# HARVEST TIMING STRATEGIES FOR IMPROVED PROFIT

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## ABSTRACT

Cutting schedules have a profound impact upon forage quality, yield, price, and economic returns. Field trials have examined changes in yield and quality over time, which assist with harvest decisions within a growth period. These indicate a narrow window of opportunity for obtaining hay of sufficient quality for the dairy market with a satisfactory yield. This is especially true in hot climates and during hot times of year where changes in yield and forage quality occur at a much faster rate than under cooler temperatures. Therefore, it is very difficult to obtain high quality alfalfa at each harvest from all the alfalfa fields on a farm given the length of time it typically takes to harvest alfalfa on an entire farm. A '*staggered'* or mixed strategy that includes harvests for high yield on some fields and harvests for high quality on other fields is suggested for agronomic benefits, to enable growers to harvest at times when returns are highest, and to ensure a more steady supply of both high- and medium-quality hay. While more data is forthcoming, growers should consider the concept of a *staggered* cutting approach (alternating 'Yield' and 'Quality' harvests) on their fields.

**Key Words: Alfalfa, *Medicago sativa*, cutting schedules, forage quality, ADF, TDN, economics, returns**

## INTRODUCTION

Harvest timing for alfalfa is a key question that researchers and growers have pondered for decades. Cutting schedule is perhaps the most profound way that growers can affect both the yield and quality of their product. Despite the attention this topic has received and the number of cutting schedule research trials that have been conducted, it is still very difficult to define the best time to harvest alfalfa for maximum returns.

One reason that decisions on optimum cutting schedules are so difficult is that growers rarely know the exact value of quality verses yield. They usually know that very immature hay is high quality (but low yield), and mature hay is lower quality (and price) with somewhat higher yields, but exactly 'how much' is rarely known. In addition, weather and season has large effects on quality. We have conducted research over the past 8 years examining methods of quantifying the yield quality tradeoff, and its linkage to economic worth. This paper is an update on the strategies that might be considered for whole-season cutting schedules for alfalfa hay.

## THE YIELD/QUALITY TRADEOFF

Cutting alfalfa at an immature growth stage (short interval between cuttings) results in relatively low yield but high forage quality. Conversely, cutting alfalfa at a mature growth stage (long

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interval between cuttings) results in high yield but low forage quality. This is commonly referred to as the yield quality tradeoff and it is an unavoidable reality for the alfalfa producer. Alfalfa harvest timing is especially problematic now because the forage quality expectations in the market place are higher than less than even a decade ago. Many dairy producers demand *Supreme* quality alfalfa hay (ADF < 27%, >56 TDN). However, there is a significant yield penalty associated with producing alfalfa of this high forage quality. The penalty associated with the production of 54.5 ADF hay was not nearly as great as it is with alfalfa of 27 or less ADF. Growers must carefully examine the yield penalty associated with producing such high quality alfalfa to be sure the price increase justifies the yield decrease.

## CHANGES IN YIELD AND QUALITY OVER TIME

Research was conducted over several years and locations (Intermountain Region and the Central Valley of California) to quantify the changes that occur as alfalfa matures. Daily changes in yield and forage quality were recently quantified for distinct alfalfa production areas in California (Ackerly *et al* 2000). Data for all sites and all cuttings clearly demonstrated the existence of the yield quality tradeoff. However, the relationship between yield and quality with advancing maturity differed by location and season of the year. In general, the yield/quality tradeoff was most pronounced under warm environmental conditions (both seasonal and location effects)—yield increased and quality decreased at more rapid rates.

## DEFINING THE MOST PROFITABLE CUTTING SCHEDULE

Numerous factors exist that change from year to year, and even within a season, that make it difficult to determine the most profitable cutting schedule. The price of alfalfa hay varies significantly, as does the price differential between *Supreme* or *Premium* alfalfa hay and the lower forage quality category *Fair* hay. The price differential is often greater in low alfalfa hay price years than it is in higher price years. The price differential depends primarily on the supply and demand for dairy quality alfalfa and the current price for dairy products. Weather conditions, especially temperature and rainfall patterns, vary greatly from year to year and have an enormous effect on both the yield and forage quality of alfalfa hay. Overall temperatures at different times during the growing season affect the amount of alfalfa that meets dairy quality standard. Warmer than normal temperatures during any portion of the growing season often results and a reduced supply of *Supreme* and *Premium* quality alfalfa hay.

Even if all these factors could be predicted, a single “optimum” cutting schedule would not be realistic. With the equipment and labor constraints most growers have, it can take 3 weeks or longer to harvest a cutting from all the fields on the farm. Therefore, even with an “optimum schedule” it may not be possible to employ that cutting schedule on all fields.

## NARROW WINDOW OF OPPORTUNITY FOR QUALITY HAY

The window of opportunity to produce dairy-quality alfalfa is very short. The average daily decline in TDN presented in Ackerly *et al* was 0.22 to 0.5 (0.33 to 0.74 % increase in ADF). This means that TDN drops one point in just 2 to 4.5 days, depending on the area and cutting. Therefore, 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. Oftentimes the alfalfa falls just short of the cut-off value to be classified dairy hay.

Recognizing that alfalfa yield and quality change rapidly as the plant matures, we developed a series of return curves to estimate at which alfalfa growth stage are grower returns optimized. The return curves demonstrated four primary outcomes (Orloff *et al*, 2002). Which one occurs depends on the price differential between high and low forage quality alfalfa hay as well as the growth rate at and daily change in forage quality. Overall, the most prevalent return curve is like the one presented in Figure 1. In this case, revenue is typically highest at two time periods—just before the cut-off for 'dairy quality' hay and then later, during the bloom stage. Harvesting just before the cut-off for 'dairy quality' allows the grower to take advantage of the price premium for 'dairy hay' but not suffer as great a yield penalty as that which would occur if the alfalfa were harvested earlier. Delaying harvest to the bloom stage to aim for high yield also maximized gross returns. The harvest times to avoid are an extremely early harvest—the price premium is rarely sufficient to compensate for the extremely low yield—and, just after the dairy hay quality cut off—the yield has not increased enough to offset the lower price.

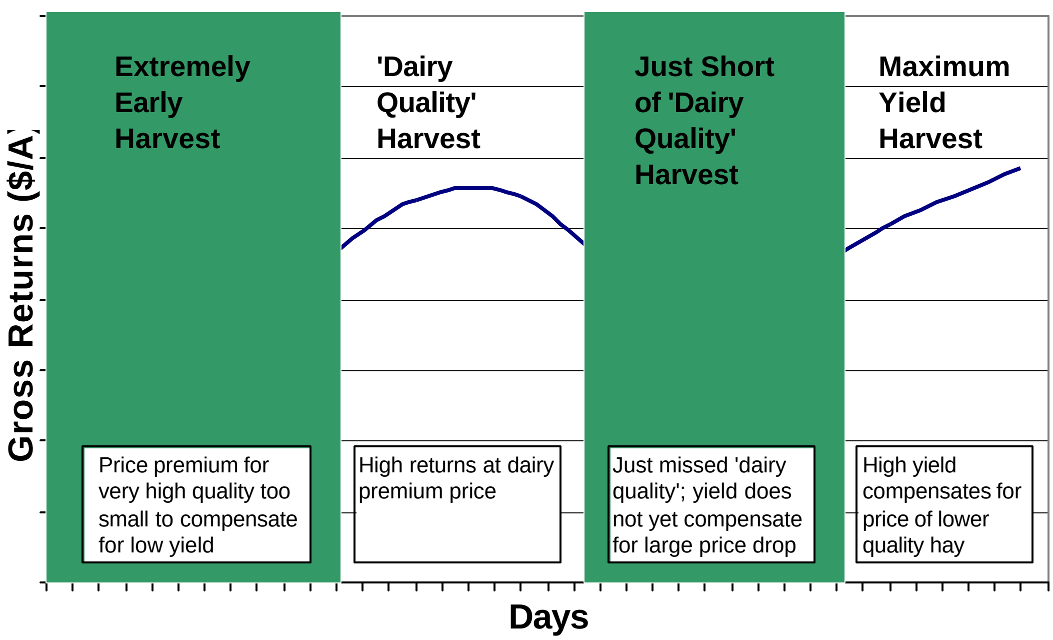


**Figure 1**. Typical gross return curve showing grower gross returns as alfalfa matures from the pre-bud stage to full bloom. The curve indicates two periods of maximum returns, *Dairy Quality Harvest* and *Maximum Yield Harvest*. Time periods to avoid are *Extremely Early Harvest* and *Just Short of 'Dairy Quality" Harvest*.

A harvest management strategy is needed for a whole farm, taking into consideration all the alfalfa fields a grower has. Ideally the harvest management strategy should take advantage of the fact that not all fields can be harvested at once (it commonly takes up to three weeks to harvest a single cutting) and that there are specific harvest timings when returns are optimized and other timings that should be avoided. An attempt should be made to harvest fields at times when returns are highest thus avoiding time periods with low returns.

## HARVEST ORDER –WORTH CHANGING?

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. Usually because of habit more than anything else, fields are harvested in the same sequence for second cutting and each cutting thereafter. We refer to this strategy as a *sequential* approach to harvest management. With a sequential approach, if alfalfa in the first field cut does not test dairy quality, it is very unlikely that any of the fields cut afterwards will either. With this approach it is very easy to just miss 'dairy quality' and end of harvesting much of the alfalfa in one of the least profitable time periods.

An alternative approach to schedule the harvest of different fields may help growers maximize returns by producing most of their hay in the two more profitable time periods and avoid the least profitable periods. This approach, referred to as *staggered* harvests, is to vary the strategy for harvests for each field, to alternate 'Quality' harvests with 'Yield' harvests (Figure 2). One way to accomplish this 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 2). This helps assure that the alfalfa in the first fields cut will be immature enough to test dairy quality even in midsummer. 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.

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 staggered approach could be used on subsequent cuttings or the grower could return to a sequential cutting order. The decision depends on the growing conditions, season of the year, and current market conditions, primarily the price spread between dairy and non-dairy hay.

The intent of the staggered cutting approach is to target specific fields for high forage quality and other fields for high yield, avoiding the least profitable areas in Figure 1. High forage quality for the dairy market and is the goal for some fields, while maximum yield for 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.

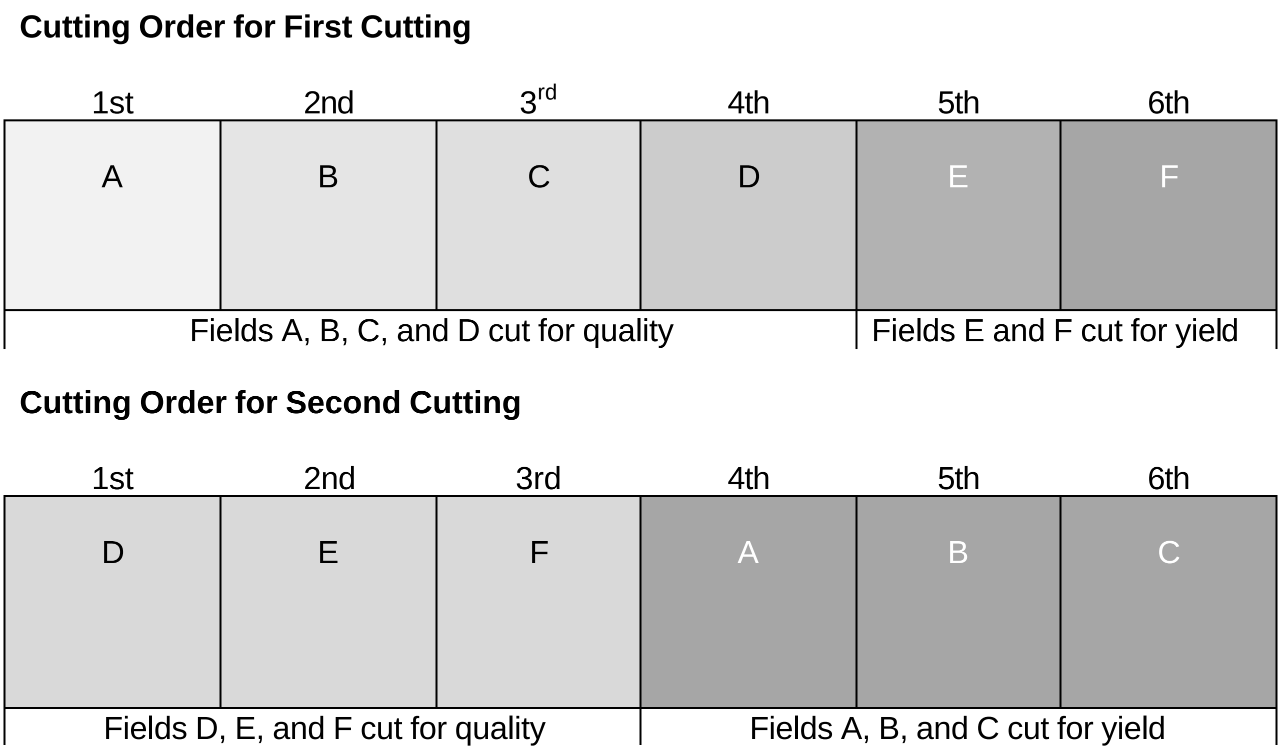


**Figure 2. Staggered Harvest Concept.**

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.

## PRELIMINARY RESULTS FROM ONGOING RESEARCH

### Plot Design and Rationale

Three trials were conducted in the Intermountain Region of Northern California to evaluate different alfalfa cutting schedules and to compare a *sequential* vs. *staggered* cutting strategy. Trials were conducted in 2000 through 2002. Single year trials were conducted with grower cooperators in Tulelake and Butte Valley (Macdoel). Field plots at the UC Intermountain Research and Extension Center (IREC) in Tulelake were harvested in 2001 and 2002 and are scheduled to continue for another year to help determine the carry-over effects of the harvest schedules.

The plots were laid out similar to the design in Figure 2. There were six plots for each harvesting scheme—*sequential* or *staggered* (Table 1). The intent was for each plot to represent a field or the area cut in a single day on a grower's farm. There were 3 to 4 days between cutting dates for each of the plots. Therefore, there were approximately 18 days between the cutting dates for the plot cut first and plot cut last for a single cutting. It was assumed that a grower would not only cut every 3 to 4 days, but would be cutting some field every day in between as well. The purpose then was to emulate a whole farm situation and cover a similar time period that it takes growers to harvest a single cutting from all fields.

**Table 1.** Sample cutting schedule treatments to compare sequential vs. staggered approach to cutting management for a three-cut schedule (a similar design was constructed for a four-cut schedule as well for the trials at IREC).

| Treatments: | | | Cut 1 | | | Cut 2 | | | | Cut 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trt*** | **Strategy** | | **Seq** | **Date** | **Stgy** | **D** | **Seq** | **Date** | **Stgy** | **D** | **Seq** | **Date** | **Stgy** |
| 1 | Sequential | Q-Y-Y | 1 | 06-Jun | Q | 39 | 1 | 15-Jul | Y | 43 | 1 | 27-Aug | Y |
| 2 | Sequential | Q-Y-Y | 2 | 09-Jun | Q | 38 | 2 | 17-Jul | Y | 43 | 2 | 29-Aug | Y |
| 3 | Sequential | Q-Y-Y | 3 | 13-Jun | Q | 39 | 3 | 22-Jul | Y | 43 | 3 | 03-Sep | Y |
| 4 | Sequential | Y-Y-Y | 4 | 17-Jun | Y | 38 | 4 | 25-Jul | Y | 43 | 4 | 06-Sep | Y |
| 5 | Sequential | Y-Y-Y | 5 | 20-Jun | Y | 39 | 5 | 29-Jul | Y | 43 | 5 | 10-Sep | Y |
| 6 | Sequential | Y-Y-Y | 6 | 24-Jun | Y | 38 | 6 | 01-Aug | Y | 43 | 6 | 13-Sep | Y |
| 7 | Staggered | Q-Y-Q | 1 | 06-Jun | Q | 49 | 4 | 25-Jul | Y | 33 | 1 | 27-Aug | Q |
| 8 | Staggered | Q-Y-Q | 2 | 09-Jun | Q | 50 | 5 | 29-Jul | Y | 33 | 2 | 31-Aug | Q |
| 9 | Staggered | Q-Y-Q | 3 | 13-Jun | Q | 49 | 6 | 01-Aug | Y | 33 | 3 | 03-Sep | Q |
| 10 | Staggered | Y-Q-Y | 4 | 17-Jun | Y | 28 | 1 | 15-Jul | Q | 53 | 4 | 06-Sep | Y |
| 11 | Staggered | Y-Q-Y | 5 | 20-Jun | Y | 27 | 2 | 17-Jul | Q | 53 | 5 | 08-Sep | Y |
| 12 | Staggered | Y-Q-Y | 6 | 24-Jun | Y | 28 | 3 | 22-Jul | Q | 53 | 6 | 13-Sep | Y |

*Trt stands for treatment. For the strategy column **Q** stands for a cutting where the goal was to cut early for quality and **Y** signifies when the intent was to maximize yield. The letter '**D**' under the cuttings signifies Days and is the number of days since the last cutting. SEQ stands for sequence and is the order in which the fields are cut.

For the first cutting, all the plots (each representing a 'field') were cut in the same order whether they represented a *sequential* or *staggered* strategy. The difference between the strategies occurred at the second cutting. For the *sequential* approach, the plots were harvested in the exact same order as was used for first cutting. The problem with this approach is that if the first field cut on second cutting does not meet 'dairy quality' each field cut thereafter would fall short of 'dairy quality' as well. Therefore, it is likely that a fair amount of the alfalfa will end up just missing 'dairy quality'—one of the time periods to avoid harvesting.

In contrast, the cutting cycle for second cutting was interrupted in the *staggered* approach. This approach recognizes that it is highly unlikely to produce "dairy quality' on all fields for second cutting. And, for the plots that won't make dairy quality the cutting interval is lengthened and maximum yield becomes the goal. In the field study, the first plot (field) cut on second cutting was the plot cut forth on first cutting (field 'D' in Figure 2). The plot cut next was the one that followed in succession on first cutting. After the last plot cut on first cutting was harvested, the cutting order backed up to cut the plot cut first on first cutting. The progression continued until the last plot was harvested. By jumping ahead in the cutting order for some fields the grower is more assured of producing dairy quality alfalfa on second cutting. (*In this research project plots* *were cut 27 to 28 days after the first cutting—a time interval that produces dairy alfalfa hay in the cooler intermountain area*). The plots cut after that have a long time period to produce maximum yield and to replenish root reserves that are needed for the growth of subsequent cuttings and for winter survival. Hence, plots cuts early on first cutting are given a longer rest period on second cutting.

## PRELIMINARY FINDINGS

### Yield

The results below show the results of one of the trials with the grower cooperator in Tulelake. Results from the other trials are too extensive to include here and will be available at a later date. As was expected, cutting date had a profound effect on alfalfa yield. It is well known that alfalfa yield increases with advancing maturity. For the three-cut schedule yield increased from 2.88 to 3.13 tons/A as harvest was delayed from 6/6 to 6/26. The yield for both the sequential harvest and the staggered harvest treatments were very similar for the first cutting. These treatments were essentially the same up to this point so yield values for the fist cutting should be the same.

Second cutting yields for the three-cut sequential treatments (treatment #'s 1-6) were very similar. They should be similar because the plots were cut in the same order as they were on first cutting so the number of days between cuttings was almost the same. Yield differed significantly within the staggered treatments because, as designed, the first three treatments (treatment #'s 7-9) had approximately 50 days since the last harvest and the second three treatments (treatment #'s 7-9) had only approximately 27 days between harvests. Hence, the yields for the plots with 50 days since the last cutting were 2.72, 3.09, and 3.29, whereas, the yield for the plots with 27 days since the last harvest were significantly less (1.87, 1.67, and 1.77).

Overall, the yield for third cutting of the *sequential* plots showed a gradual decline with the later cutting schedules (i.e. treatments 1, 2 and 3 compared to treatments 4, 5, and 6. Even though each of these plots (simulating a field) had the same number of days to grow between 2$^{nd}$ and 3$^{rd}$ cutting (approximately 43 days), the ones with the later cutting dates yielded less. This is most likely because a day of growth in mid July is not equal to a day of growth in August or September due to differences in photoperiod (day length effects) as well as temperature. For the staggered plots there was little difference between the plots that had 32 days of growth between 2$^{nd}$ and third cutting and those that had approximately 55 days. Here again, additional growing days toward the end of the season does not result in as much growth as occurs with additional growing days in mid-season. All three four-cutting schedules had similar yields throughout the season. The yield per cutting was generally less than with the three-cut schedules.

There were significant differences in total seasonal yield for the different treatments. Interestingly, the *staggered* treatments tended to have both the highest and lowest total yields when compared to the *sequential* three or four cutting schedules. The *staggered* treatments with a long growth period before 2$^{nd}$ cutting had a significantly higher total yield than the treatments with a long growth period before 3$^{rd}$ cutting. This re-emphasizes the point that extra growing time in mid summer results in more growth than extra days in fall.

**Table 2.** The effect of different harvest dates on yield and a comparison of a *sequential* vs. *staggered* approach to cutting management.

| # | Cutting Dates[1] | Strat[2] | Yield Tons/A | | | | |
|---|---|---|---|---|---|---|---|
| | | | Cut 1 | Cut 2 | Cut 3 | Cut 4 | Total |
| 1 | 6/6, 7/15, 8/28 | Seq 3 | 2.88 | 2.32 | 1.79 | – | 6.99 |
| 2 | 6/9, 7/18, 8/31 | Seq 3 | 2.95 | 2.32 | 1.66 | – | 6.92 |
| 3 | 6/13, 7/24, 9/5 | Seq 3 | 2.87 | 2.62 | 1.49 | – | 6.98 |
| 4 | 6/19, 7/27, 9/8 | Seq 3 | 2.87 | 2.38 | 1.17 | – | 6.43 |
| 5 | 6/22, 7/31, 9/12 | Seq 3 | 3.04 | 2.52 | 1.13 | – | 6.69 |
| 6 | 6/26, 8/3, 9/15 | Seq 3 | 3.13 | 2.41 | 1.23 | – | 6.77 |
| 7 | 6/6, 7/27, 8/28 | Stag 3 | 2.90 | 2.72 | 1.50 | – | 7.15 |
| 8 | 6/9, 7/31, 8/31 | Stag 3 | 2.82 | 3.09 | 1.30 | – | 7.21 |
| 9 | 6/13, 8/3, 9/5 | Stag 3 | 2.95 | 3.29 | 1.14 | – | 7.38 |
| 10 | 6/19, 7/15, 9/8 | Stag 3 | 2.98 | 1.87 | 1.50 | – | 6.36 |
| 11 | 6/22, 7/18, 9/12 | Stag 3 | 2.85 | 1.67 | 1.36 | – | 5.88 |
| 12 | 6/26, 7/24, 9/15 | Stag 3 | 3.11 | 1.77 | 1.30 | – | 6.19 |
| 13 | 6/2, 7/3, 8/3, 9/12 | Seq 4 | 2.57 | 2.72 | 1.68 | 0.98 | 6.97 |
| 14 | 6/9, 7/10, 8/9,9/15 | Seq 4 | 2.83 | 2.20 | 1.80 | 1.22 | 6.84 |
| 15 | 6/11, 7/12, 8/11, 9/18 | Seq 4 | 2.81 | 1.88 | 1.92 | 0.91 | 6.82 |
| LSD 0.05 | | | 0.29 | 0.23 | 0.23 | 0.21 | 0.45 |

[1] Cutting dates represent the actual days the plots were cut for the two 3-cut schedules (sequential and staggered cutting order) and for the four cut schedule.

[2] Strategy: indicates whether the plots were cut in sequential order or in a staggered order as shown in Figure 2.

**Forage Quality**

As expected, cutting schedule strategy had a profound effect on forage quality. Forage quality is estimated using Acid Detergent Fiber (ADF), Total Digestible Nutrients (TDN), Neutral Detergent Fiber (NDF), and Crude Protein (CP) (Tables 3-6). ADF represents some of the most difficulty-digested portions of the plant, whereas NDF represents the total Cell Wall (including portions that are digested by ruminants) and is sometimes used to indicate intake potential. TDN is calculated from ADF using the California equation (90%DM). Lower fiber (ADF, NDF) and higher CP and TDN generally indicate superior quality, using a standard hay test.

Delays in harvest in the spring caused higher fiber content (Tables 3 & 5), lower CP and TND content (Tables 4 & 6)—a trend that should not surprise growers. Many of these strategies where cutting is delayed in the spring would cause growers to loose significant crop value under current market conditions during the first cutting, which is often their best chance to obtain dairy quality hay.

The four-cut sequential system provided consistently higher forage quality than most of the four-cut strategies (Tables 3-6). ADF and NDF values were lower, and TDN and CP values were higher during those cuts compared with most of the three-cut strategies. While forage quality of the four-cut *staggered* strategy was in all cases superior to the three-cut *staggered* strategy (especially during cut 2), this was not always the case for the *staggered* cutting schedules—several of these treatments had reasonably high quality during first, second, and third cutting, though not generally equal to those of the four-cut strategies.

**Table 3.** The effect of different harvest dates on Acid Detergent Fiber (ADF) and a comparison of a *sequential* vs. *staggered* approach to cutting management.

| # | Cutting Dates[1] | Strat[2] | ADF % | | | |
|---|---|---|---|---|---|---|
| | | | Cut 1 | Cut 2 | Cut 3 | Cut 4 |
| 1 | 6/6, 7/15, 8/28 | Seq 3 | 26.1 | 31.8 | 30.4 | – |
| 2 | 6/9, 7/18, 8/31 | Seq 3 | 25.0 | 31.5 | 29.8 | – |
| 3 | 6/13, 7/24, 9/5 | Seq 3 | 26.1 | 31.1 | 26.3 | – |
| 4 | 6/19, 7/27, 9/8 | Seq 3 | 30.1 | 32.0 | 27.6 | – |
| 5 | 6/22, 7/31, 9/12 | Seq 3 | 29.5 | 31.9 | 24.8 | – |
| 6 | 6/26, 8/3, 9/15 | Seq 3 | 30.1 | 29.3 | 23.8 | – |
| 7 | 6/6, 7/27, 8/28 | Stag 3 | 25.5 | 32.4 | 26.3 | – |
| 8 | 6/9, 7/31, 8/31 | Stag 3 | 25.6 | 32.4 | 25.1 | – |
| 9 | 6/13, 8/3, 9/5 | Stag 3 | 27.1 | 30.5 | 24.1 | – |
| 10 | 6/19, 7/15, 9/8 | Stag 3 | 28.9 | 27.4 | 28.6 | – |
| 11 | 6/22, 7/18, 9/12 | Stag 3 | 29.9 | 26.9 | 27.1 | – |
| 12 | 6/26, 7/24, 9/15 | Stag 3 | 29.1 | 27.8 | 26.2 | – |
| 13 | 6/2, 7/3, 8/3, 9/12 | Seq 4 | 25.2 | 29.5 | 27.2 | 24.0 |
| 14 | 6/9, 7/10, 8/9,9/15 | Seq 4 | 24.9 | 26.6 | 27.4 | 22.4 |
| 15 | 6/11, 7/12, 8/11, 9/18 | Seq 4 | 26.2 | 27.3 | 27.3 | 23.7 |
| LSD 0.05 | | | 1.7 | 2.1 | 2.2 | NS |

[1] Cutting dates represent the actual days the plots were cut for the two 3-cut schedules (sequential and staggered cutting order) and for the four cut schedule.

[2] Strategy: indicates whether the plots were cut in sequential order or in a staggered order as shown in Figure 2.

**Table 4.** The effect of different harvest dates on Total Digestible Nutrients (TDN) and a comparison of a *sequential* vs. *staggered* approach to cutting management.

| # | Cutting Dates[1] | Strat[2] | TDN % | | | |
|---|---|---|---|---|---|---|
| | | | Cut 1 | Cut 2 | Cut 3 | Cut 4 |
| 1 | 6/6, 7/15, 8/28 | Seq 3 | 56.5 | 52.6 | 53.6 | – |
| 2 | 6/9, 7/18, 8/31 | Seq 3 | 57.2 | 52.8 | 54.0 | – |
| 3 | 6/13, 7/24, 9/5 | Seq 3 | 56.5 | 53.1 | 56.4 | – |
| 4 | 6/19, 7/27, 9/8 | Seq 3 | 53.8 | 52.5 | 55.5 | – |
| 5 | 6/22, 7/31, 9/12 | Seq 3 | 54.2 | 52.6 | 57.4 | – |
| 6 | 6/26, 8/3, 9/15 | Seq 3 | 53.8 | 54.3 | 58.0 | – |
| 7 | 6/6, 7/27, 8/28 | Stag 3 | 56.9 | 52.2 | 56.4 | – |
| 8 | 6/9, 7/31, 8/31 | Stag 3 | 56.8 | 52.2 | 57.2 | – |
| 9 | 6/13, 8/3, 9/5 | Stag 3 | 55.8 | 53.5 | 57.8 | – |
| 10 | 6/19, 7/15, 9/8 | Stag 3 | 54.6 | 55.6 | 54.8 | – |
| 11 | 6/22, 7/18, 9/12 | Stag 3 | 53.9 | 55.9 | 55.8 | – |
| 12 | 6/26, 7/24, 9/15 | Stag 3 | 54.5 | 55.3 | 56.4 | – |
| 13 | 6/2, 7/3, 8/3, 9/12 | Seq 4 | 57.1 | 54.2 | 55.7 | 57.9 |
| 14 | 6/9, 7/10, 8/9,9/15 | Seq 4 | 57.3 | 56.2 | 55.6 | 59.0 |
| 15 | 6/11, 7/12, 8/11, 9/18 | Seq 4 | 56.4 | 55.7 | 55.7 | 58.1 |
| LSD 0.05 | | | 1.1 | 1.4 | 1.5 | NS |

[1] Cutting dates represent the actual days the plots were cut for the two 3-cut schedules (sequential and staggered cutting order) and for the four cut schedule.

[2] Strategy: indicates whether the plots were cut in sequential order or in a staggered order as shown in Figure 2.

**Table 5.** The effect of different harvest dates on Neutral Detergent Fiber (NDF) and a comparison of a *sequential* vs. *staggered* approach to cutting management.

| # | Cutting Dates[1] | Strat[2] | NDF % | | | |
|---|---|---|---|---|---|---|
| | | | Cut 1 | Cut 2 | Cut 3 | Cut 4 |
| 1 | 6/6, 7/15, 8/28 | Seq 3 | 33.1 | 37.9 | 36.9 | – |
| 2 | 6/9, 7/18, 8/31 | Seq 3 | 32.4 | 37.3 | 36.6 | – |
| 3 | 6/13, 7/24, 9/5 | Seq 3 | 33.7 | 37.3 | 32.8 | – |
| 4 | 6/19, 7/27, 9/8 | Seq 3 | 37.8 | 37.7 | 34.4 | – |
| 5 | 6/22, 7/31, 9/12 | Seq 3 | 37.1 | 37.6 | 32.1 | – |
| 6 | 6/26, 8/3, 9/15 | Seq 3 | 37.6 | 35.3 | 30.1 | – |
| 7 | 6/6, 7/27, 8/28 | Stag 3 | 33.0 | 38.4 | 32.3 | – |
| 8 | 6/9, 7/31, 8/31 | Stag 3 | 33.3 | 38.9 | 31.0 | – |
| 9 | 6/13, 8/3, 9/5 | Stag 3 | 34.8 | 37.2 | 30.0 | – |
| 10 | 6/19, 7/15, 9/8 | Stag 3 | 36.5 | 32.6 | 36.3 | – |
| 11 | 6/22, 7/18, 9/12 | Stag 3 | 37.8 | 32.8 | 34.9 | – |
| 12 | 6/26, 7/24, 9/15 | Stag 3 | 36.7 | 33.3 | 33.7 | – |
| 13 | 6/2, 7/3, 8/3, 9/12 | Seq 4 | 32.1 | 34.8 | 32.6 | 30.9 |
| 14 | 6/9, 7/10, 8/9,9/15 | Seq 4 | 32.5 | 31.4 | 33.5 | 28.5 |
| 15 | 6/11, 7/12, 8/11, 9/18 | Seq 4 | 34.0 | 32.7 | 33.4 | 30.3 |
| LSD 0.05 | | | 1.6 | 2.2 | 2.2 | NS |

[1] Cutting dates represent the actual days the plots were cut for the two 3-cut schedules (sequential and staggered cutting order) and for the four cut schedule.

[2] Strategy: indicates whether the plots were cut in sequential order or in a staggered order as shown in Figure 2.

**Table 6.** The effect of different harvest dates on Crude Protein (CP) and a comparison of a *sequential* vs. *staggered* approach to cutting management.

| # | Cutting Dates[1] | Strat[2] | CP % | | | |
|---|---|---|---|---|---|---|
| | | | Cut 1 | Cut 2 | Cut 3 | Cut 4 |
| 1 | 6/6, 7/15, 8/28 | Seq 3 | 21.8 | 20.0 | 20.1 | – |
| 2 | 6/9, 7/18, 8/31 | Seq 3 | 22.5 | 20.3 | 19.9 | – |
| 3 | 6/13, 7/24, 9/5 | Seq 3 | 21.3 | 19.9 | 23.3 | – |
| 4 | 6/19, 7/27, 9/8 | Seq 3 | 19.2 | 20.2 | 21.8 | – |
| 5 | 6/22, 7/31, 9/12 | Seq 3 | 19.3 | 20.2 | 22.4 | – |
| 6 | 6/26, 8/3, 9/15 | Seq 3 | 19.1 | 21.4 | 23.8 | – |
| 7 | 6/6, 7/27, 8/28 | Stag 3 | 22.0 | 19.3 | 23.4 | – |
| 8 | 6/9, 7/31, 8/31 | Stag 3 | 22.5 | 18.5 | 24.4 | – |
| 9 | 6/13, 8/3, 9/5 | Stag 3 | 20.4 | 18.9 | 26.2 | – |
| 10 | 6/19, 7/15, 9/8 | Stag 3 | 19.5 | 23.6 | 20.6 | – |
| 11 | 6/22, 7/18, 9/12 | Stag 3 | 18.8 | 24.1 | 20.1 | – |
| 12 | 6/26, 7/24, 9/15 | Stag 3 | 19.1 | 23.8 | 21.1 | – |
| 13 | 6/2, 7/3, 8/3, 9/12 | Seq 4 | 23.0 | 21.7 | 23.8 | 22.7 |
| 14 | 6/9, 7/10, 8/9,9/15 | Seq 4 | 22.6 | 24.7 | 23.3 | 25.0 |
| 15 | 6/11, 7/12, 8/11, 9/18 | Seq 4 | 21.1 | 24.3 | 23.3 | 24.8 |
| LSD 0.05 | | | 1.0 | 1.3 | 1.5 | NS |

[1] Cutting dates represent the actual days the plots were cut for the two 3-cut schedules (sequential and staggered cutting order) and for the four cut schedule.

[2] Strategy: indicates whether the plots were cut in sequential order or in a staggered order as shown in Figure 2.

## SELECTING A HARVEST STRATEGY FOR COMMERCIAL FIELDS

Total yield and forage quality for the four-cut schedules appear very favorable (Tables 2-6). A logical question might be why not cut four times on all fields? One compelling reason not to cut four times on all fields is the extra harvest cost associated with an extra cutting. Also, to achieve four cuttings it was necessary to start cutting earlier and end later. This makes those fields more vulnerable to rain damage. In addition, with relatively short growing season (like that in most of the Intermountain Region) there is simply not enough time to harvest four cuttings on all fields. A mixture of three and four cuttings on the farm for different fields may be a viable option. For example, cut approximately half the farm on a four cut schedule (treatments 13-15) and select the most profitable three-cut schedules for the rest of the farm as long as the harvest dates do not conflict.

These data also suggest that there is merit to a *staggered* cutting approach. Using the *staggered* cutting sequence, 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 2). This helps assure that the alfalfa in the first fields cut will be immature enough to test dairy quality even in midsummer. 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.

The *staggered* approach to the cutting order of fields adds another degree of sophistication to alfalfa harvest management. It better enables growers to take advantage of the behavior of the alfalfa market and harvest primarily at times when returns are greatest. In the trial presented in the tables, there were only six fields to represent an entire ranch. However, there were several days between cuttings assuming that commercial growers would cut nearly every day so the total number of fields that this study can represent is greater than six. A commercial alfalfa farmer would have greater flexibility to implement this approach with multiple fields than what we had in this study with only six plots (fields). One could use a technique such as the UC Intermountain Alfalfa Prediction Stick (Orloff and Putnam 2001) to predict when to start cutting and with which field to begin the harvest cycle. There is nothing magic about starting with a field in the middle of the cutting sequence. Start with a field in the sequence that is predicting to be just above the dairy quality designation.

The staggered approach could be used on subsequent cuttings in addition to the second cutting or the grower could return to a sequential cutting order—the same order used on the previous cutting. The decision depends on the growing conditions, season of the year, and current market conditions, primarily the price spread between dairy and non-dairy hay.

Again, the intent of the staggered cutting approach is to target specific fields for high forage quality and other fields for high yield, avoiding the least profitable areas in Figure 1. High forage quality for the dairy market is the goal for some fields, while maximum yield for 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. While the next step for these data is to apply economic criteria (including the cost/benefits of additional harvests for four cuts vs. three and a comparison of the *staggered* vs. *sequential* approach taking into consideration the volume of the differing qualities); these data provide some interesting insights into the relative productivity and quality of different harvest strategies.

## SUMMARY

Even if an optimum cutting schedule to maximize returns could be developed, it would not be possible to apply the "optimum" harvest schedule to all fields given the length of time required to harvest the number of alfalfa fields most growers have. For most growers in the intermountain area it typically requires at least 15 to 25 days to harvest all fields for a cutting. During that time period alfalfa yield and quality change significantly. A staggered cutting strategy to alternate *Quality* harvests with *Yield* harvests may have merit to maximize returns and to avoid harvesting at times when returns are lowest. It allows for a more predictable supply of "dairy quality" alfalfa and high-yield alfalfa. Alternating *Quality* and *Yield* harvests provides plants a longer interval cutting between dairy harvests. This longer period when the strategy is to aim for yield rather than quality gives the plants a "resting" period and an opportunity to build up root reserves. Additional data are forthcoming, but preliminary analysis indicates that a *staggered* approach may be a viable harvest management strategy for growers to consider.

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