# The Multiple Impacts of Cutting Strategy on Alfalfa Yield, Quality, and Stand Life

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## ABSTRACT

Cutting strategy impacts forage yield and stand life and is the primary method by which growers can influence the nutritional quality of alfalfa hay. Lengthening the time interval between cuttings increases yield and may increase stand life, but reduces forage quality. Frequent cutting is required to produce alfalfa hay that satisfies the increased quality demands of today's dairy industry. However, such frequent cutting depletes stored carbohydrate root reserves reducing alfalfa vigor, yield, and eventually stand persistence. Allowing the alfalfa to bloom at least once during the season may ameliorate some of the negative effects of frequent cutting. Fall harvest management is another important consideration, especially in cold areas. Alfalfa plants should have sufficient time to replenish root reserves before making the final cutting of the season. Insufficient root reserves going into winter can result in reduced vigor, stand loss, and lower yields the following spring.

**Key words: cutting frequency, cutting schedules, fall harvest management, yield, persistence, forage quality**

## INTRODUCTION

Cutting strategy affects nearly all aspects of alfalfa production. Forage yields, quality, plant vigor, stand persistence, susceptibility to insect injury, and weediness are all influenced by cutting strategy. Therefore, adjustment of cutting schedules is one of the primary tools used to manage alfalfa.

Alfalfa yield generally increases as plants mature. In theory, maximum yield occurs when alfalfa is at full bloom. Sometimes maximum yield is obtained when alfalfa is less mature (i.e. 50 percent bloom) due to leaf loss from shading of lower leaves when alfalfa matures. The maturity of alfalfa when it is cut, has a greater impact on alfalfa quality than any other single factor. Most of the yield increase that occurs as alfalfa matures from prebud stage to full bloom is actually due to an increase in the yield of stems rather than an increase in the yield of leaves (figure 1). The amount of leaves remains relatively constant, while the stems become longer and thicker. At immature growth stages the proportion of leaves is greater than that of stems. However, at about the time of first bloom, the weight of stems exceeds that of leaves. Since leaves are far more nutritious and palatable than stems, the forage quality of alfalfa declines significantly as alfalfa matures beyond the early bud stage. Not only does the amount of stems increase as alfalfa matures, the digestibility of stems declines because their fiber content increases.

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Cutting schedule also impacts stand persistence. Alfalfa stores some of the carbohydrates produced during photosynthesis in its crown and root. These stored carbohydrates are used for growth in spring, regrowth after cutting, and for winter survival (more important in northern climates). Root reserves are depleted after cutting until the alfalfa plant reaches a height of about 6 to 8 inches, typically 2 weeks after cutting (or longer in cool climates). At this point the carbohydrates produced during photosynthesis exceed the needs of the growing plant and the plant begins replenishing root reserves. Carbohydrate root reserves of alfalfa increase until the alfalfa reaches full bloom. Cutting alfalfa at excessively immature growth stages, such as pre- or early-bud stage, does not allow sufficient time for the root reserves to be replenished. Stand life and alfalfa vigor can be reduced significantly if plants are repeatedly cut before root reserves are replenished.

## CONSIDERATIONS WHEN SELECTING A CUTTING STRATEGY

There is no optimum cutting schedule for all growers in all locations. Several factors must be kept in mind when deciding on a cutting strategy. Some of the more important factors include the variety of alfalfa produced, desired stand life, the intended use for the hay, and the alfalfa market.

How frequently a field should be cut is influenced by the variety of alfalfa produced. The primary varietial characteristic influencing cutting frequency is dormancy. Typically, alfalfas representing a range of fall dormancies are grown in an alfalfa-production area. For example, in the intermountian area of northern California, varieties with fall dormancy ratings of 2, 3, and 4 are grown. In the Sacramento Valley, varieties with fall dormancy ratings of 5, 6, and 7 are predominately grown. In contrast, fall dormancy ratings typically range from 7 to 9 in the San Joaquin Valley. In general, nondormant varieties have faster regrowth after cutting and mature quicker than do more dormant varieties. Therefore, given the range of fall dormancies grown in an area, those on the more nondormant side of the scale can be cut more frequently than those on the dormant side of the scale.

The desired stand life is another important point to consider. As mentioned earlier, long intervals between cuts allows the alfalfa plant more time to replenish root reserves and usually prolongs stand life. This is important if growers desire a stand life of 4 or more years. However, if alfalfa is only a rotation crop between plantings of a more profitable crop, allowing time to replenish root reserves before cutting is much less important.

The appropriate cutting strategy should reflect both the intended use for the hay and the status of the alfalfa market. If the anticipated market for the hay is the dairy industry, the alfalfa must be cut more often than hay that will be fed to beef cattle or "hobby" horses. For the grower that is selling hay rather than feeding it to his or her own livestock, the price premium received for dairy-quality hay must be high enough to offset any yield loss or increased harvest cost that may occur with short cutting intervals. The price premium associated with dairy quality hay varies depending on the strength of the hay market. Oftentimes the premium is not sufficient to compensate for yield losses and increased harvest costs but it becomes an issue of demand rather than price. Sometimes the demand for mediocre hay is so low that there is little movement or market for this class of hay.

## METHODS USED TO SCHEDULE HARVESTS

Alfalfa fields are sometimes harvested on a calendar basis, using a fixed interval and fixed number of cuttings per season. Alfalfa in the Central Valley is commonly harvested on a 26- to 28-day schedule. The advantage of this method is that the date of cuttings and the number of cuttings per season is predetermined. This facilitates planning—it allows advance scheduling of irrigation, the cutting of other fields, and other activities. The problem with this method is that it does not account for weather or dormancy differences among alfalfa varieties. Weather, primarily temperature, has a significant effect on alfalfa development and will cause the date of plant maturity to vary from year to year.

Another method of scheduling alfalfa harvests uses the growth stage of alfalfa to indicate the appropriate time to cut and the number of cuttings per season. The grower selects a specific alfalfa growth stage (such as bud, late-bud, 10-percent bloom, etc.) at which harvest will begin. This method takes into account the effects of environmental and varietal differences and results in more consistent, predictable forage yield and quality than when harvesting on a calendar basis. In some areas, the alfalfa growth stage at harvest is based on the appearance of bud or bloom; in others, regrowth from crown buds is used to indicate the proper time to cut. The primary drawbacks to cutting based on stage of development is that it is difficult to plan for the cutting of fields and irrigations (especially a problem when fields are custom harvested), and the number of cuttings per season is not defined—a partial cutting may remain at the end of the season.

A combination of methods, where both calendar date and growth stage are considered, is usually the best approach. It is impractical with large acreages to inspect each field every day as the anticipated harvest approaches and harvest each field on the appropriate day. An effective compromise may be to forecast harvest dates taking into account climatic changes due to seasons. For example a typical cutting schedule in the San Joaquin Valley may allow for 32 days between cuttings in the early spring and late fall and be reduced to only 26 days between cuttings in mid summer. The actual number of days between cuts can be altered according to weather conditions.

## THE YIELD VERSUS QUALITY DILEMMA

As mentioned above, selecting a cutting strategy is a compromise between maximum yield and maximum quality. Unfortunately, yield and quality are almost always inversely related. Alfalfa yields increase with longer cutting intervals. This is logical—alfalfa has more time to grow with long rather than short cutting intervals. However, lengthening the interval between cuttings usually results in fewer cuttings per season. With fewer cuttings per season, is the total yield for the season still higher with long cutting intervals? The answer is usually less.

Numerous studies were conducted in the different alfalfa production regions of California to evaluate the effect of cutting schedules on alfalfa yield and quality (tables 1- 7). The results for the different areas are surprisingly similar. The yield benefit with longer cutting intervals can be dramatic. In the Davis study (table 4) the yield increase averaged approximately one ton for each one-week delay in cutting. An Imperial Valley study showed that harvesting the variety CUF 101

on a 42-day schedule yielded 15 percent higher than a 35-day schedule, 30 percent more than a 28-day schedule, and 72 percent more than a 21-day schedule (table 3). In the intermountain area of northern California the choice is between three and four cuttings per year. In the first year of a multiple-year study currently underway, the three-cut systems out-yielded the four-cut system by nearly 0.9 tons (table 1). These data are in agreement with previous studies conducted by Marble et al. With all of these studies the yield advantage for longer cutting intervals was greatest for the more dormant varieties tested.

There are secondary benefits to longer cutting intervals. Not only do longer cutting intervals result in higher seasonal yield, the alfalfa is more vigorous, and stand persistence is often improved. A more vigorous and dense stands is better able to compete with weeds and withstand the effects of alfalfa weevil feeding (table 6).

The results of cutting schedule studies led to the recommendation to cut alfalfa at the one-tenth bloom stage. This stage was considered to represent the best compromise between yield and quality without seriously reducing stand and vigor. However, unfortunately for the hay grower, the quality of alfalfa hay requested by the dairy industry has changed. While 54% TDN was once considered premium hay, 54.5, 55, or even 56% TDN is now demanded. Growers cannot cut alfalfa at the one-tenth bloom stage and make hay that would satisfy this stringent quality requirement.

Alfalfa must be cut at the mid-bud stage (or earlier depending on the time of year) to meet the quality demands of today's dairy market. As the data in the tables demonstrate, the penalty for cutting alfalfa at such an immature growth stage is a significant reduction in yield. Repeatedly cutting at early to mid bud does not allow sufficient time to replenish the plant's carbohydrate root reserves. Plant vigor, yield, and stand persistence are all reduced as a result.

It was easier to produce dairy quality hay without suffering extensive yield loss when 54% TDN was the requirement than it is today with the requirement being 55% TDN or higher. It is especially difficult to produce such high quality hay in the middle of the summer—mid-summer alfalfa must be cut at a more immature growth stage to produce the same forage quality as alfalfa in the early spring or fall. In most areas it is simply not possible to produce 55% TDN hay on all fields for all cuttings. The interval between cuttings would have to be extremely short. The yield loss associated with such a short cutting interval is unacceptable.

An alternative cutting strategy may be appropriate given the difficulty of producing dairy quality hay on all cuttings. Although this strategy has not been adequately researched and deserves further study, the principles involved are sound. One approach is to target certain cuttings to harvest early to produce high-test hay, while lengthening the cutting interval at other cuttings to give plants more time to grow and replenish root reserves. A mid-summer cutting, when it is most difficult to produce high-quality hay, may the best time to delay cutting until 10 percent bloom or even later. The grower will obtain higher yields the cutting(s) where the harvest interval is lengthened and the hay may be sold to feed stores for horse hay or for dry cows (animals whose energy demand is less than that of lactating dairy cows). While this strategy

allows the growers to produce some dairy-quality hay, it also allows for a rest period for the plants to recover and replenish root reserves.

Another approach that allows for a recovery period involves altering the order in which fields are cut. Common practice is to start with one field at first cutting and then establish a set sequence for the cutting of other fields. This same sequence is typically used for subsequent cuttings for the remainder of the season. Another, perhaps preferred, approach is to vary the order so that a field that was cut last one cutting may be one of the first to cut the next cutting. By altering the order in which fields are cut, high quality can be attained from selected fields at one cutting, while at the same time giving alfalfa plants in other fields a chance to replenish root reserves. Fields that are cut at a very immature growth stage would be given a rest period either before or after they are cut early. Hence, the same field would not always be cut early to attain dairy quality. A benefit to this approach is that growers can take advantage of the fact that all fields cannot be cut on the same day; some fields are cut early while others are given an opportunity to recover. The result is a relatively constant supply of "test" and "nontest" hay throughout the season.

## FALL HARVEST MANAGEMENT

The decision about when to make the last cutting of the season is another important consideration. Although weather conditions and their suitability for making hay are important, they are not the only criteria. Growers should also consider the effects of fall harvest management on stand life and vigor. The importance of fall harvest management depends on the severity of the winters, alfalfa variety, and desired stand life. Timing of the last cutting is most important in cold, short season growing areas where hard frosts are common and winter kill is a possibility. Therefore, fall harvest management is very important in the intermountain area of northern California, less important in the Central Valley, and even less important in the Imperial Valley. It is usually more important with varieties that regrow after the last cutting in the fall than those that go dormant. Fall harvest management is also more important where a long stand life is desired than where alfalfa is merely used as a rotation crop between plantings of more profitable crops.

The principles of fall harvest management are similar to those of cutting schedules. Stored carbohydrates provide the energy for regrowth after cutting and initial regrowth in spring. You must allow alfalfa sufficient time to replenish root reserves before cutting it. Adequate root reserves are important for spring regrowth (and for winter hardiness in cold climates). Insufficient root reserves going into winter can result in reduced vigor, stand loss, and lower yields the following spring. Therefore, the last harvest of the growing season should occur 4 to 6 weeks before the first killing frost. (A killing frost is generally believed to be 25° to 26°F.) Cutting after a killing frost does not deplete root reserves. Consequently, a late harvest or grazing can be made if field conditions permit and growth is sufficient for a profitable crop. Unfortunately, curing conditions are seldom favorable at this time, so grazing or silage is usually the only option.

Predicting when a killing frost is likely to occur can be difficult. A grower can only rely on experience and historical weather data to time final cuttings. When a grower has numerous fields, cutting them all at the optimum time may be impossible. Fields cut too close to the first killing

frost should be allowed to grow to a late stage of development before the first cutting is made the following spring. The consequence of not doing so is reduced subsequent yields.

## CONCLUSION

Selecting a cutting schedule is difficult because of the tradeoffs that exist between yield and quality. A cutting schedule that is best for maximizing yield and stand life will not result in top quality. The relationship between cutting frequency and yield and quality must be known for the alfalfa varieties being grown before the optimum cutting schedule can be determined. While increased cutting frequency will improve forage quality, it may result in more cuttings per season and quite possibly reduced total yield for the season. Therefore, the price differential between "test" and "nontest" hay must be sufficient to more than compensate for any decrease in yield or increase in harvest costs associated with frequent cutting. In many cases, the best approach is to target specific cuttings and fields for making dairy-quality hay. It is much easier to produce high-test hay in cuttings made in spring and fall. Also, growers can change the order in which fields are cut which would vary the time interval between cuttings on a specific field. Short intervals would allow the grower to produce dairy quality hay, while longer intervals would allow the plants sufficient time to replenish root reserves.

## REFERENCES

Hagemann, R. W. and V. L. Marble. 1983. Variety response to cutting schedules in Imperial Valley. Proceedings, 13th California Alfalfa Symposium, 6–15. December 7–8, Holtville, CA.

Marble, V. L. 1980. Effect of harvest frequency and variety on yield, quality, and stand life. Proceedings, 10th California Alfalfa Symposium, 22–38. December 10–11, Visalia, CA.

Orloff, S. B., and V. L. Marble. 1995. Harvest management. In S. B. Orloff and H. L. Carlson (eds.), *Intermountain alfalfa management*. Oakland: University of California Division of Agriculture and Natural Resources, Leaflet 3366.

Schoner, C. 1981. The effect of late fall harvest on alfalfa stand and yield - a progress report. Proceedings, 11th California Alfalfa Symposium, 15–21. December 9–10, Fresno, CA.

Sheaffer, C. C., G. D. Lacefield, and V. L. Marble. 1988. Cutting schedules and stands. In A. A. Hanson, D. K. Barnes, and R. R. Hill, Jr. (eds.), *Alfalfa and alfalfa improvement*, 412–37. Madison, WI: American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America. Number 29.

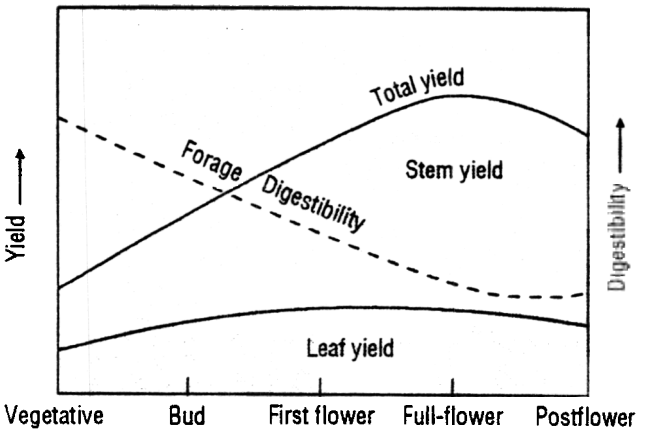


**Figure 1.** Forage yield relative to quality at different alfalfa growth stages.

**Table 1.** Effect of cutting strategy on yield, 6 varieties averaged, 1994, Tulelake (Orloff)

| | Yield (tons/A) | | | | |
|---|---|---|---|---|---|
| **Schedule** | **1st Cut** | **2nd Cut** | **3rd Cut** | **4th Cut** | **Total** |
| 4 Cut | 2.27 | 1.51 | 1.52 | 1.31 | 6.61 |
| 3 Cut early 2nd[1] | 2.67 | 2.57 | 2.29 | | 7.53 |
| 3 Cut even[2] | 2.66 | 2.70 | 2.15 | | 7.51 |

[1]Second cutting taken early (36 days after 1st cut)
[2]Cuttings evenly spaced (approx 45 days apart)

**Table 2.** Effect of cutting strategy on forage quality, 6 varieties averaged 1994, Tulelake (Orloff)

| | Percent TDN[1] | | | |
|---|---|---|---|---|
| **Schedule** | **1st Cut** | **2nd Cut** | **3rd Cut** | **4th Cut** |
| 4 Cut | 55.2 | 54.5 | 56.7 | 58.0 |
| 3 Cut early 2nd[2] | 54.2 | 53.8 | 53.9 | |
| 3 Cut even[3] | 54.0 | 52.5 | 53.6 | |

[1] Total digestible nutrients (TDN) @ 90% D.M.
[2]Second cutting taken early (36 days after 1st cut)
[3]Cuttings evenly spaced (approx 45 days apart)

**Table 3.** Three-year yield summary of four harvest intervals of CUF 101 alfalfa. Imperial Valley Field Station (Hagemann and Marble)

| | Yield (tons/A) | | | |
|---|---|---|---|---|
| Days Between Harvest | 1979 | 1980 | 1981 | 3-Year Average |
| 42 | 6.27 | 8.57 | 8.83 | 7.89 |
| 35 | 5.99 | 7.79 | 6.85 | 6.88 |
| 28 | 5.63 | 7.88 | 4.67 | 6.06 |
| 21 | 4.75 | 5.24 | 3.80 | 4.60 |

**Table 4.** Effect of harvest frequency on yield, 8 varieties averaged, 1975-1978, UC Davis (Marble).

| Schedule | No. Cuts | Yield (tons/A) 1975 | 1976 | 1977* | 1978 | 4-Yr Avg. |
|---|---|---|---|---|---|---|
| 6 Weeks | 5 | 7.69 | 10.81 | 12.64 | 9.91 | 10.24 |
| 5 Weeks | 6 | 7.04 | 10.82 | 10.72 | 8.89 | 9.41 |
| 4 Weeks | 7 | 7.22 | 9.53 | 10.41 | 8.58 | 8.85 |
| 3 Weeks | 9 | 5.35 | 7.94 | 6.86 | 6.53 | 6.68 |
| LSD .05 | | 0.41 | 0.60 | 0.54 | 0.53 | 0.44 |

*Late harvest made in 1977 for 4- (4/11) and 6- (11/17) week schedules.

**Table 5.** Effect of harvest frequency and varieties on stand decline in 3rd, 4th and 5th year of stand life; UC Davis (Marble).

| Harvest frequency | 1977 3rd yr May 19 | 1977 3rd yr Oct 13 | 1978 4th yr May 2 | 1979 5th yr Apr 20 |
|---|---|---|---|---|
| | ----------Percent Stand Remaining---------- | | | |
| 6 weeks | 78.6 | 73 | 66.6 | 60.0 |
| 5 weeks | 75.8 | 72 | 61.6 | 49.7 |
| 4 weeks | 71.7 | 51 | 52.8 | 39.7 |
| 3 weeks | 70.0 | 51 | 46.9 | 33.1 |

**Table 6.** Effect of harvest frequency and variety on yield, weed contamination and Egyptian alfalfa weevil damage for 1st harvest of the 5th year, April 20, 1979, UC Davis (Marble).

| Harvest frequency | Weed-free alfalfa | Weed content | Alfalfa + weeds | Weevil damage[1] |
|---|---|---|---|---|
| | T/A | % | T/A | |
| 6 weeks | 1.14 | 16.44 | 1.33 | 2.6 |
| 5 weeks | 1.07 | 19.50 | 1.31 | 3.3 |
| 4 weeks | 0.72 | 49.98 | 1.44 | 5.0 |
| 3 weeks | 0.52 | 68.67 | 1.26 | 5.0 |

[1] Weevil damage rating scale: 1 = no damage; 2 = slight webbing of leaves; 9 = complete defoliation of leaves.

**Table 7.** Effect of harvest frequency on alfalfa quality factors. All harvests and varieties averaged, 1977, UC Davis (Marble).

| | Percent | | |
|---|---|---|---|
| **Schedule** | **TDN[1]** | **Crude Protein** | **Leaves[2]** |
| 3 weeks | 55.9 | 30.13 | 58.00 |
| 4 weeks | 54.0 | 26.34 | 52.82 |
| 5 weeks | 50.6 | 22.61 | 47.43 |
| 6 weeks | 50.4 | 22.16 | 45.69 |
| LSD .05 | 0.5 | 0.43 | 1.00 |

[1] Total digestible nutrients (TDN) @ 90% D.M.

[2] Average of two years, 1976 and 1977.