Experimental: A new trial was planted fall, 2012 to test the concept of the reduced lignin trait. This trait has been developed through genetic engineering by Forage Genetics Int’l and is scheduled for release in 3-4 years. In this trial, 4 Low Lignin (LL) lines are compared with 4 conventional lines at two cutting schedules. An (approximately) 7 cut system will be compared with a 5 cut system at Davis (27-28 day vs. 35-36 day). One key issue is whether forage quality can be maintained at later cutting schedules compared with early harvests in the LL lines (as compared with conventional lines). These are FD 4 lines, and higher dormancy groups are expected to be released later. This same trial has been planted at Tulelake and at two sites in the Midwest.

Questions: The key issue is the interaction between cutting schedule and these low lignin lines as it influences yield and quality. Specifically:

- Are there differences in lodging or agronomic performance between LL and conventional lines? Are yields acceptable?
- Would LL trait confer quality advantages at both early and late cutting schedules?
- Would the LL trait indirectly increase yields by enabling later harvests, producing the same quality as attained with earlier harvests?
- Is the decline in quality slower in the LL lines vs. conventional?

Background: Although yield is the most important economic factor affecting returns for alfalfa, forage quality is a close second. That’s because “quality” broadly defined predicts the amount of milk (or meat) produced per pound or kilogram of forage. After all there are other forages that yield more than alfalfa, but few match the quality of alfalfa for dairy rations. Alfalfa confers an important combination of digestibility, energy, protein, and high yield. Forage quality designation for alfalfa in California markets is currently worth greater than $250 million/year in California alone.

However, the digestibility of the fibrous portion of all forages, including alfalfa, is a major limiting factor for extraction of nutrients by ruminants. Fiber (the NDF or cell wall portion) is usually between 30 and 50% of the dry matter of the hay, and its digestibility ranges between 30% and 70%, (and typically less than 55%) so it’s only partially utilized. This represents a tremendous quantity of energy that could be potentially used by ruminants—by increasing the digestibility of the NDF fraction. Even differences of about 10% digestibility could be very important to animal production.
**Relationship to yield.** Since growers routinely cut early to attain quality, they typically compromise significant yield. Figure 1 is data from Yolo County from many cuts, showing that yield maximizes at about 2 tons/acre per cutting at about 35-40 days, but is approximately ½ ton/acre when harvested at about 21 days. Conversely, quality is lowest at the high yield (late) cutting schedule and highest at a short cutting schedule. Typically, growers compromise between yield and quality, cutting at about 28 days – unfortunately this often misses ‘dairy quality’ designation, resulting in both lower yields and lower quality.

This is because stem quality rapidly declines after about 24-26 days (Figure 2). Most of this decline is due to lignification of the cell walls in the stems. Quality is a complex trait including the digestible energy of a feed, the protein content, protein digestibility, and the intake potential, as well as the physical value of the fiber itself to rumen function. However, a key limiting factor for forage crops is both the fiber content (%NDF) and the digestibility of the fiber fraction (%NDFD). Thus, if the decline in stem quality can be delayed, even by a matter of 4-7 days, this would be a significant.

![Figure 1. Relationship between yield and quality-Yolo County. Maximum quality rarely occurs at maximum yield-growers must compromise.](image1)

![Figure 2. Stem quality rapidly declines in alfalfa typically between 25 and 35 days of growth significantly reducing quality of the whole plant](image2)
The Low-Lignin Concept. Through genetic studies and engineering, the pathway which produces lignification of the cell wall is modified so that the decline in NDFD is less as the plant matures (Figure 3). This should have major effects on both milk production and marketability of the hay. Milk production has a high relationship to alfalfa maturity (Figure 4).

Need to Include NDFD in Marketing. However, current markets do not largely recognize differences in digestibility of the fiber fraction. University and USDA researchers have encouraged hay growers and industry members for years to include digestibility estimates in evaluating hay quality. This is true currently with 'conventional' varieties, but is especially true when evaluating LL alfalfa. These lines are likely to be similar in NDF but differ primarily in the digestibility and intake levels of the hay.

Figure 3. The concept of the Low Lignin trait in alfalfa. While traditional lines declines rapidly in NDF digestibility, LL lines may maintain digestibility over a range of maturities, increasing flexibility in harvest management.

Figure 4. Effect of alfalfa maturity on milk production at four concentrate levels. Higher levels of concentrates do not compensate for lower quality hay.