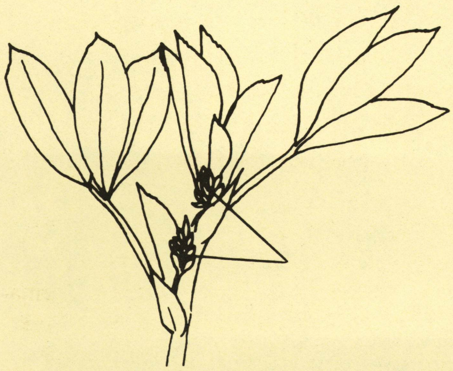
MSC	% ADF	% CP	% DDM	TDN	Hay quality
1.0	22.5	27.2	71.4	67.9	Premium
1.2	24.5	26.0	69.8	66.5	Premium
1.4	26.1	25.0	68.6	65.3	Premium
1.6	27.6	24.2	67.4	64.2	Premium
1.8	28.9	23.4	66.4	63.3	Premium
2.0	30.0	22.7	65.7	62.4	Good
2.2	31.1	22.1	64.7	61.7	Good
2.4	32.0	21.5	64.0	61.0	Good
2.6	32.9	21.0	63.3	60.3	Fair
2.8	33.7	20.5	62.6	59.7	Fair
3.0	34.4	20.1	62.1	59.2	Fair
3.2	35.1	19.7	61.5	58.7	Fair
3.4	35.8	19.3	61.0	58.2	Fair
3.6	36.4	18.9	60.5	57.7	Fair
3.8	37.0	18.5	60.1	57.3	Fair
4.0	37.6	18.2	59.6	56.9	Poor

Stage 1: Midvegetative. Stem length 16 to 30 cm (6 to 12 inches). No visible buds, flowers, or seed pods.

As the stem continues to develop, axillary branch formation begins with the appearance of one or two leaves in the axil. Development of axillary leaves is more pronounced in the midportion of the stem than at the base or apex.

Stage 2: Late vegetative. Stem length equal to or greater than 31 cm (12 inches). No visible buds, flowers, or seed pods.

Elongating branches are often found in the axils of the leaves at this stage. It may be possible to feel buds at the growing apex, but they are not visible without peeling back the enclosing leaves. Stage 2 stems are often rare in midsummer because of the rapid appearance of buds on shorter stems. This is a result of environmental conditions that hasten maturation.



Flower buds become visible as their basal stalk elongates.

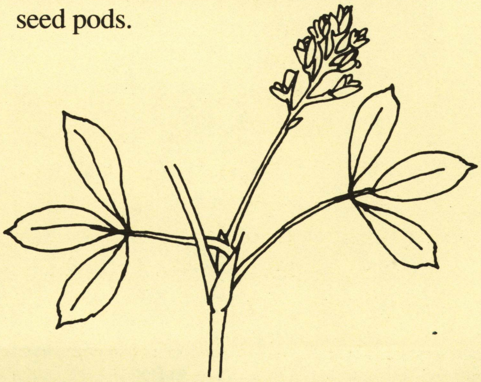
Flower bud development

Flower buds first appear near the growing apex of a stem or an axillary branch. At the transition from vegetative stages to bud stages, flower buds can be difficult to identify. At first, buds are small, distinctly round, and appear hairy or fuzzy. In contrast, new leaves are flattened and oblong.

Stage 3: Early bud. One to two nodes with visible buds. No flowers or seed pods.

Flower buds appear clustered at the stem tip because of the closely spaced nodes in that part of the shoot. As the nodes elongate during development into the next stage, it becomes easier to distinguish individual nodes for the purpose of counting. (A node is a region of the stem with one or more leaves attached.)

Stage 4: Late bud. Three or more nodes with visible buds. No flowers or seed pods.



At bloom, alfalfa flowers are clustered in a loose raceme at the end of a branch.

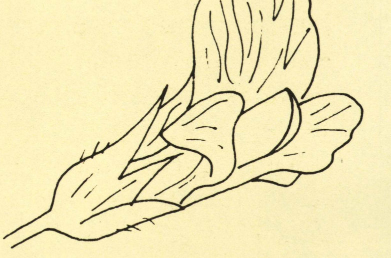
This stage differs from the previous one only in number of nodes with flower buds. The structure of the developing inflorescence (arrangement of flowers on the flowering stem) becomes visible with elongation and cleaner separation of individual flower buds in the raceme. (A raceme is a variety of flower cluster in which single flowers grow on short stems arranged at intervals along a single, larger stem.)

Flowering

When environmental conditions meet specific requirements for temperature and photoperiod, flower buds develop into flowers. Flowering normally occurs in the field, but in the autumn when there are fewer than 12 hours of daylight, buds may abort without forming flowers. Flowers may be purple, blue cream, yellow, white, or variegated combinations of those colors.

Stage 5: Early flower. One node with one open flower and no seed pods.

To be counted as an "open" flower, the standard petal of the flower must be unfolded. One or more flowers within the raceme may be open; however, the definition of stage 5 is open flowers at only one node. Because one raceme arises from each node, the number of racemes with open flowers is what is actually counted. Flowering usually begins near the apex of the stem while buds are still developing rapidly above and below the point of initial flower opening.



The individual flower has five petals; the standard petal is the largest and first to unfold.

Stage 6: Late flower. Two or more nodes with open flowers and no seed pods.

This stage differs from stage 5 in that stage 6 has more racemes with open flowers. Nodes with flowers are spread throughout the midportion of the stem.

Seed production

Seed production stages 7 to 9 are omitted since they have no relevance in determining high-quality hay.

Acknowledgments — David Barton, Jerome County Extension agricultural agent; Stacey Camp, District III Extension agricultural agent, water quality; Charles Cheyney, Butte County Extension agricultural agent; Gene Gibson, Gooding County Extension agricultural agent; Bill Hazen, Lincoln County Extension agricultural agent; Ivan Hopkins, Minidoka County Extension agricultural agent; Jeff Rast, Camas County Extension agricultural agent; Northwest Laboratories, Jerome, Idaho; United Dairymen of Idaho; and Gooding Feed and Seed.

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Drawings on page 3 are from *Alfalfa Quality, Maturity, and Mean Stage of Development*, Information Bulletin 217, Cornell University, Department of Agronomy, College of Agriculture and Life Sciences, Ithaca, NY.

Issued in furtherance of cooperative extension work in agriculture and home economics, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, LeRoy D. Luft, Director of Cooperative Extension System, University of Idaho, Moscow, Idaho 83844. The University of Idaho provides equal opportunity in education and employment on the basis of race, color, religion, national origin, gender, age, disability, or status as a Vietnam-era veteran, as required by state and federal laws.

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