SELECTING CUTTING SCHEDULES—THE YIELD AND QUALITY TRADEOFF

Steve B. Orloff and Dan H. Putnam

ABSTRACT

Manipulation of cutting schedule is the primary technique by which growers can affect forage yield and quality. However, it is not always clear what alfalfa growth stage will produce dairy-quality hay without unduly sacrificing yield. Field research was conducted to quantify the relationship between alfalfa maturity and yield and forage quality under intermountain conditions. First cutting yield increased 80 pounds per day (averaged over two years, two alfalfa varieties, and two locations). Forage quality declined, averaging a 0.33 percentage point increase in ADF (0.22 percentage point decrease in TDN), 0.3 percentage point increase in NDF, and 0.2 percentage point decline in CP per day. The yield increase and quality decrease were significantly more rapidly for second cutting. This underscores the trouble growers often experience producing dairy-quality hay in mid summer (second cutting). Given the difficulty in producing dairy-quality alfalfa for all cuttings throughout the year, an alternative cutting strategy is suggested. The best approach may be to alter the order in which fields are cut from cutting to cutting. The intent is to target specific fields and cuttings for the dairy market while aiming to maximize the yield of other fields.

Key Words: Alfalfa, *Medicago sativa*, harvest frequency, forage quality, ADF, TDN, NDF, CP, economics

INTRODUCTION

Yield and quality are inversely related. This means that harvesting alfalfa at an immature growth stage will result in low yield but high forage quality. Conversely, delaying cutting until a more mature growth stage will result in higher yield but poorer, often unacceptable, forage quality. This relationship takes on even greater importance with the current standards used for ‘dairy-quality’ hay. While 54% TDN was once sufficient, dairy producers now seek 55 or even 56% TDN alfalfa hay (*TDN figures on 90% dry matter basis*). The yield reduction associated with producing such high-quality hay can be severe.

This presents a dilemma for the alfalfa grower who desires both high yield and high forage quality. The logical question arises: *Does the price premium received for high-quality hay offset the yield penalty associated with harvesting alfalfa at such an immature growth stage?* This is not an easy question to answer and many factors need to be included in the analysis, not the least of which are the strength of the alfalfa hay market, weather conditions in a given year, and the amount of equipment and labor available. However, the first step is to define the degree to
which harvest date affects yield and forage quality. Knowledge of this relationship can serve as the basis for harvest timing decisions.

PROCEDURES

Field trials were established to quantify the relationship between alfalfa growth stage at harvest and the yield and forage quality that can be expected. Studies were conducted in two high-mountain valleys of Siskiyou County, CA: Scott Valley (elevation 2700 ft.) and Butte Valley (elevation 4200 ft.). Two alfalfa varieties, Blazer XL and Archer were used in the study. These varieties were chosen to represent a range in fall dormancy; Blazer XL has a fall dormancy rating of 3, and Archer has a fall dormancy rating of 5.

Alfalfa was harvested every few days, typically every two to three days, throughout first and second cutting. The first harvest was made at the late vegetative pre-bud stage. The last harvest was made at full bloom. A different area of each field, an area with a uniform first-cutting harvest date, was selected for the second cutting harvest. This way second cut yields were not influenced by the different first cutting harvest dates. The total number of harvests per cutting period averaged 12, ranging from 9 to 14 depending on the cutting and the location. First cut developed slower and had more harvest dates than did second cutting. Forage yield was determined at each harvest date. Each plot was subsampled to determine the moisture content and forage quality. Acid detergent fiber (ADF), neutral detergent fiber (NDF), and crude protein (CP) were evaluated using near infrared spectroscopy (NIRS) analysis. The study was conducted in 1996 and repeated in 1997.

RESULTS AND DISCUSSION

Weather conditions during the spring of 1996 and 1997 were very different. The spring of 1996 was unseasonably cool and alfalfa development was delayed approximately 10 days to two weeks compared with 1997. This illustrates the problem using a calendar date to time harvests. Using an estimate of plant maturity is a far more accurate way to time harvests than is calendar date. Alfalfa harvests in the higher elevation area, Butte Valley, averaged 16 days later than in Scott Valley.

The location (Scott Valley or Butte Valley), alfalfa variety (Blazer XL or Archer), the cutting (first or second cutting) and the year all had significant effects on yield and quality changes over time. Location and variety effects, while statistically significant, were small. The intent of this study was to quantify changes in yield and quality with time, not to compare varieties or regions. The varieties and locations were included to develop a robust relationship that could be used for most intermountain regions. The relationship would likely be different in areas with widely different varieties or growing conditions than those tested.

Yield Increases

As alfalfa matured from the late vegetative pre-bud stage to full bloom, the daily increase in yield for the first cutting was 80 pounds averaged over two years, two varieties, and two locations (Figure 1.). In other words, each day delay in first-cutting harvest resulted in an 80-
pound increase in yield. The rate of yield increase was greater for second cutting; each day delay resulted in an increase of 112 pounds per day (Figure 1.).

![Graph showing yield (tons/A) over days from Pre Bud to Full Bloom with data points for Cut 1 and Cut 2]

**Figure 1.** Daily change in the yield of alfalfa harvested from pre bud to full bloom for first and second cutting (averaged over two locations, two years, and two varieties). Each tick mark on the x-axis represents one day.

**Forage Quality Declines**

As expected, forage quality declined as the alfalfa matured. On first cutting the ADF content increased 0.33 percentage points per day (Figure 2). This equates to a loss of 0.22 percentage points of TDN per day (Figure 3). ADF and TDN are commonly used to estimate the digestibility of alfalfa and other forages. The NDF content is used to account for the fill factor and estimate forage intake by livestock. The increase in NDF per day was very similar to ADF 0.3 percentage points per day (Figure 4). Crude protein dropped 0.2 percentage points per day (Figure 5).

Forage quality declined at an even more rapid rate on second cutting. The ADF content increased 0.4 percentage points per day on second cutting (21% more rapid decline than first cutting). This increase in ADF equates to a 0.27 percentage point loss in TDN per day delay in second cutting. The NDF content increased 0.38 percentage points per day. The drop in CP on
Figure 2. Daily change in ADF content of alfalfa harvested from pre bud to full bloom for first and second cutting (averaged over two locations, two years, and two varieties). Each tick mark on the x-axis represents one day.

Figure 3. Daily change in TDN content of alfalfa harvested from pre bud to full bloom for first and second cutting (averaged over two locations, two years, and two varieties). Each tick mark on the x-axis represents one day.
Figure 4. Daily change in NDF content of alfalfa harvested from pre bud to full bloom for first and second cutting (averaged over two locations, two years, and two varieties). Each tick mark on the x-axis represents one day.

Figure 5. Daily change in CP content of alfalfa harvested from pre bud to full bloom for first and second cutting (averaged over two locations, two years, and two varieties). Each tick mark on the x-axis represents one day.
second cutting was even more rapid, 0.34 percentage points per day. This decrease in CP is 75% more rapid than the drop that occurs on first cutting.

Growers rarely harvest alfalfa on first or second cutting that has a TDN content greater than 56% (less than 27% ADF) because the yield penalty is generally too great. Or, in the case of first cutting, weather conditions in spring are too variable to chance such an early harvest. The lower limit for dairy-quality alfalfa hay is generally considered to be 54.5% TDN (29% ADF). This is the California standard for ‘Premium’ hay. Therefore, most of the dairy-quality hay on first and second cutting falls between 54.5 and 56% TDN (27-29% ADF).

Narrow Window of Opportunity for Quality Hay

Using the average daily decline in TDN found in these experiments for first cutting, alfalfa goes from 56 to 54.5% TDN in just 7 days. This is not a very large window of opportunity to produce dairy-quality alfalfa. Timeliness of harvest is even more critical on second cutting. The window of opportunity to produce dairy-quality alfalfa hay is even shorter; it takes only 5.5 days to go from 56 to 54.5% TDN. With the equipment and labor constraints many growers have, it can take 3 weeks or longer to harvest. Fortunately, the situation is not quite as bleak as this. The dairy-quality harvest window may only be 7 days for one field. However, individual fields may differ in their maturity due to variety, date of last cutting in the fall (or date of first harvest in the case of second cutting), and the microclimate at a particular field. Therefore, the length of the quality harvest window for an entire ranch may be somewhat longer than a week.

The window of opportunity for dairy-quality alfalfa hay is usually so short that it is impossible for most growers to produce ‘test hay’ from all fields every cutting. Often the alfalfa falls just short of the cut-off value to be classified dairy hay. Just missing the quality window is unfortunate; the grower does not receive the price increase for premium hay yet didn’t benefit from the full yield increase that occurs by delaying cutting. If the hay is going to fall short of dairy quality, it is especially important to maximize yield.

Staggered Harvests

An alternative approach to scheduling the harvest of different fields may help assure growers of producing some dairy-quality hay every cutting. In addition, it will help maximize the yield of some fields and help avoid just missing the dairy-quality cut-off. Growers ordinarily harvest alfalfa fields in a fixed order. The order may be determined by habit, the field’s proximity to the headquarters, dryness of a field, dormancy of the alfalfa variety, or any number of other factors. Typically, fields are harvested in the same sequence for second cutting and each cutting thereafter. Therefore, if the alfalfa in the field cut first does not test dairy quality, it is unlikely that any of the fields cut afterwards will either.

Another approach is to vary the harvest order so that the field cut first on first cutting will not be the first one cut on second cutting. A field that was cut in the middle of the sequence on first cutting may be the first one cut on second cutting (see Figure 6). This helps assure that the
alfalfa in the first fields cut will be immature enough to test dairy quality even in mid summer. The first field in the sequence can be determined by visually estimating the maturity of the alfalfa or by using a technique such as the Intermountain Alfalfa Quality Prediction Stick (see references). Using this altered cutting sequence; fields cut first on first cutting have a longer interval between first and second cutting. These fields will obviously not test dairy quality. The intent is to maximize yield on these fields and give the plants an opportunity to recover from being cut at an immature growth stage on first cutting.

**Cutting Order for First Cutting**

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<td>B</td>
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Fields A, B, C, and D cut for quality

Fields E and F cut for yield

**Cutting Order for Second Cutting**

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Fields D, E, and F cut for quality

Fields A, B, and C cut for yield

**Figure 6. Staggered Harvest Concept.**

Assume a grower has six fields labeled A, B, C, D, E, and F. The fields are harvested in this sequence for first cutting. Because of the time required to cut all fields, the harvest of fields E and F is delayed. By the time the grower harvests these fields, they will have lower quality and higher yield (as indicated by the darker shades of gray). Therefore, for the first harvest the grower would attempt to maximize quality on fields A, B, C, and D and maximize yield on fields E and F.

Rather than staying with the same sequence at the second harvest, the order is interrupted and harvest begins with D, E, and F. These fields would be less mature and are harvested early to maximize quality. If it requires the same time to harvest D, E, and F as in the first cutting, these will each have uniform high quality. Fields A, B, and C will be harvested later and will likely have lower quality but higher yield.

This 'staggered' harvest strategy should enable growers to produce premium quality hay on selected fields, and maximum yield on other fields. This approach has the added benefit of providing at least one long growth period for each field during the year, giving the plants a 'rest' to replenish root reserves to improve vigor and stand persistence.
The order in which to harvest fields on third or subsequent cuttings depends on the weather conditions. If the weather has been cool and it appears that all fields have dairy-quality alfalfa, then cutting order is not that important. The same sequence used on the previous cutting could be used again, giving each field equal growing time. However, if the weather has been hot and it is unlikely all fields will produce dairy-quality alfalfa, the cutting order can be changed from the previous cutting and a more immature field harvested first.

The intent of the staggered cutting approach is to target specific fields for high forage quality and other fields for high yield. The dairy market and high forage quality is the goal for some fields, while maximum yield and the horse or beef cow market is the goal for other fields. The end result of the staggered cutting approach is a relatively constant or predictable supply of ‘test’ and ‘non-test’ hay throughout the season, even during times of the year when it is typically very difficult to produce ‘high-test’ hay.

Growers must carefully weigh the economic consequences of early cutting to be certain the price premium for high-quality hay more than justifies the loss in production. Conversely, it is unwise to delay cutting for maximum yield when the price for dairy hay far exceeds that of ‘non-test’ hay and may be the difference whether the hay sells or sits.

SUMMARY

The yield/quality tradeoff in alfalfa production is unavoidable. As the plants mature, yield increases but quality decreases. The rate of yield increase and quality decrease with advancing alfalfa maturity is faster in mid summer (second cutting) than it is in spring (first cutting). Consequently, the harvest window when growers can produce dairy-quality alfalfa is short at first cut (7 days) but much shorter (5 days) in mid summer. Given the limited harvest window and the time required to harvest all the fields on a hay ranch, it is usually not feasible to produce dairy-quality hay on all fields for all cuttings. The solution is to understand how much yield increases and quality decreases each day in order to select harvest timings that make the most sense economically. It may be best to alter the order in which fields are cut from one cutting to the next. In so doing specific fields and cuttings are targeted for the dairy market while other fields are harvested later to maximize yield and allow the alfalfa plants more time to replenish root reserves.

REFERENCES

