CUTTING MANAGEMENT: Your Most Critical Decision

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The primary goal of every alfalfa grower is to produce high yields of top-quality alfalfa. Alfalfa is known world-wide as the queen of forages and its nutritional value surpasses that of nearly every other forage crop. However, if the crop is not managed properly much of the nutritional value and potential yield can be lost. 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. Forage quality is so important that alfalfa hay is rarely sold for milking cows in the West without first having a laboratory analysis to assess its feeding value. This creates tremendous pressure for the alfalfa grower to produce top quality alfalfa hay.

Harvest timing (the maturity at which the alfalfa is cut) is the most powerful tool under the grower's 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 vice 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 (Figure 1). 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

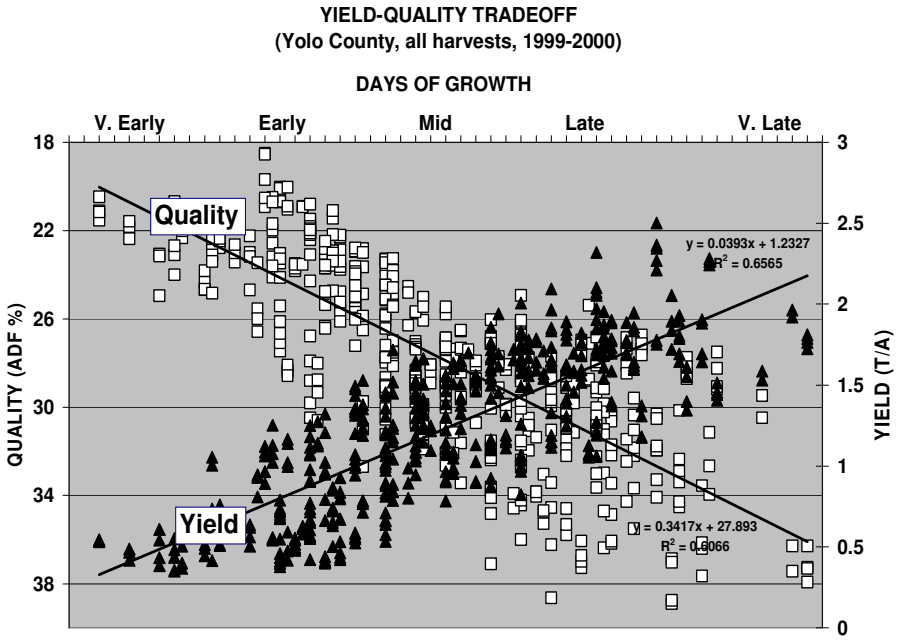

Figure 1. The yield quality tradeoff. As alfalfa matures there is a linear increase in yield and a linear decrease in forage quality.

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provides more time for the plant to replenish root reserves.

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. This was clearly the case this last year where prices were at a record high and the price premium for high quality hay was relatively small in most areas.

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 2. 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. 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 low-quality end of the curve **(C)** there is little drop in price associated with each change in ADF.

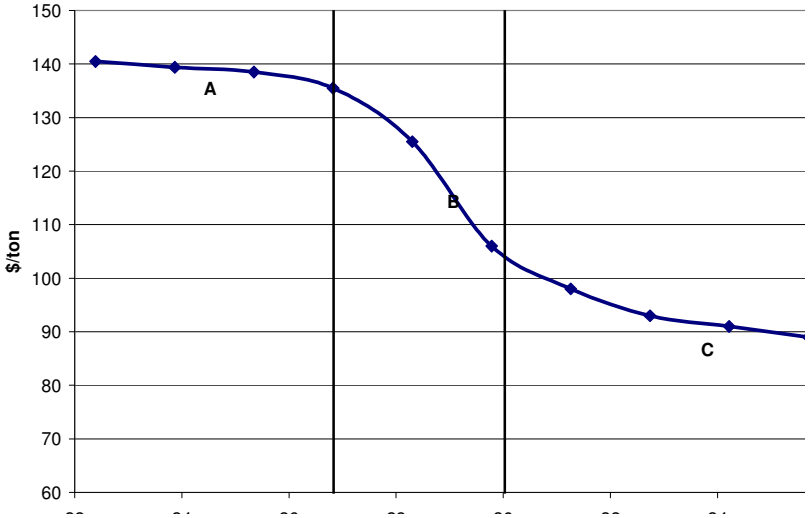

Figure 2. Typical relationship between price and forage quality (ADF) in the West with three distinct phases. There is little change in price at the highest quality end of the curve (A) where ADF is below 27 percent. Price falls dramatically in the center portion (B) at the perceived "dairy quality" 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 3 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 hay quality cutoff where price drops off precipitously yet yield has not increased enough to offset the lower price.

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.

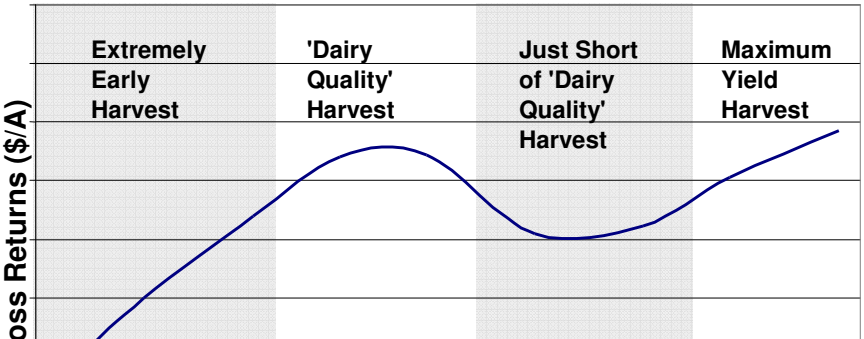

Figure 3. Typical gross return curve showing grower gross returns as alfalfa matures from the pre-bud stage to full bloom. The curve indicates two periods of maximum returns, *Dairy Quality Harvest* and *Maximum Yield Harvest*. Time periods to avoid are *Extremely Early Harvest* and *Just Short of "Dairy Quality" Harvest*.

Harvest Order

Most alfalfa 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 be either.

An alternative strategy referred to as a *staggered* approach may have merit for some producers. With the staggered strategy the cutting sequence is interrupted so that '*Quality'* harvests are alternated with '*Yield'* harvests (Figure 4). This is accomplished by varying 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. 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. 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.

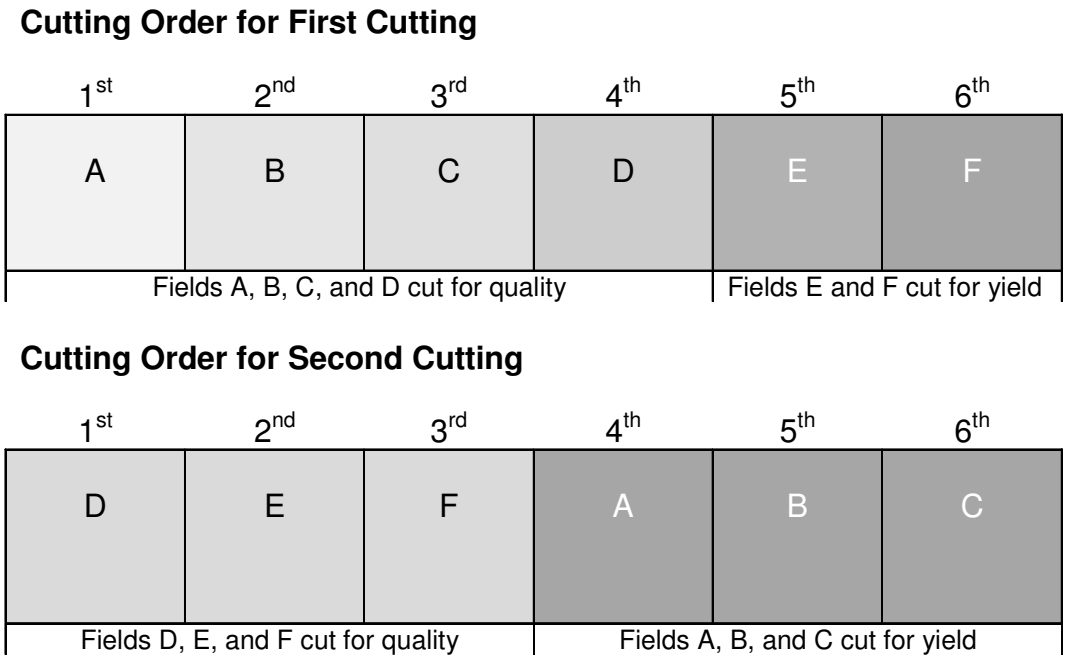

Figure 4. Staggered Harvest Concept.

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.

Varieties and Cutting Schedules

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.

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 5). 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* cutting schedules resulted in 82% production in the '*Premium'* and '*Supreme'*

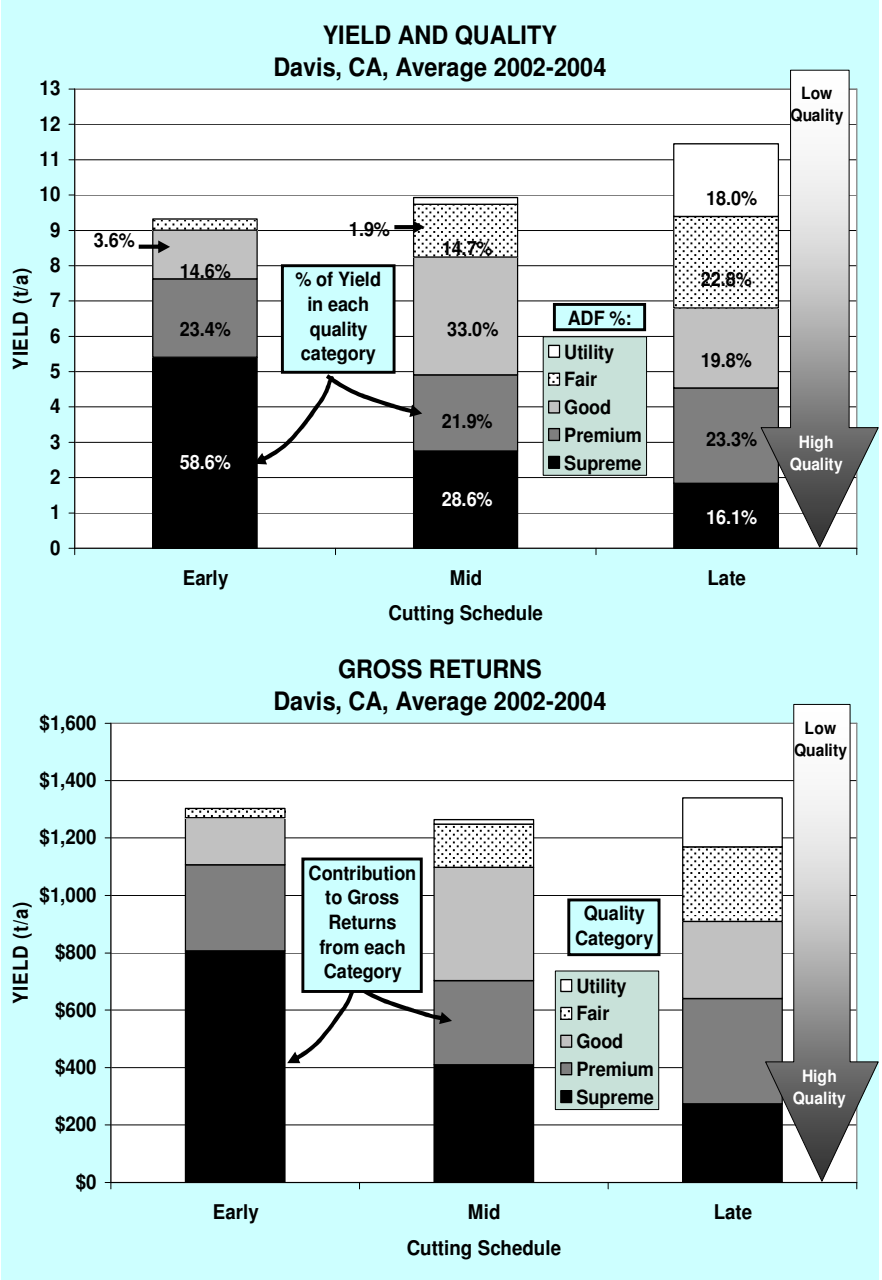

Figure 5. Yield, quality, gross returns of alfalfa harvested at 23 days (Early), 28 days (Mid) and 34 days (Late) cutting schedules, Davis, CA. Data average of 18 varieties, 3 replications, and 3 years. Price is average of all CA markets, 2001-2005. Putnam.

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 5). It is noteworthy that the most common cutting schedule in Central 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.

Variety Effect

Variety has an important effect on both quality and yield. Varieties with a low Fall Dormancy

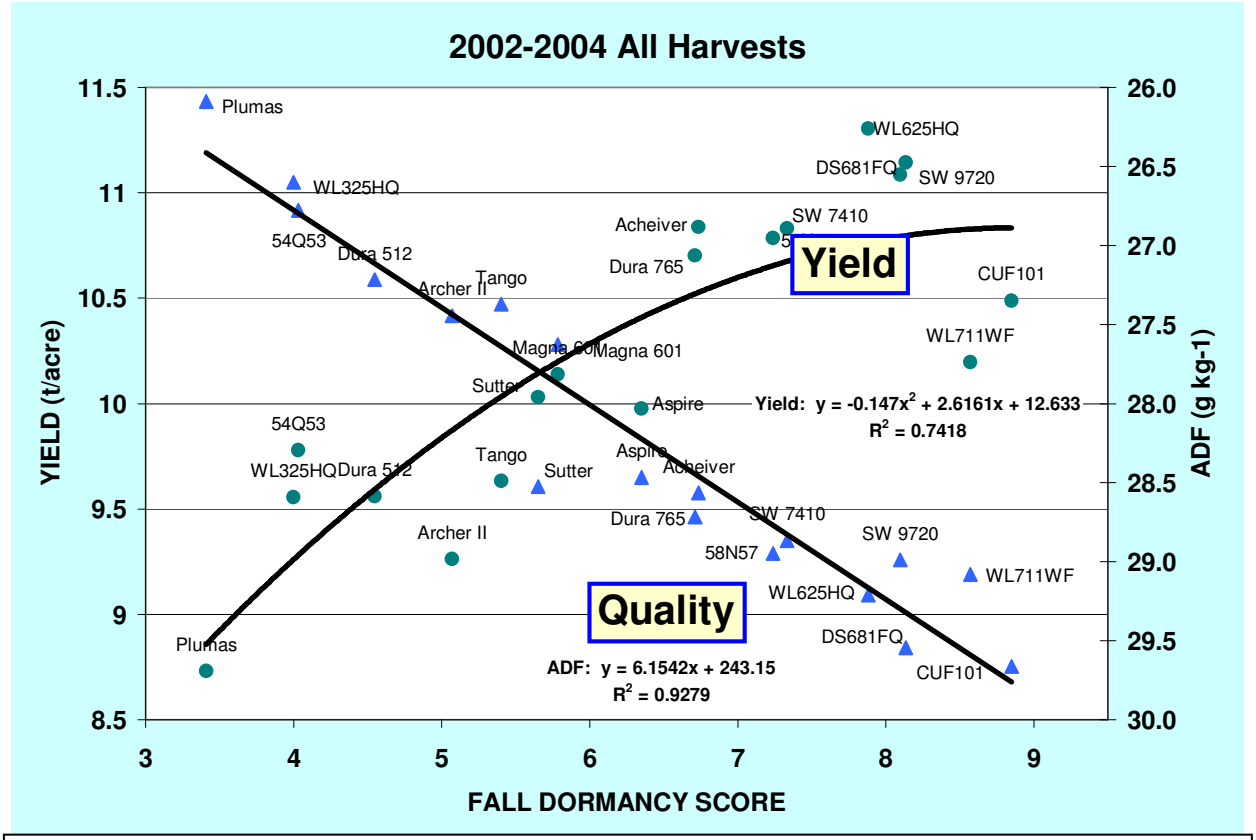

Figure 6. Effect of Variety on yield and quality of alfalfa –average of 3 years and 3 cutting schedules, Davis, CA, 2002-2005. Putnam. UC Davis.

produce significantly higher quality harvests, but lower yields (Figure 6), 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 6).

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.

This study also supports the general concept that no single strategy 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 yield, may make the most sense. This is especially true since practical limitations to precise cutting schedules may require different strategies for different fields.

Advances in Genetic Engineering

A major emphasis of this paper has been to explain the yield/quality tradeoff—specifically how yield increases but quality deceases with advancing maturity. However, through the use of genetic engineering this concept may have been altered. Researchers from the Nobel Foundation, the U.S. Dairy Forage Research Center (USDFRC), and Forage Genetics have developed what are referred to as low-lignin alfalfa varieties. Lignin is the least digestible component of the fiber in alfalfa. Researchers identified the genetic pathways to making lignin in alfalfa and knocked out a gene at each step to find candidates that decreased lignin but had no negative impact on agronomic traits. The low-lignin varieties that were developed have been estimated to produce a 10 percent increase in fiber digestibility. According to studies by U.S. Dairy Forage Research Center, an increase in digestibility of this magnitude could increase milk or beef production by $350 million per year and decrease manure solids by 2.8 million tons per year in the United States.

One of the other benefits of these reduced-lignin alfalfa lines is that they retain their forage quality longer in the field, which could give producers a much larger harvest window. Field trials are currently underway in California, Wisconsin and Minnesota to document changes in yield and quality with advancing maturity for low-lignin varieties compared with varieties without the trait. These trials were just initiated this year but this technology could prove very beneficial for alfalfa and dairy producers alike. New varieties containing this low-lignin trait may be commercially available as early as 2012.

Summary

Alfalfa growers strive to produce alfalfa with both high yield and high quality. The yield/quality tradeoff in alfalfa production is unavoidable with current alfalfa varieties. As plants mature, yield increases but quality decreases. The challenge for alfalfa producers is to identify the appropriate compromise where acceptable quality is achieved with satisfactory yields without reducing alfalfa vigor and stand life excessively. A staggered approach to

cutting fields where the order in which fields are cut from one cutting to the next is altered may provide a partial solution. In so doing, specific fields and cuttings are targeted for superior quality while other fields are harvested later to maximize yield and allow the alfalfa plants more time to replenish root reserves. Alternating the number of cuttings taken from fields and from one year to the next may also 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" in order to replenish carbohydrate root reserves. Planting a more dormant alfalfa variety on a portion of the fields is another approach to achieve high quality and increase flexibility. In the longer term, genetically engineered low-lignin alfalfa varieties may provide growers with a means of achieving both high yield and high quality at the same time.