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Cutting Management Strategies for Established Alfalfa

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Three trials were conducted in the Intermountain Region of Northern California to compare *sequential* vs. *staggered* cutting strategies and to evaluate different alfalfa cutting schedules (3 versus 4 cuts). Single-year trials were conducted on the property of grower cooperators in Tulelake and Butte Valley (Macdoel). Field plots located at the UC Intermountain Research and Extension Center (IREC) in Tulelake were harvested in 2001 through 2003 with a single uniform harvest in 2004.

The plots were laid out to simulate an entire alfalfa farm. 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 the different 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 trial located 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 were cut.

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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 chronological order as was used for first cutting. In contrast, the cutting cycle for second cutting was interrupted in the staggered approach so that the first plot cut on second cutting was the plot cut forth on first cutting. 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 continued with the plot cut first on first cutting. 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 next have an extended growing period to produce maximum yield and to replenish root reserves. Hence, plots cuts early on first cutting are given a longer rest period on second cutting.

PRELIMINARY FINDINGS

Yield

The results below are from 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 once the alfalfa forage quality analyses are completed. Cutting date had a profound effect on alfalfa yield. It is well known that alfalfa yield increases with advancing maturity. Yield increased from 2.88 to 3.13 tons/A for the three-cut schedule, 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, as these treatments were essentially the same up to this point.

Second cutting yields for the three-cut sequential treatments (treatment #'s 1-6) were very similar. Plots were cut in the same order as first cutting so the number of days between cuttings was almost the same and the yields should be similar. 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 yield 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 had the same number of days to grow between 2nd and 3rd 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 2nd 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.

There were significant differences in total seasonal yield between treatments. The staggered treatments tended to have both the highest and lowest total yields when compared to the sequential three-cut schedule. The staggered treatments with a long growth period before 2nd cutting had a significantly higher total yield than the treatments with a long growth period before 3rd cutting.

The four cut schedule had the highest total forage yield. While it may at first appear that a four-cut schedule is the preferred strategy there several factors to consider. Four cuttings are feasible in some years but not all—the length of the growing season varies considerably from year to year in the Intermountain Region. Even in warm years the growing season is too short to obtain four cuttings on all fields. Plots with four cuttings were cut earlier in the spring and later in the fall. It would not be feasible

to extend the season out long enough on both ends to accommodate four cuttings, especially with the increased risk of rain damage at that time of year. In addition, a four-cut schedule has higher harvest costs.

Forage Quality

The cutting schedule strategy had a profound effect on forage quality Acid Detergent Fiber (ADF), Total Digestible Nutrients (TDN), Neutral Detergent Fiber (NDF), and Crude Protein (CP). Only the TDN data is presented here, as TDN is the quality factor used to determine price (Table 3).

The staggered 3-cut system had significantly more high quality alfalfa than the sequential approach. The staggered strategy resulted in some 'Supreme' and 'Premium' quality alfalfa on second cutting, whereas all the second-cutting alfalfa with the sequential cutting order was 'Fair' quality. The staggered system also resulted in more 'Supreme' and 'Premium' alfalfa on third cutting than the sequential approach. Over the season, five more plots (simulated fields) had 'Supreme' or 'Premium' using the staggered approach. Therefore, the staggered cutting order would increase revenue over the sequential order because the quality was higher while the total seasonal yield was the same for both systems. Approximately 90 percent of the alfalfa in the 4-cut system was 'Supreme' or 'Premium'. The 4-cut system had higher total yield and superior forage quality. However, as noted above it is often not possible to cut all fields four times in short-season areas. Therefore, alternating between three and four cuts from one year to the next may be an effective strategy to maximize yield and quality, while giving the plants a 'rest' to replenish carbohydrate root reserves in the 3-cut years.

How Project Objectives Were Met

The original project objectives were as follows:

1. Document the changes that occur in yield and forage quality for different cuttings.
2. Study the effect of harvest timing on seasonal alfalfa yield.
3. Compare the yield and forage quality of 3 vs. 4 cuttings per year harvest schedules.
4. Compare the profitability of a staggered cutting schedule with a fixed sequential cutting approach.

All these original project objectives will be met. The forage quality analysis needs to be completed and once that is finished more of the data to date can be analyzed. A more thorough analysis of the profitability of a staggered versus sequential harvest strategy will be done once the trial is completed.

Relevance of the Research to California Agriculture

Profitability is definitely a key issue, if not the key issue, for California agriculture. Alfalfa is one of the few commodities that have been consistently profitable for many California farms. Forage quality directly affects the price received and therefore profitability. There is a large yield penalty if growers harvest alfalfa at the early maturity stage necessary to produce the quality currently demanded by the dairy industry. Often growers fall just short of dairy quality alfalfa missing the premium price and still not achieving top yield. A cutting management strategy is needed to improve the profitability of alfalfa production in California so that growers can have more of their alfalfa meet the quality requirement for dairy quality hay while still achieving reasonable yield and stand life on the whole farm. The staggered cutting approach evaluated in this study has potential to improve profits by harvesting alfalfa at times when returns are highest. Stand life may also be improved by giving plants a "resting period" between dairy quality cuttings. While these results are from the intermountain area of California, the concept may be relevant for other areas of the state as well.

Appendix

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	7.95
14	6/9, 7/10, 8/9,9/15	Seq 4	2.83	2.20	1.80	1.22	8.06
15	6/11, 7/12, 8/11, 9/18	Seq 4	2.81	1.88	1.92	0.91	7.52
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.

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.)

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**

The results of this research have been presented at numerous grower meetings, Field Days and professional society meetings. The trial was featured at a Forage Field Day held at IREC in September of 2002. The results were presented at the National Alfalfa Improvement Conference held in Sacramento in July of 2002. A presentation of the preliminary data and a proceedings article were prepared for the Western Alfalfa Conference held in December of 2002 in Reno, NV. A presentation was given at the American Society of Agronomy meetings in Indianapolis in 2003. The results of this research were presented at the National Alfalfa Symposium in San Diego in December 2004. A refereed journal article is expected upon completion of the project. It will most likely be published in the American Society of Agronomy journal Forage and Grazinglands and/or California Agriculture.