CUTTING SCHEDULE STRATEGIES TO MAXIMIZE RETURNS

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ABSTRACT

Unfortunately, yield and quality are generally inversely related. This presents a real dilemma for growers who seek to maximize both yield and quality. Frequent cutting to produce high-quality hay results in low yield, whereas, a long interval between cuts increases yield but quality is reduced. The best cutting strategy ("go for yield" or "go for quality") to maximize returns is often not readily apparent. Research was conducted in the Intermountain area and the Sacramento Valley of California to evaluate the economics of different cutting schemes. The objective was to identify cutting strategies such as cutting order, number of cuttings per season and variety selection to maximize returns. A 'Staggered' cutting schedule strategy, which targets some harvests for quality and others for yield and improved stand life, may be an effective approach. The number of 'dairy-quality' cuttings was increased using a staggered cutting order. Using this strategy, fields are given 'rest' periods, which benefit the health of the root and crown, and therefore may improve stand persistence. Producing a more dormant variety on some fields is an alternative strategy to produce high quality provided the yield penalty associated with the more dormant variety is not too great. Cutting schedule studies at UC Davis showed that a 28 day schedule did not produce the highest returns; returns were higher with either a late (34 day) or early (23 day) schedule, depending upon year. We suggest that no single strategy (e.g. cutting only for yield or only for quality) is optimal, but mixed strategies which assure a supply of both high and medium quality hay may be reasonable and sustain crop production and profitability over time.

Key Words: Alfalfa, *Medicago sativa*, harvest management, cutting schedules, forage quality, varieties, economics, ADF, NDF CP

Producing high quality alfalfa has always been a concern for the alfalfa grower, but it has never been as important as it has become over the last decade. The price premium for dairy quality hay has increased dramatically. A *Supreme* quality hay designation was even created in 1999 to reflect the dairy industry's demand for even higher quality alfalfa. In fact, forage quality is so important that alfalfa hay is rarely sold for milking cows in the West without a laboratory analysis first to assess its feeding value. This creates tremendous pressure for the alfalfa grower to produce top quality alfalfa hay.

HARVEST TIMING EFFECTS

Few things have as profound an influence on the profitability of an alfalfa farm as the cutting schedule. The maturity at which the alfalfa is cut is the most powerful tool under the grower's

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control to determine both yield and quality. Unfortunately, a fundamental reality of alfalfa production is that yield and quality are inversely related. As yield increases quality almost always decreases and visa versa. Alfalfa cut at immature growth stages (i.e., pre-bud or early bud) has high forage quality but yield suffers. Conversely, alfalfa cut in the bloom stage is higher yielding but lower forage quality—typically too low to meet dairy-quality standards for milking cows. This phenomenon is often referred to as the yield/quality tradeoff. There is a linear **increase** in yield as alfalfa matures from pre-bud to late bloom growth stages while there is a linear **decrease** in forage quality over the same time period.

Further complicating the cutting management decision is the effect of cutting frequency on alfalfa vigor and ultimately stand persistence. Repeatedly cutting alfalfa at immature growth stages lowers the carbohydrate root reserves of the plant, reducing plant vigor and eventually reducing stand. Allowing a longer interval or "rest period" between cuttings provides more time for the plant to replenish root reserves. Maximum returns requires a difficult balancing act weighing the benefits of early cutting for forage quality against the negative effects of early cutting on total yield and stand persistence

DEVELOPING A HARVEST STRATEGY

A fundamental question alfalfa growers continually wrestle with relates to which harvest strategy is best. *Is it more profitable to harvest early for high quality even though yield will suffer? Or, does the increased yield acquired by delaying harvest more than compensate for any drop in price that occurs for lower quality hay?* Which strategy is best is complex and depends on numerous market and biological factors. The difference in price between top-quality alfalfa hay (*Supreme* and *Premium*) and lower quality hay varies considerably from year-to-year depending largely on demand and the relative abundance or scarcity of high-quality hay. The price differential is often greater in low alfalfa hay price years than it is in higher price years. The price is also influenced by current price for dairy products.

The ease of producing dairy-quality hay varies over the season and from year-to-year depending on weather conditions. It is far easier to produce high-quality alfalfa in spring and fall when the alfalfa growth rate and the rate of lignification are slower. Therefore, the cutting schedule should be flexible in order to respond to fluctuations in both the alfalfa market and weather. The alfalfa variety and its fall dormancy characteristics also affects growth rate and the cutting schedule required to produce top quality alfalfa.

Developing the most profitable cutting schedule requires a thorough understanding of these factors. However, even if it was possible to integrate all these factors and develop an "optimum" cutting schedule, the reality is that growers could not implement it across their farm simply because of the number of days required to cut all their fields. Due to equipment and labor constraints, it often takes as long as 3 weeks to cut all the fields on a farm. Therefore, the fields cut first in the sequence will likely produce dairy-quality hay, while those cut last often do not.

INFLUENCE OF FORAGE QUALITY ON PRICE

Unlike other areas of the country, most of the alfalfa hay in the West is grown as a cash crop and marketed off-farm. The price is largely based on its expected nutritional value as determined through laboratory testing to assess its Total Digestible Nutrients (TDN), acid detergent fiber (ADF) or Relative Feed Value (RFV). A typical relationship between price and forage quality (ADF) in the West is depicted in Figure 1. There are three distinct segments to the price curve: At the high quality end of the curve **(A),** price does not increase much when ADF values fall below 27 percent (TDN values increases over 56%). In the mid-range **(B)** there is a precipitous drop in price. This is characteristic of the commonly observed 'dairy hay' cutoff perceived by the market. At the lower-quality end of the curve **(C)** there is little drop in price associated with each change in ADF.

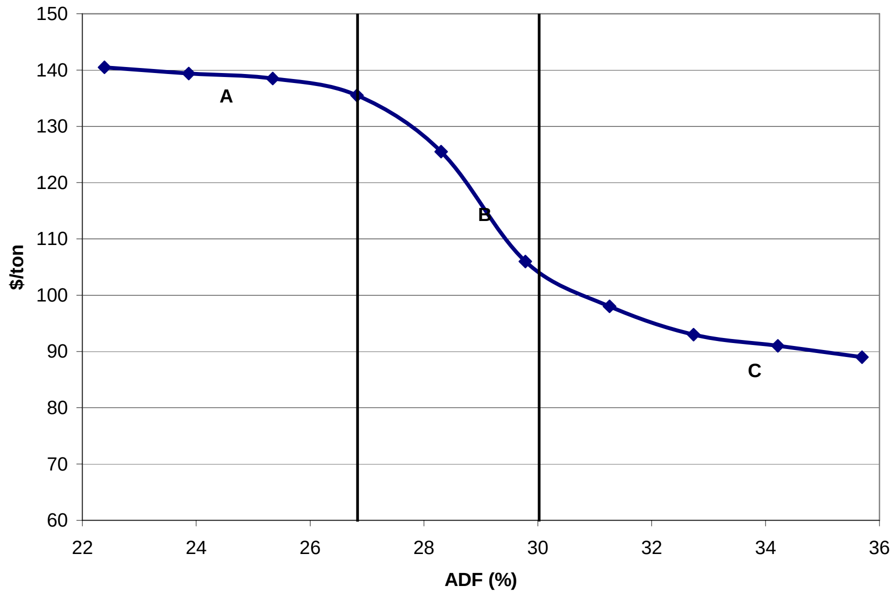

Figure 1. Typical relationship between price and forage quality (ADF) in the West with three distinct phases. There is little change in price at the highest quality end of the curve **(A)** where ADF is below 27 percent. Price falls dramatically in the center portion **(B)** at the perceived "dairy quality" cutoff where ADF increases from 27 to 30 percent. At the low end of the curve most of the hay is not sold based on it chemical analysis and other factors such as weediness or visual appearance become more important than chemical analysis.

Gross returns for a cutting are the expected yield multiplied by the price for the anticipated quality of hay. Figure 2 shows the hypothetical returns as alfalfa matures from pre-bud to full bloom. 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 high quality alfalfa (just before the cut-off for 'dairy quality') allows the grower to take full advantage of the price premium for 'dairy hay' at a higher yield than that which would occur with an extremely early harvest. Delaying harvest until the bloom stage to aim for high yield also produces higher gross returns. The harvest times to avoid are: 1) an extremely early harvest (the price premium for such high quality alfalfa is insufficient to compensate for the very low yield) and; 2) just after the "dairy quality" cut off where price drops off precipitously yet yield has not increased enough to offset the lower price.

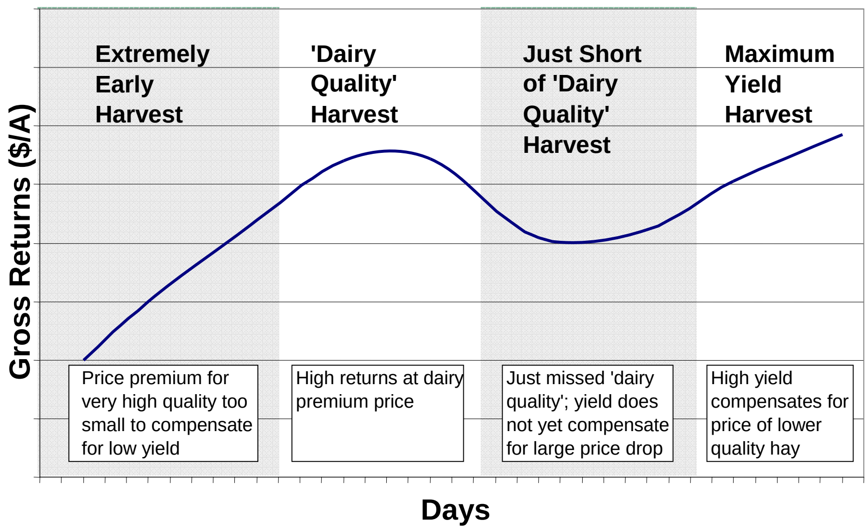

Figure 2. Typical gross return curve showing grower gross returns as alfalfa matures from the pre-bud stage to full bloom. The curve indicates two periods of maximum returns, *Dairy Quality Harvest* and *Maximum Yield Harvest*. Time periods to avoid are *Extremely Early Harvest* and *Just Short of 'Dairy Quality' Harvest*.

Growers need a harvest scheme that takes into account the whole farm and all the different fields. Ideally, the harvest management strategy should allow for 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 specific harvest timings are more profitable than others. An attempt should be made to harvest fields when returns are highest thus avoiding time periods with low returns.

CHANGING HARVEST ORDER

Most growers do not give much thought to the order in which they harvest different fields. Habit, the field's proximity to the headquarters, or the dryness of a field typically determines the harvest order. Once an order is established, the same harvest sequence is followed for each subsequent cutting. This strategy is referred to as a *sequential* approach to harvest management. With this approach, if the first field harvested is not dairy quality, it is likely that none of the subsequently cut fields will either. It is very easy to just miss producing 'dairy quality' and end up harvesting much of the alfalfa in one of the least profitable time periods.

An alternative strategy referred to as a *staggered* approach has been previously introduced at this conference. The intent of this approach is for growers to maximize returns by producing most of their hay in the more profitable time periods (right at dairy quality hay and for top yield) and avoid the least profitable periods. With the staggered strategy the cutting sequence is interrupted so that '*Quality*' harvests are alternated with '*Yield*' harvests (Figure 3). 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 3). This helps ensure 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 providing time for the plants to replenish root reserves for improved vigor and stand persistence. 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. 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 more 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.

Cutting Order for First Cutting

1st	2nd	3rd	4th	5th	6th
A	B	C	D	E	F
Fields A, B, C, and D cut for quality				Fields E and F cut for yield	

Cutting Order for Second Cutting

1st	2nd	3rd	4th	5th	6th
D	E	F	A	B	C
Fields D, E, and F cut for quality			Fields A, B, and C cut for yield		

Figure 3. 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.

SUMMARY OF FIELD TRIAL RESULTS ON CUTTING ORDER

The economic viability of the staggered cutting strategy was compared with the sequential approach in a series of trials in the Intermountain Region. Single-year trials were conducted with grower cooperators in Tulelake and Butte Valley (Macdoel). Another trial was conducted at the Intermountain Research and Extension Center (IREC) where staggered and sequential treatments were assessed for 3 consecutive years. The Intermountain Region is a three- to four-cut area with three cuttings being most common.

Intermountain Experiments. The plots were laid out similar to the design in Figure 3. Six treatments (6 plots with 4 replications) were used to designate a farm. The six plots were cut in either a sequential or staggered order. 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 just 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.

The sequential plots were cut in the same chronological order at each cutting. For the staggered plots, the order was altered so that the plot cut 4th on first cutting was cut 1st on second cutting, the plot cut 5th on first cutting was cut 2nd on second cutting, and the plot cut 6th on first cutting was cut 3rd on second cutting (Table 1). The order for second cutting then continued with the plots cut 1st, 2nd, and 3rd on first cutting. Using this approach, the first three plots cut were relatively immature for high quality and the others had a longer growing period for maximum yield. The cutting order for third cutting returned to the same order as was used for first cutting.

There were three 4-cut treatments in the plots conducted with grower cooperators. The intent of the four-cut treatments was to compare the yield from three- and four-cut schedules with the thought that a grower could have a combination of three and four cuttings on a farm. The trial at IREC had a complete set of both three-cut and four-cut staggered and sequential treatments. After the treatments were imposed for 3 years (3^{rd}-year data not shown), a single uniform harvest was made on the same date the following year to evaluate any carry-over effect from the treatments.

Effects on Yield. There were significant differences in yield between the different harvest dates. The purpose of this research was not to identify the optimum cutting dates, but rather to compare sequential and staggered cutting regimes and, secondarily, to compare three versus four cuts. The total yield for the season was very similar for the sequential and staggered treatments (Tables 1 and 2). This suggests that the yield on a farm would be very similar whether the fields were cut in a sequential or staggered order. The largest difference in yield occurred at the second cutting for the 3-cut schedules and the middle cuttings for a 4-cut schedule (yield data for each cutting not shown). As expected, the plots cut at a short interval (cut for quality) using the staggered approach had the lowest yield. Whereas, the long-interval staggered plots (cut for yield) had the highest yield. These plots balanced each other so that averaged over all the plots (or simulated fields) the total yield for the sequential and staggered systems were very similar.

Whether the 3- or 4-cut system yielded higher varied depending on the year and the location. This is consistent with experience in the Intermountain Region. Most growers only cut three times per year, but there are years when four cuttings would be preferable. However, in many areas because of the short growing season it is not possible to make four cuts on all fields. A reasonable approach may be to take four cuts on some fields and three cuts on others.

There were significant differences in yield between treatments for the uniform first cutting harvest made on the same date in the 4th year. This suggests that the cutting schedule treatments impacted carbohydrate root reserves and alfalfa vigor. The 3-cut schedules yielded higher than the 4-cut schedules, indicating that after 3 years of frequent cutting, the 4-cut schedules had reduced alfalfa vigor. The average yield for the 3-cut sequential and 3-cut staggered fields were essentially identical. Similarly, the average yield for the 4-cut sequential and the 4-cut staggered were also the same. This suggests that if alfalfa is cut at short intervals—like what occurred in the 3-cut and 4-cut staggered strategies—the plants rebound provided there is a longer growth period before the subsequent cutting.

Table 1. The effect of different harvest dates on yield comparing a *sequential* vs. *staggered* approach to cutting management. Trials conducted with grower cooperators in 2000 and 2001.

Tulelake Grower 2000	
Cutting Dates	**Total Yield**
6/6, 7/15, 8/28	6.99
6/9, 7/18, 8/31	6.92
6/13, 7/24, 9/5	6.98
6/19, 7/27, 9/8	6.43
6/22, 7/31, 9/12	6.69
6/26, 8/3, 9/15	6.77
Average Sequential	**6.80**
6/6, 7/27, 8/28	7.15
6/9, 7/31, 8/31	7.21
6/13, 8/3, 9/5	7.38
6/19, 7/15, 9/8	6.36
6/22, 7/18, 9/12	5.88
6/26, 7/24, 9/15	6.19
Average Stagger	**6.70**
6/2, 7/3, 8/3, 9/12	7.95
6/9, 7/10, 8/9,9/15	8.05
6/11, 7/12, 8/11, 9/18	7.52
Ave. 4-cut Seq.	**7.84**
LSD .05	**0.45**

Butte Valley Grower 2001	
Cutting Dates	**Total Yield**
6/5, 7/13, 8/28	5.12
6/8, 7/17, 8/31	5.49
6/12, 7/20, 9/4	5.89
6/15, 7/24, 9/7	6.09
6/20, 7/27, 9/11	5.65
6/22, 7/31, 9/16	5.96
Average Sequential	**5.70**
6/5, 7/24, 8/28	5.50
6/8, 7/27, 8/31	5.96
6/12, 7/31, 9/4	6.34
6/15, 7/13, 9/7	5.86
6/20, 7/17, 9/11	5.88
6/22, 7/20, 9/16	5.38
Average Stagger	**5.82**
6/1, 7/3, 8/3, 9/11	4.86
6/5, 7/6, 8/8, 9/16	5.05
6/8, 7/10, 8/10, 9/18	5.20
Ave. 4-cut Seq.	**5.04**
LSD .05	**0.49**

Table 2. The effect of different harvest dates on yield comparing a *sequential* vs. *staggered* approach to cutting management for three and four cuttings per season. Trials conducted at IREC, Tulelake, CA., 2001, 2002, and 2004.

IREC 2001	
Cutting Dates	**Total Yield**
6/5, 7/13, 8/28	7.32
6/8, 7/17, 8/31	7.41
6/12, 7/20, 9/4	7.92
6/15, 7/24, 9/7	8.03
6/19, 7/27, 9/11	8.48
6/22, 7/31, 9/16	8.48
Average Sequential	**7.94**
6/5, 7/24, 8/28	7.43
6/8, 7/27, 8/31	7.82
6/12, 7/31, 9/4	8.27
6/15, 7/13, 9/7	7.70
6/19, 7/17, 9/11	7.71
6/22, 7/20, 9/16	7.78
Average Stagger	**7.79**
5/25, 6/26, 7/27, 8/31	6.74
5/29, 6/29, 7/31, 9/4	7.13
6/1, 7/3, 8/3, 9/7	6.96
6/5, 7/6, 8/7, 9/11	7.37
6/8, 7/10, 8/10, 9/16	7.35
6/12, 7/13, 8/14, 9/18	7.54
Average Sequential	**7.18**
5/25, 7/6, 7/27, 8/31	6.47
5/29, 7/10, 7/31, 9/4	6.92
6/1, 7/13, 8/3, 9/7	7.08
6/5, 6/26, 8/7, 9/11	7.35
6/8, 6/29, 8/10, 9/16	7.47
6/12, 7/3, 8/14, 9/18	7.58
Average Stagger	**7.15**
LSD .05	**0.37**

IREC 2002	
Cutting Dates	**Total Yield**
6/7, 7/12, 8/27	7.05
6/11, 7/16, 8/30	7.72
6/14, 7/19, 9/3	7.59
6/18, 7/23, 9/6	7.54
6/21, 7/26, 9/10	7.88
6/25, 7/30, 9/13	8.18
Average Sequential	**7.66**
6/5, 7/23, 8/27	7.66
6/8, 7/26, 8/30	7.33
6/12, 7/30, 9/3	8.05
6/15, 7/12, 9/6	7.39
6/19, 7/16, 9/10	7.60
6/22, 7/19, 9/13	7.87
Average Stagger	**7.65**
5/31, 7/2, 8/2, 9/6	6.51
6/4, 7/5, 8/6, 9/10	6.72
6/7, 7/9, 8/9, 9/13	7.23
6/11, 7/12, 8/13, 9/17	7.18
6/14, 7/16, 8/16, 9/20	7.38
6/18, 7/19, 8/20, 9/24	7.88
Average Sequential	**7.15**
5/31, 7/12, 8/2, 9/6	6.82
6/4, 7/16, 8/6, 9/10	7.11
6/7, 7/19, 8/9, 9/13	7.33
6/11, 7/2, 8/13, 9/17	7.67
6/14, 7/5, 8/16, 9/20	7.92
6/18, 7/9, 8/20, 9/24	8.08
Average Stagger	**7.49**
LSD .05	**0.59**

IREC 2004
Single Harvest on 6/1/04
3.35
3.22
3.16
3.05
3.46
3.03
3.21
3.13
3.29
3.06
3.19
3.26
3.09
3.17
3.03
2.90
2.82
2.61
2.86
2.81
2.84
2.82
2.97
2.84
2.71
2.91
2.96
2.87
0.27

Effect on Forage Quality. The cutting schedule strategy had a profound effect on forage quality. Forage quality was evaluated using Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), and Crude Protein (CP), but only the ADF values are presented here because ADF is the analysis that determines the hay marketing designations in California.

There were large differences in forage quality between cutting dates and between cuttings. Much more dairy quality hay (*Supreme* or *Premium*) was produced some years than others. For example, far more dairy quality hay was produced in the 2002 plots at IREC than in 2001 even though the cutting dates started a couple of days later. This emphasizes the importance of cutting based on growth stage rather than calendar date.

Which Strategy was best? The most important finding of this research was that the staggered cutting management approach for a 3-cut system resulted in more cuttings that tested dairy quality than the conventional sequential approach in every one of the trials regardless of year or location (Tables 3–6). The greatest difference occurred in the second cutting. Rarely was any "dairy quality" hay produced on second cutting with a sequential harvest system, and when there was it was only *Premium* quality not *Supreme*. Either none or one out of the six treatments produced *Premium* hay on second cutting for the sequential treatment. In contrast, three of the six treatments in the staggered system (those cut on a short interval earmarked for a quality harvest) tested dairy quality on second cutting. This is significant, as producing dairy quality alfalfa on second cutting is difficult. Similarly, there were more plots that produced *Supreme* or *Premium* hay on the third cutting for the staggered compared with the sequential approach. For the 3-cut schedule there was a total of 12 harvests for 2^{nd} and 3^{rd} cuttings (6 treatments x 2 cuttings). There were 7, 4, 6, and 4 more harvest that tested a quality grade higher in the staggered system compared to a sequential system in the Tulelake grower trial, Butte Valley grower trial, and IREC 2001, and 2002 trials, respectively. This represents a significant improvement in forage quality with no added cost—simply a different order of cutting.

The four-cut systems provided consistently higher forage quality than most of the 3-cut strategies (Tables 3–6). However, as pointed out earlier, because of the short growing season in the Intermountain area, it is not possible in most areas to make four cuttings on all fields. In addition, harvest costs are higher with four cuts per season compared with three.

Sequential and staggered 4-cut schedules were only compared at the IREC site in Tulelake. The staggered approach is not advantageous for a 4-cut system in the Intermountain Region. It is difficult enough to fit four cuttings into the short growing season. The interval between cuttings is so short that most cuttings will ordinarily test dairy quality. Using the staggered approach—where the interval between cuttings is alternately shortened or lengthened—actually causes more cuttings to occur at the least profitable times shown in Figure 2. By further shortening the interval between cuts in a 4-cut schedule, some of the cuttings ended up being extremely low yielding (less one ton per acre) with very high forage quality (ADF's in the low 20's). As pointed out in Figure 2, this situation is not profitable because the price premium for such high quality hay is too low to compensate for the low yield. For the cuttings where the interval was lengthened in the 4-cut staggered system, the alfalfa just fell short of dairy quality (the other less profitable area in Figure 2).

A WHOLE FARM APPROACH

These results suggest that if a grower in the Intermountain area chooses to make three cuttings, a staggered cutting management strategy may be more profitable. A *staggered* approach to the cutting order of fields is a more sophisticated method of harvest management. It better enables growers to take advantage of the behavior of the alfalfa market.

In the example presented in this research, the cutting order was altered by starting second cutting with the field in the middle of the harvest cycle. To implement a staggered strategy it is not imperative that it be structured as it was in this research. A commercial alfalfa farmer would generally have far more than the six plots (fields) used in this study, providing even greater flexibility to the cutting order. Start with a field in the sequence that the grower is confident would be just above the 'dairy-quality' cut-off. The key is for growers to pay close attention to cutting order rather than habitually cutting each field in the same order for each cutting.

Four cuttings instead of three is another option to improve profitability. Four-cut schedules produced higher forage yield at some locations and superior forage quality. The feasibility of four cuttings in the Intermountain Region depends on the location and the weather conditions each year. The decision of whether or not to pursue four cuttings is not an easy one. Obviously, there are extra harvest costs with four cuttings. Also, to achieve four cuttings in short growing season areas it is necessary to begin cutting earlier in the season and end later. This increases the likelihood of rain damage. For many areas of the Intermountain Region there simply is not enough time to harvest four cuttings on all fields.

A mixture of three and four cuttings on a farm may be a prudent strategy to consider. Begin the season with the fields that will be cut four times, following with the 3-cut fields. The growing period for the second cutting of the three-cut fields should be lengthened to maximize yield. This approach seemed to be the most profitable of the 3-cut fields (plots) in the field trials. Total yield for the season is increased and you don't attempt to make 'dairy-quality' hay in mid summer when it is most difficult to achieve.

The uniform cutting in the last year of the trial at IREC demonstrated that continually cutting a field four times per year weakens the plant and yield is reduced. For this reason, it would be wise to alternate between three and four cuts from one year to the next. This strategy would maximize yield and quality, while giving the plants a 'rest' period in the 3-cut years to replenish carbohydrate root reserves.

VARIETIES AND CUTTING SCHEDULES

UC Davis Data. Another strategy that has been used in some alfalfa production regions in an attempt to attain higher quality is to produce more dormant varieties than those normally grown. For example, in the Central Valley of California growers may produce Fall Dormancy 4 varieties instead of Fall Dormancy 7-9. The more dormant varieties mature more slowly, and at a given cutting frequency will be less mature than their nondormant counterparts. Being less mature, their forage quality should be higher. This idea is only feasible in regions where a wide range of Fall Dormancy groups can be grown.

However, as with cutting schedules, the 'yield quality tradeoff' must be considered. Although the more dormant varieties likely have higher forage quality, they are generally lower yielding.

To address this issue, a 3-year trial was established at UC Davis in the Sacramento Valley of California, with 18 varieties, ranging from FD 3 to FD 9, harvested at 3 schedules, from very early (23-24 days) to late (33-34 days).

The average yield over 3 years was greater with the later cutting schedule, but the amount of 'high quality' harvests was less (Figure 4). The 'short' cutting schedules produced lower yields, but significantly higher quantities of high-quality forage. Cutting intervals had a stronger influence on quality in this trial than did variety. *Early*

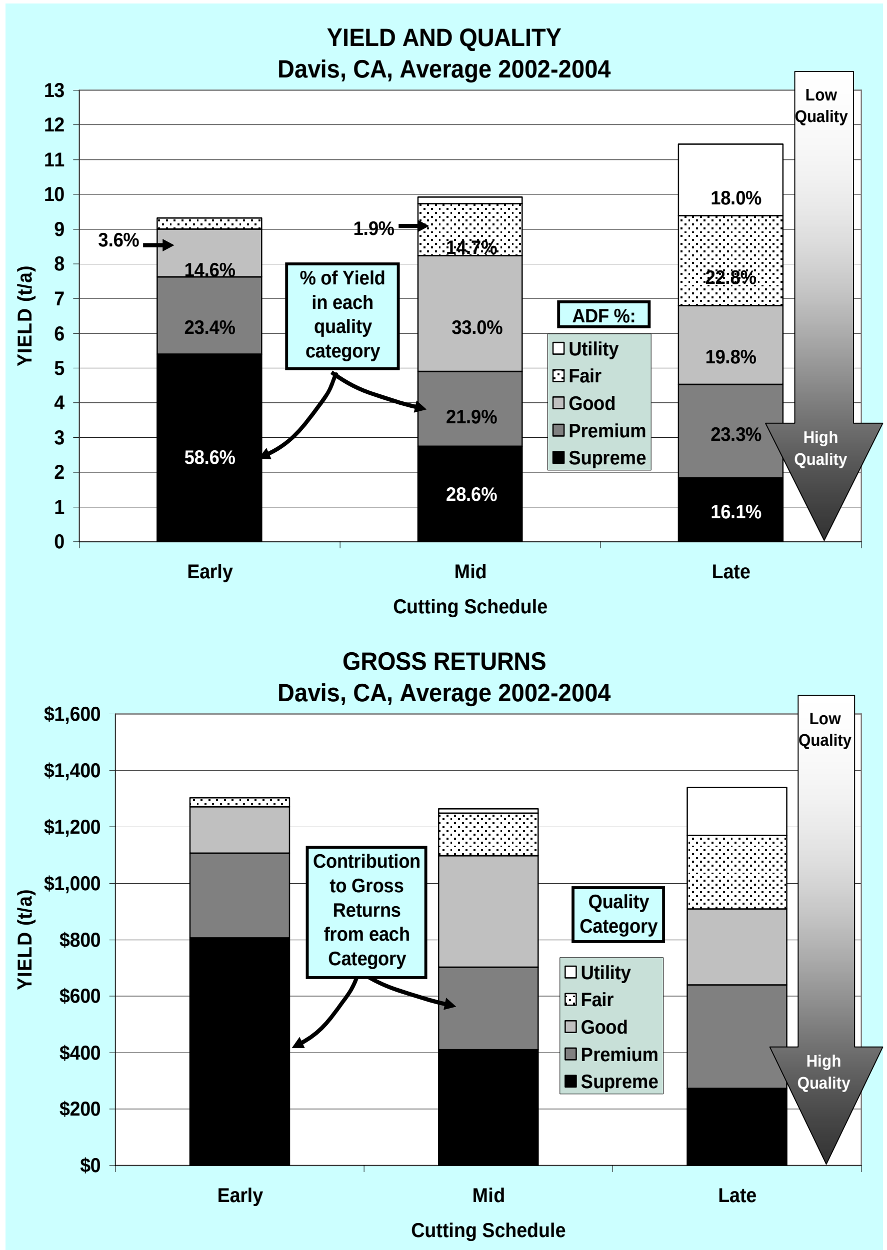

Figure 4. Yield, quality, gross returns of alfalfa harvested at 23 days (Early), 28 days (Mid) and 34 days (Late) cutting schedules, Davis, CA. Data average of 18 varieties, 3 replications, and 3 years. Price is average all CA markets, 2001-2005.

cutting schedules resulted in 82% production in the '*Premium*' and '*Supreme*' categories, whereas *Medium* and *Late* cutting schedules resulted in 50% and 39% of the production in those categories, respectively in 2002 (average of 18 varieties).

The greatest gross returns were obtained from the late schedule, intermediate with the early schedule, and least with the 28 day schedule, averaged across years (Figure 4). It is noteworthy that the most common cutting schedule in California (28 days) showed the least gross returns of all strategies. These results do not consider costs of the different strategies, primarily harvest costs, which would decrease the value of the more frequent cutting strategies (early and mid), compared with the late cutting schedules.

Varieties and Cutting Schedules. Variety has an important effect on both quality and yield. Varieties with a low Fall Dormancy produce significantly higher quality harvests, but lower

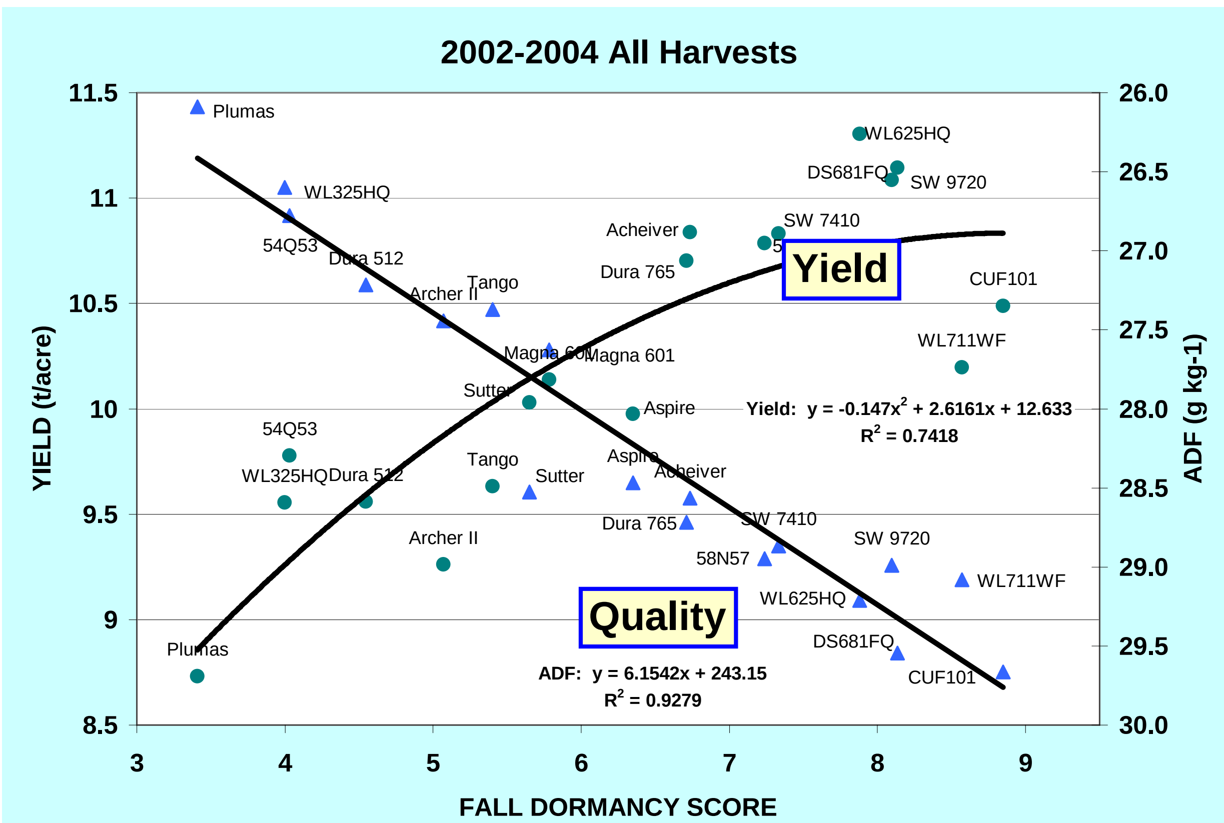

Figure 5. Effect of Variety on yield and quality of alfalfa –average of 3 years and 3 cutting schedules, Davis, CA, 2002-2005

yields (Figure 5), whereas varieties with high Fall Dormancy ratings generally produce higher yields, but lower quality. More dormant varieties (FD 2-4) produced lower fiber (average 2-3 points ADF) and higher protein forage (approximately 2 points CP) than nondormant lines (FD 8-10). However, yields were almost always lower with the more dormant varieties. The average yield penalty for each unit of FD ranged from about 0.3 tons/acre to 0.6 tons/acre per year per unit of FD in these studies—total annual yield differences of up to 2.5 tons/A between some varieties (Figure 5).

Interactions between Variety and Cutting Schedules. Gross return data from this study has shown that the effect of cutting schedules was not overcome by planting higher quality varieties (data not shown). Since growers have to somehow integrate the yield potential with the quality of the harvest (and thereby the value), gross returns are a good first approximation. However, we should be careful to account for the higher costs of more frequent harvests. Our data indicates that 1) Higher gross returns were seen at the long cutting schedule or the short cutting schedule but not at the medium cutting schedule (28 day), depending upon year, 2) Varieties were not as important as cutting schedules in determining yield, quality, and returns, 3) Planting dormant varieties in an attempt to improve the quality of later harvests was effective at improving quality, but not sufficient to improve gross returns. The improvement in quality of more dormant varieties was approximately counter-acted by the decrease in yield, so that gross returns were remarkably constant across varieties.

This study also supports the general concept that no single strategy (high yield/low quality vs. low yield/high quality) is consistently the best in terms of the balance of yield, quality, or total returns. Mixed strategies, which include the planting of some lower-yielding but high quality varieties along with varieties planted to maximize yields may make the most sense. This is especially true since practical limitations to precise cutting schedules may require differential strategies in for different fields.

CONCLUSIONS

No single strategy (e.g. cutting only for yield or only for quality) is always optimal due to fluctuation in the alfalfa hay market and the tradeoffs between yield and quality due to cutting schedule. Mixed strategies which assure a supply of both high and medium quality hay in response to market conditions may be reasonable to sustain profitable crop production over time. A flexible and diverse approach is important so that a grower can employ different management strategies to respond to the market conditions at the time. Most alfalfa growers have multiple fields requiring weeks to harvest a single cutting so it is feasible to employ different cutting management strategies on different fields. Alternating the number of cuttings taken from fields and from one year to the next may be a wise practice. In so doing, high quality alfalfa would be obtained from fields where an aggressive cutting frequency was used. Fewer cuttings would be taken from that field the following year, giving the plants a chance to “rest” to replenish carbohydrate root reserves. The same tactic can also be used within a season (a staggered cutting approach) alternating “quality” and “yield” cuttings to maximize quality while allowing for a recovery period. Planting a more dormant alfalfa variety on a portion of the fields is another approach to achieve high quality and increase flexibility.

Table 3. The effect of cutting strategy (sequential and staggered 3-cut systems and a 4-cut system) on the ADF content of alfalfa hay. (The field numbers 1-6 signify different plots intended to represent various fields on a grower's farm.) Grower Cooperator, Tulelake 2000.

Strategy	Field	ADF % Cut 1	Cut 2	Cut 3	Cut 4
Sequential	1	26.1	31.8	30.4	–
	2	25.0	31.5	29.8	–
	3	26.1	31.1	26.3	–
	4	30.1	32.0	27.6	–
	5	29.5	31.9	24.8	–
	6	30.1	29.3	23.8	–
Staggered	1	25.5	32.4	26.3	–
	2	25.6	32.4	25.1	–
	3	27.1	30.5	24.1	–
	4	28.9	27.4	28.6	–
	5	29.9	26.9	27.1	–
	6	29.1	27.8	26.2	–
4-Cut	1	25.2	29.5	27.2	24.0
	2	24.9	26.6	27.4	22.4
	3	26.2	27.3	27.3	23.7

<27 ADF **Supreme** **27-29 ADF** **Premium** **>29 ADF** **Good & Fair**

Table 4. The effect of cutting strategy (sequential and staggered 3-cut systems and a 4-cut system) on the ADF content of alfalfa hay. (The field numbers 1-6 signify different plots intended to represent various fields on a grower's farm.) Butte Valley 2001.

Strategy	Field	ADF % Cut 1	Cut 2	Cut 3	Cut 4
Sequential	1	23.97	28.21	30.47	-
	2	26.02	29.95	28.78	-
	3	25.96	29.69	29.05	-
	4	24.55	31.11	28.69	-
	5	25.82	31.94	29.04	-
	6	25.70	30.62	29.39	-
Staggered	1	24.25	31.66	27.64	-
	2	25.33	31.06	28.24	-
	3	25.99	31.00	28.13	-
	4	26.71	26.84	29.12	-
	5	26.36	28.13	30.96	-
	6	26.81	27.84	30.99	-
4-Cut	1	25.35	24.83	26.45	26.88
	2	24.17	26.86	25.46	22.43
	3	25.48	27.93	27.42	18.66

<27 ADF **Supreme** **27-29 ADF** **Premium** **>29 ADF** **Good & Fair**

Table 5. The effect of cutting strategy (sequential and staggered 3-cut systems and a 4-cut system) on the ADF content of alfalfa hay. (The field numbers 1-6 signify different plots intended to represent various fields on a grower's farm.) IREC 2001.

		ADF %			
Strategy	**Field**	**Cut 1**	**Cut 2**	**Cut 3**	**Cut 4**
Sequential	1	28.55	30.53	27.48	-
	2	30.23	30.85	27.97	-
	3	29.90	32.70	30.14	-
	4	30.81	31.69	28.05	-
	5	31.24	31.50	27.68	-
	6	32.03	28.52	28.57	-
Stagger	1	31.65	32.36	26.00	-
	2	29.97	34.85	26.98	-
	3	30.41	29.27	26.88	-
	4	29.35	27.92	29.22	-
	5	33.64	26.14	28.94	-
	6	33.07	28.28	28.99	-
Sequential	1	25.04	25.84	26.74	24.13
	2	26.31	24.35	24.92	24.31
	3	27.97	-*	25.98	23.49
	4	29.77	29.11	26.03	24.22
	5	30.13	29.21	24.10	24.50
	6	29.70	29.36	26.51	22.46
Stagger	1	25.34	29.24	23.70	22.71
	2	26.94	31.29	23.27	24.48
	3	27.60	31.46	24.67	22.97
	4	29.39	23.16	29.17	24.25
	5	29.96	23.50	28.04	26.52
	6	29.83	-*	28.14	23.89

<27 ADF **Supreme** **27-29 ADF** **Premium** **>29 ADF** **Good & Fair**

*Missing data

Table 6. The effect of cutting strategy (sequential and staggered 3-cut systems and a 4-cut system) on the ADF content of alfalfa hay. (The field numbers 1-6 signify different plots intended to represent various fields on a grower's farm.) IREC 2002.

Strategy	Field	ADF % Cut 1	Cut 2	Cut 3	Cut 4
Sequential	1	25.57	28.14	26.73	-
	2	23.80	29.65	25.75	-
	3	24.78	32.30	28.15	-
	4	27.09	31.48	24.15	-
	5	25.59	30.06	26.39	-
	6	28.20	31.13	24.01	-
Stagger	1	22.82	34.08	26.23	-
	2	24.14	29.84	24.28	-
	3	23.37	36.98	23.35	-
	4	25.75	27.93	26.48	-
	5	25.59	26.60	25.95	-
	6	26.21	28.49	25.84	-
Sequential	1	20.79	24.58	24.03	20.87
	2	21.03	25.82	22.76	20.00
	3	25.25	28.04	26.17	20.06
	4	25.25	25.73	23.45	18.13
	5	24.55	28.19	24.46	19.70
	6	25.42	32.00	23.72	17.85
Stagger	1	20.09	27.59	20.71	18.58
	2	22.81	30.82	19.53	19.89
	3	26.08	30.91	22.12	19.99
	4	23.86	21.31	23.65	19.95
	5	25.30	22.88	26.42	22.37
	6	27.99	24.94	24.91	19.10

<27 ADF **Supreme** **27-29 ADF** **Premium** **>29 ADF** **Good & Fair**

REFERENCES

Ackerly, T. 2001. *Characterizing and predicting the yield/quality tradeoff in alfalfa.* Masters Thesis. University of California, Davis, CA. 104 pp.

S. Orloff and D. Putnam. 2004. *Balancing Yield, Quality, and Persistence.* Proceedings, National Alfalfa Symposium, 13–15 Dec. 2004. San Diego, CA. UC Cooperative Extension. pp. 197–208.