Producing quality alfalfa in California's mountain valleys

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Delaying the first cutting may increase yield but decrease quality

Conservative management practices have tended to keep mountain county alfalfa stands (above 3,000 feet) in production for long periods. Making two cuttings per season at the full-bloom stage, in mid- to late June and again in mid- to late August, was once a widespread practice. Yields averaged 3 to 4 tons per acre per season, and most hay was fed locally to beef cows, calves, and yearlings.

Recently a market has developed for high-quality hay suitable for exporting to dairy areas. This hay is produced by cutting at an early stage of plant maturity — at the late flower bud stage to 10 percent bloom. Our studies have shown that alfalfa hay cut at this stage is most palatable to livestock and highest in yields of hay, total digestible nutrients, crude protein, and leaf content.

Palatability and quality decrease as alfalfa matures and when foreign material (particularly weeds), mold, and dust are present. Immature alfalfa has a greater percentage of its weight as leaves. With increasing maturity, stems become longer, larger, and more fibrous, thereby producing greater yield for an individual cutting. At the 10 percent bloom stage, alfalfa leaves contain 65 to 75 percent of the plant's protein, minerals, vitamins, and digestible nutrients, averaging about 25 percent crude protein, with stems averaging 12 percent. As plants become older, stems elongate and they lose lower leaves rapidly, resulting in decreased protein and digestible components.

At 10 percent bloom, 10 percent of the stems in the alfalfa field have one or more open blossoms. Because very few flowers are visible at this stage, crown bud development is a more reliable guide: at the late flower bud stage, zero to one-half of the crowns have buds just emerging; at 10 percent bloom, at least 60 percent of the crowns have buds, with regrowth ½ to ¾ inch long; at 50 percent bloom, at least 80 percent of the crowns have buds, with regrowth 1 to 2 inches long; and at 100 percent bloom, buds are 2 inches or longer on every crown.

Conditions during hay-making affect the soundness of alfalfa hay after baling — freedom from objectionable odors, mold, dust, excessive dryness or moisture, leaf shatter, and excessive heating. Moisture above 17 percent at baling can result in heating, mold, or fermentation; temperatures above 120°F turn alfalfa dark brown and reduce protein digestibility. Other workers have shown that leaf loss from raking and baling hay that is too dry (a severe problem in the dry Intermountain West) can lower feeding value up to 50 percent and reduce hay yields up to 30 percent.

Hay produced by different growers in the same area can vary widely in quality. Although maturity, leafiness, foreign matter content, condition, and green color are important visible criteria, chemical analysis is the only accurate way to determine alfalfa's value as an energy, fiber, and protein source. Chemical evaluation requires a dry matter determination and analysis of either modified crude fiber, which predicts total digestible nutrients, or acid detergent fiber, which estimates digestible dry matter and digestible energy.

Cutting schedules

Twenty years ago or so, most alfalfa varieties lacked the rapid regrowth potential, winter hardiness, or bacterial wilt resistance needed for the intensive management required by frequent cutting. Newer varieties now combine winter hardiness and rapid regrowth after cutting with resistance to insects and stand-depleting diseases. Some of them flower three to seven days earlier than the old ones and can be cut more frequently with assurance that stands will last. The two-cut system should now be considered only at high elevations in very cold areas with short growing seasons. Any late third cuts from such areas will be low in yield but very high in quality.

In recent years, we have conducted harvest frequency studies comparing two to five cuts at: Tulelake (4,143 feet) and Macdoel (4,300 feet) in Siskiyou County; McArthur (3,300 feet) in Shasta County; Alturas and Cedarville (4,300 feet) in Modoc County; Susanville (4,255 feet) in Lassen County; and near Bishop (4,500 feet) in Mono County. All trials demonstrated that yields per acre of dry hay, crude protein, and total digestible nutrients were highest when alfalfa was harvested at 10 percent bloom. Harvesting at the 50 percent bloom stage (three cuts per season) and at the 100 percent bloom stage (two cuts per season) reduced yield by 0.3 and 1 ton per acre per season, respectively, and dropped total digestible nutrients by 1 to 3 percentage units and crude protein by 2 to 6 percentage units (tables 1 through 5).

The McArthur trial is representative of 3,000- to 4,000-foot elevations and their 140- to 160-day growing seasons (fig. 2). Plant density was not greatly affected after four years of different harvest frequencies (table 1). Even cutting

TABLE 1. Influence of harvest frequency on hay yield, total digestible nutrients (TDN), and crude protein (CP) — McArthur, Shasta County, 1966-69*

Treatment	Hay yield† (T/A)	TDN† T/A	TDN† %	CP† T/A	CP† %	Final stand (plants/sq ft)
5 cuts (prebud, monthly)	5.6	3.5	62.5	1.4	23.7	7.6
4 cuts (bud stage)	6.6	3.8	57.7	1.4	20.1	5.8
3 cuts early (10% bloom)	7.4	4.2	56.8	1.4	18.1	5.2
3 cuts late (50% bloom)	7.1	4.1	57.8	1.3	17.0	4.2
2 cuts (100% bloom)	6.4	3.5	54.8	1.1	15.3	4.6

* Average of 4 years.
† 100% dry matter basis. T/A = tons per acre.

TABLE 2. Effect of stage of maturity and harvest frequency on hay yield and quality — Cedarville, Modoc County, 1964*

Treatment	Hay yield (T/A)	TDN lb/A	TDN average %	CP lb/A	CP average %
3 cuts (bud stage)	4.68	4,781	58	1,780	21.6
3 cuts (10% bloom)	7.72	7,742	57	2,811	20.7
2 cuts (50% bloom)	7.34	7,270	56	2,271	17.5
2 cuts (100% bloom)	5.48	5,021	52	1,583	16.4

* 100% dry matter basis.

Four alfalfa crowns illustrating crown bud development equivalent to flower bud and bloom stages. Above: bud stage, without visible regrowth (left), and 10 percent bloom, with crown buds ½ to ¾ inch long (right), the point at which quality is highest.

five times in the vegetative stage did not reduce the plant population below that of alfalfa harvested less frequently. Stand density declined by more than 50 percent (from 22 to 10 plants per square foot) during the first 18 months, but plant loss was much slower in the next three years. Apparently a density of five to six plants per square foot is sufficient to maintain production in the mountain counties. Frequent cutting in the pre-bud or bud stage did reduce alfalfa plant vigor and resulted in much lower yields (table 1) but gave dramatically higher quality (fig. 2).

This research indicates the advantage of the early three-cut system and the need for the first cutting to be in late May or very early June. If the second cutting is delayed into early August, then the cooler nights and shorter days of August and September reduce the growth rate and yield of the third cutting (fig. 2). In addition, if three harvests are completed by early September, the high-quality fall regrowth can continue until late October, just before a killing frost, and can be used as pasture, greenchop, silage, or hay without damaging the stand or reducing the yield of the next year's crop. The system will also reduce contamination from weeds that germinate in the early fall when stands are exposed and without cover or competition. Higher quality hay is therefore possible in the first cutting because of reduced weed contamination and the harvesting of immature forage.

The information from Cedarville, Modoc County, represents the 4,000- to 4,300-foot elevation with 120- to 140-day growing seasons. Results were similar to those of the McArthur trial. Making three cuts in the 10 percent bloom stage gave the highest season total yield of hay, total digestible nutrients and crude protein per acre (table 2). Even higher quality hay can be produced by cutting in the bud stage, but yield is reduced.

In areas at 4,300 to 5,300 feet with 90- to 120-day growing seasons, the possibility of late spring and early fall frosts, and traditional two-cut systems, such as Macdoel, Tulelake, and the Madaline Plains, the first cutting was ordinarily near the end of June or the first of July. In these cooler environments, there was little difference in tonnage between the two-cut and three-cut systems, but quality was better when the first cutting was earlier and three cuts were made (tables 3 and 4). Costs of the additional harvest were more than offset by the increased value of the better quality hay, as measured by total digestible nutrients and crude protein content, especially of the first and third harvests. Harvesting at the 10 percent bloom stage gave the greatest production of nutrients per acre while still producing a yield equal to or better than that of the two-cut mature systems.

The trial near Bishop, Mono County, was at a 4,500-foot elevation, but in this more southerly location altitude has a less pronounced effect on length of growing season than in northern California. The 160- to 180-day growing season normally permits four cuttings at 10 percent bloom. The response in yield, quality,

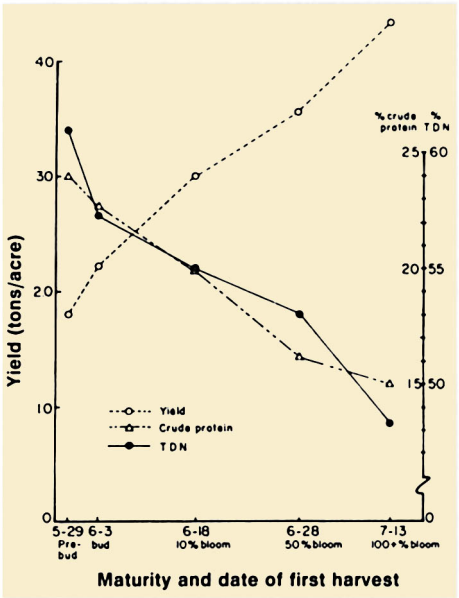
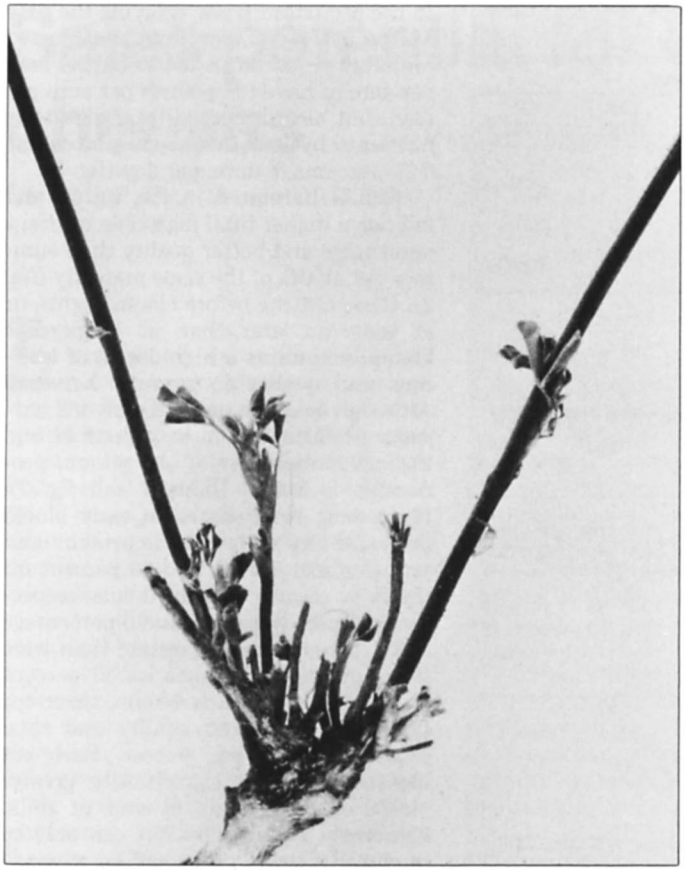
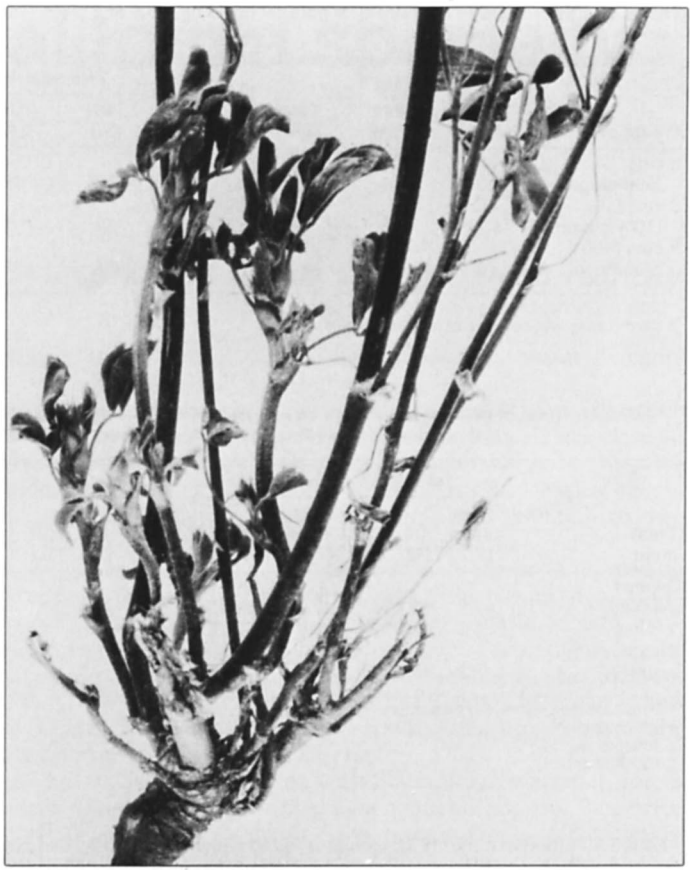


Fig. 1. Delaying the first cutting increased weight yields but decreased total digestible nutrients and crude protein.



Crown at 50 percent bloom stage, with 1½-inch regrowth. Harvesting at this stage permits three cuttings per season.



Crown at 100 percent bloom, with 2-inch or longer buds. Cutting at this stage permits two crops per season, but quality suffers.

and stand, however, was essentially equal to that in the northerly locations in that highest yields of dry matter and crude protein were obtained at 10 percent bloom with four cuttings (table 5).

Final stand density in this location was not significantly different for any of the treatments. Cutting in the flower bud stage did not deplete stands, although vigor was greatly affected. Cutting in the bud stage caused smaller crowns, slowed spring growth, delayed regrowth by as much as seven days between cuttings after two years, and greatly increased infestation of summer annual grassy weeds. At this location, cutting four times in the 50 percent bloom stage did not increase yields. Taking the second and third cuttings (summer) in the bud stage with the first and fourth at the 50 percent bloom stage did increase quality of the summer cuttings but reduced overall seasonal yield.

The percentage of crude protein and total digestible nutrients increased from 1 to 3 percentage units, depending on the season, when alfalfa was harvested in the

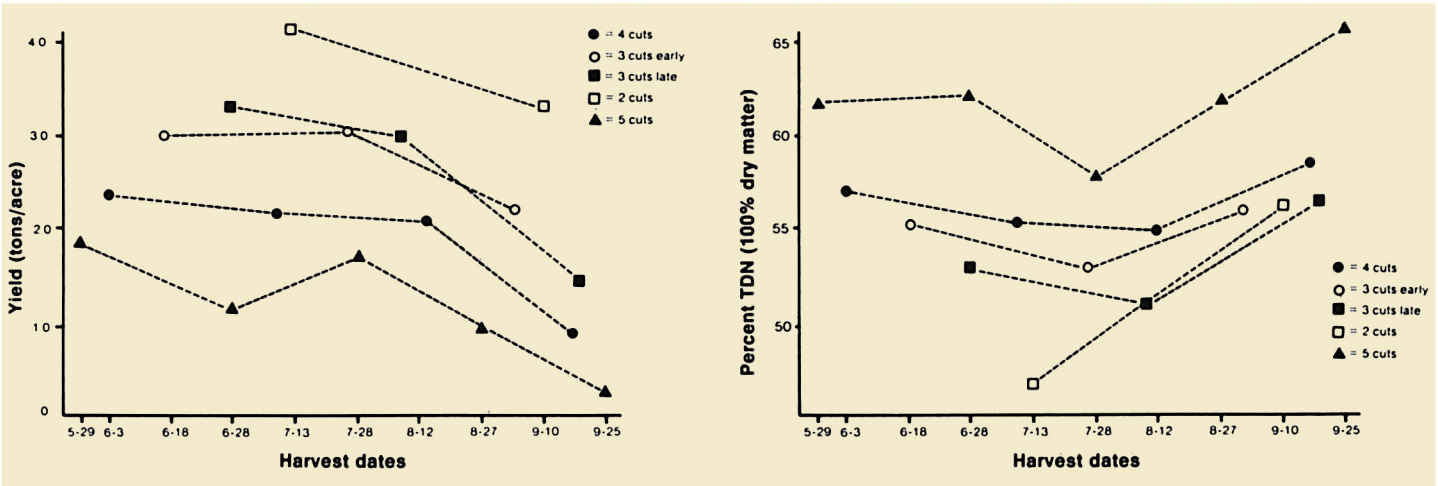


Fig. 2. Seasonal variation in yield and total digestible nutrients under five cutting frequencies at McArthur, Shasta County, representative of 3,000- to 4,000-foot elevations.

TABLE 3. Effect of stage of maturity at harvest on hay quality and yield — MacDoel, Siskiyou County, 1963-64*

Treatment	1963 (T/A)	1964 (T/A)	Total (T/A)	Two-year average Yield (T/A)	TDN (%)	CP (%)	TDN (T/A)	CP (T/A)
2 cuts (bud stage)	3.3	4.3	7.6	3.8	56	20	2.1	0.76
2 cuts† (10% bloom)	4.2	4.6	8.8	4.4	52	18	2.3	0.79
2 cuts (100% bloom)	3.9	4.1	8.0	4.0	52	17	2.1	0.68

* 100% dry matter basis.
† Third cutting lost because of frost in both years.

TABLE 4. Effect of number of cuttings on hay yield, crude protein, and total digestible nutrients for each cutting — Tulelake, Siskiyou County, 1963-67*

Treatment	1st cut Hay yield (T/A)	CP (%)	TDN (%)	2nd cut Hay yield (T/A)	CP (%)	TDN (%)	3rd cut Hay yield (T/A)	CP (%)	TDN (%)	Total Hay yield (T/A)	CP (%)	TDN (%)	CP (T/A)	TDN (T/A)
3 cuts† (early)	2.2	19.7	56	2.8	16.3	53	1.1	22.1	61	6.1	19.4	56	1.18	3.41
2 cuts‡	3.1	17.6	54	2.8	15.7	51	—	—	—	5.9	16.6	53	0.98	3.13
2 cuts§ (late)	3.2	15.2	49	2.9	14.7	51	—	—	—	6.1	14.9	50	0.90	3.05

* 5-year average, 100% dry matter basis.
† 10% bloom.
‡ 50% bloom.
§ 100% bloom.

TABLE 5. Effect of maturity at harvest on alfalfa hay yield, quality, and persistence — Bishop, Mono County, 1976-78*

Treatment	Hay yield† (T/A)	TDN‡ T/A	TDN‡ %	CP† T/A	CP† %	Final stand spring 1979 (plants/sq ft)
5 cuts (late bud stage)	6.4	1.6	52.8	3.4	24.1	6.5
4 cts (10% bloom)(grower)	7.3	1.5	51.3	3.7	21.0	7.0
4 cuts (#1 and #4 at 50% bloom; #2 and #3 at bud)	6.4	1.5	52.9	3.4	24.1	6.0
4 cuts (50% bloom)	7.1	1.5	52.3	3.7	21.2	5.3

* Average of 3 years.
† 100% dry matter basis.
‡ 90% dry matter basis.

TABLE 6. Predicted daily gains, intake, and feed conversion of different qualities of alfalfa hay fed to 500-pound steers

Stage of hay maturity	Hay quality	Daily intake (% of body weight)	CP (%)	Daily gain (lb/day/steer)	Conversion (lb hay/ lb gain)
Early bloom	high	3.0-3.3	20	2.00	8-10
50% -75% bloom	medium	2.5-2.8	16	1.33	11-13
100% bloom	low	2.0-2.5	12	0.60	15-17

late flower bud stage as compared with 10 percent bloom. The 13 percent yield reduction for bud-stage hay cannot be made up by the increased selling price of higher quality hay, especially when one considers the severe contamination from summer grassy weeds that would eliminate any price advantage, and would probably mean a price reduction when compared with hay harvested at 10 percent bloom.

Quality and maturity

Because the first cutting of alfalfa in the intermountain area constitutes 40 to 60 percent of the season's total production, the temptation is to increase the yield of that cutting by delaying harvest. In the McArthur trials, delaying the date of first cutting 45 days from late May to mid-July produced an additional 2.4 tons per acre of hay (105 pounds per acre per day), but also decreased total digestible nutrients by 0.29 and crude protein by 0.22 percentage units per day (fig. 1).

Alfalfa harvested in the spring and fall has a higher total digestible nutrient percentage and better quality than summer-cut alfalfa of the same maturity (fig. 2). Early cutting before bloom begins, or at least no later than at 10 percent bloom, maintains a high degree of leafiness and quality in summer harvests. Although late summer and early fall harvests produce the most digestible and highest protein hay of the season, production is lowest (table 4 and fig. 2). Harvesting three times in early bloom produced hay with a crude protein content of about 20, 18, and 19 percent for the first, second, and third cuts, respectively. These were 4, 2, and 0 percentage units higher in crude protein than were the same cuttings taken at 50 percent bloom. With the early bloom, three-cut system, both overall quality and total seasonal yield were greater. Early-cut hay can produce significantly greater yields of beef (table 6) and of milk. Extremely high quality hay can only be produced if the grower is willing to sacrifice substantial yield (fig. 1).

Second-cut hay for horses

During July, weather in the intermountain counties is very dry and free of rain. Cool nights usually cause dew, which prevents excessive leaf loss during raking. Warm, low-humidity days allow very rapid curing of alfalfa hay, especially if it has been well crimped with a hay conditioner mounted on the swather. Alfalfa hay produced under such conditions is normally very green, moderately leafy, and free of weeds, dust, and mold, and it may be sold for feeding to horses.

Such a crop can be allowed to grow and mature four to seven days longer than when cut for dairy cows, and tonnage will increase by ¼ to ½ ton per acre. Normally, more mature high-quality horse hay sells for about the same as early-cut, high-quality dairy hay. A price premium may be possible if bales weigh less than 115 pounds.

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