The Influence of Management Methods on Seedings of Perennials in the Annual Range Area

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Increasing the yield per acre, reducing the year-to-year fluctuation in production, and improving the quality of forage is sound range conservation. In California the foothill range is composed principally of annuals. The annuals have a short green period and production is low and varies greatly from year to year (Bentley and Talbot, 1951).

The Three-Point Range Improvement Program that was developed by the Soil Conservation Service has given great promise for range improvement (Chohlis, 1954). The first step is the fertilization of portions of the annual range with ammonium-phosphate-sulphate. Hoglund, *et al.* (1952) showed that fertilization increased production, lengthened the green feed period, and gave more uniform yield among years. The second step is the seeding of selected sites to a Hardinggrass-legume mixture. The seeded sites are also fertilized annually. The seeded areas provide green feed before the fertilized annuals are ready to graze and after they have dried (Miller, *et al.* 1953). The third step is the use of a system of grazing by which the seeded mixture, fertilized annuals, and unimproved portions of the annual range are grazed in rotation. The method of grazing the Hardinggrass-legume mixture in this system to maintain yield and composition is a most important objective of management.

The results of clipping trials to simulate 3 methods of managing grazing of a Hardinggrass-legume mixture are reported in this paper. The work was done by the Pleasanton, California, Soil Conservation Service Nursery in cooperation with the California Agricultural Experiment Station, Davis, California.

Methods

Clipping trials to simulate grazing were made near Sunol, California, on typical annual range under lease from the City of San Francisco Water Department. The annual rainfall averages 16 inches and falls mainly in the five months November through March. The inherent conditions of this site are typical of about two and a half million acres of annual range in California. Much of this land has been dry farmed to grain at one time or another but has been abandoned, has reverted to annual forage, and is now used for grazing. The soil is rated as grade 4 (35 per cent) by Weir and Storie (1936). It is mapped tentatively as Positas gravelly-clay loam. According to the Soil Conservation Service Soil Survey, it is in land

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capability classes III and IV (Wohletz and Dolder, 1952). From 25 to 75 per cent of the surface soil has eroded away. The sub-soil is a stiff red clay which retards the downward movement of water and retains moisture.

Land preparation for these trials was done according to the system developed by the Soil Conservation Service (Miller, *et al.*, 1953). A contour field 40 feet wide and 400 feet long was worked in the spring of 1949 before the earliest annuals produced seed. During the summer a crop of Sudan grass was grown to complete the preparatory land treatments. The Sudan was fertilized with 100 pounds per acre of ammonium sulphate (20-0-0) at the time of seeding and was cut for hay.

In the fall after the first rain, a good firm seedbed was prepared by disking, harrowing, and cultipacking, and a mixture of Hardinggrass (*Phalaris stenoptera*); Mt. Barker sub-clover (*Trifolium subterraneum*); and burnet (*Sanguisorba minor*), diluted with rice hulls, was seeded on the area. The rates of seeding were Hardinggrass, 4 pounds; Mt. Barker sub-clover, 5 pounds; and burnet, 3 pounds per acre. In the establishment year the entire seeding was clipped twice for weed control.

Prior to the first rain in the fall of 1950, and each fall thereafter, 200 pounds per acre of ammonium-phosphate-sulphate (16-20-0) was broadcast over the area. The tract was then divided into four plots, each 10 feet wide and 400 feet long. Each plot was clipped in a different manner to simulate three different methods of grazing management. The three methods included *continuous* use on one plot, *modified rotation-deferred* use on two plots, and *early and late* use on the other plot. These simulated management plans from a season of use standpoint, are illustrated in Figure 1.

Clipping was done with an ordinary mowing machine. Air dry yields from each clipping were taken and separations made to determine the amount of perennials and annuals and, in some cases, the amount of legumes. The clipping treatments were begun in 1951 and repeated for 5 years.

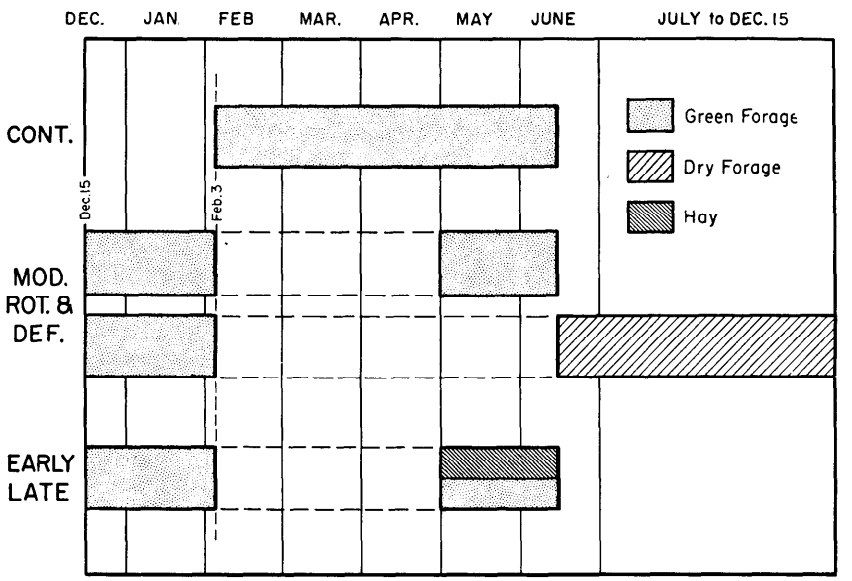

FIGURE 1. Season of use chart for three systems of grazing.

The first clippings on the continuous use plot were made at the grazing readiness of Hardinggrass (4 to 6 inches). The forage was cut back to a height of 2½ inches. Subsequent clippings were made each time the Hardinggrass reached a height of 8 inches, and these clippings were made to leave a 4-inch growth.

The two plots used in the modified rotation-deferred system were both harvested in the early part of the growing season when the fertilized annual range (in adjacent plots) was ready to graze. This was 4 to 6 weeks after the Hardinggrass had reached readiness. One of these plots was harvested again at the late growth stage of the Hardinggrass, which coincided with the end of the green feed period of the annual range. The early and late clipping dates in this treatment were adjusted to the readiness and to the end of the green feed period of the fertilized annual range because, in the Three-Point Range Improvement Program, fields of seeded perennials are grazed before fields of fertilized annual range and again after the annual range is dry. The harvest of the other plot was deferred until the Hardinggrass had produced some seed but was still partially green. The plots harvested at the late and the deferred periods were alternated each year.

In the early and late use management method, the plot was clipped first when the fertilized annual range was ready to graze and the late clipping was made when the annual range was dry. Hardinggrass had made its maximum vegetative growth at this time but remained green for an average of another 6 weeks. The same plot was used each year for this treatment.

The average dates at which clippings were made for each treatment are shown in Table 1.

Results

The three systems of management affected yield per acre, date of grazing readiness in early winter, and the composition of the forage.

The annual yield per acre as influenced by treatment is shown in Table 1. The highest average yield for the 5 years was obtained from

Table 1. Influence of system of management and season on the production of forage by a Hardinggrass-legume mixture in the annual range area.

Year	Continuous					Modified Rotation-Deferred				Early-Late		
	1st	2nd	3rd	4th	Total	Early	Late	Deferred	Total	Early	Late	Total
						Pounds per acre, air-dry						
						672	→	5,650	6,322			
1951	748	1,364	1,004	752	3,868	672	5,576	←	6,248	392	3,744	6,236*
						1,444	→	5,504	6,948			
1952	1,028	444	1,540	180	3,192	1,480	5,720	←	7,200	872	6,452	7,324
						388	→	2,944	3,332			
1953	564	244	872	304	1,984	524	1,940	←	2,464	200	2,540	2,740
						240	→	3,788	4,028			
1954	176	200	384	1,752	2,512	216	3,860	←	4,076	128	4,708	4,836
						16	→	1,800	1,816			
1955	16	84	216	1,320	1,636	108	2,880	←	2,988	32	3,884	3,916
Average	506	467	803	862	2,638	576	3,996	3,938	4,542	324	4,266	5,010
Average Date Cut	Feb. 3	Mar. 10	Apr. 4	May 1		Jan. 28	May 3	July 12		Jan. 28	May 3	

* Includes 2,100 pounds per acre regrowth after the late cutting.

the early-late system and the lowest from the system reflecting continuous use. The difference was more than 2,300 pounds. The average annual production from the modified rotation-deferred system was slightly less than from the early-late system.

Total annual yield from the three systems varied by treatment in the same way as did the averages for the 5 seasons. The annual yield varied with differences in growing conditions as influenced by weather. The variation was somewhat less in the system reflecting continuous use, but the continuously used plot failed to respond to above normal rainfall and temperature in 1952.

Average production of forage at the early cutting was greater from the rotation-deferred system than from the early-late system. The difference was approximately 250 pounds, which represented at least 0.3 animal-unit-months of grazing per acre. However, the difference in yield at the late cutting in these two treatments was reversed. Late cuttings in the early-late system produced an average of 4,266 pounds of forage which represented about 5.33 animal-unit-months of grazing per acre. The average production from late cuttings in the rotation-deferred system of grazing was equivalent to approximately 5 animal-unit-months of grazing.

The average yield from the deferred plots in the rotation-deferred system was essentially the same as that from the late plots. The deferred plots were clipped approximately 2 months after the late plots. The Hardinggrass had set some seed, but the stems and some leaves were still green. No estimate of grazing capacity was made on this cutting, but experience in the field shows that its value is at least 25 per cent of that of green forage.

Table 2 shows the date of grazing readiness for each year under the three methods of harvest. The plots were regarded as ready to graze when the Hardinggrass was 4-6 inches tall. The table also shows the end of the green feed period. The same dates are shown for fertilized annual range in adjacent plots because it is used in rotation with seeded perennials in the Three-Point Range Improvement Program.

There was no difference in the date of readiness between the early-late and modified rotation-deferred systems in any year. The Hardinggrass consistently reached grazing readiness on or before mid-December. The date of grazing readiness on the continuous use treatment was always later than on the other treatments and varied widely by years.

When the readiness dates of the early-late and rotation-deferred systems are compared with those of the fertilized annuals, it will be seen that they were always earlier and more consistent.

Table 2 also shows the end of the

Table 2. Date of grazing readiness and end of green-feed period of a Hardinggrass-legume mixture as influenced by system of management and season. Data for fertilized annual range are shown for comparison.

Modified Rotation-Deferred Year	Perennials: Date of Grazing Readiness			Perennials: End of Green Feed Period	Fertilized Annuals: Date of Grazing Readiness	Fertilized Annuals: End of Green Feed Period
	Continuous	Modified Rotation-Deferred	Early-Late			
1951	Nov. 23	Nov. 23	Nov. 23	June 8	Dec. 15	Apr. 16
1952	Feb. 21	Dec. 10	Dec. 10	June 18	Dec. 17	Apr. 29
1953	Jan. 7	Dec. 10	Dec. 10	June 10	Dec. 20	May 1
1954	Jan. 10	Dec. 15	Dec. 15	June 15	Feb. 25	May 3
1955	Dec 15	Dec. 7	Dec. 7	July 1	Jan. 26	May 15

green feed periods for the seeded plots. The average date was about June 15. It varied slightly by season and was the same for all treatments. The dates for the end of the green feed period for the fertilized annuals are also shown. The average date was about May 1 and varied by season in the same manner as did the end of the green feed period of the Hardinggrass. The annual range was dry and had cast some seed at this date. The Hardinggrass in the seeded plots remained green an additional 6 weeks.

Table 3 shows the composition of the forage from the seeded plots as affected by treatment, season, and age of stand. The forage was divided into three kinds: Hardinggrass, subterranean clover, and annual grass and filaree. Treatment was the greatest factor affecting composition.

Table 3. Influence of system of management and season on the composition of forage from seeded perennials on annual range.

	Treatment			
	Continuous	Modified Rotation-Deferred		Early and Late
		Early-Late	Early-Deferred	
	Percent	*Percent*	*Percent*	*Percent*
1951				
Harding	43	31	38	52
Sub-clover	50	20	20	20
Annuals	7	49	42	28
1952				
Harding	22	38	22	30
Sub-clover	56	19	0	30
Annuals	22	43	78	40
1953				
Harding	20	37	32	30
Sub-clover	55	12	5	25
Annuals	25	51	63	45
1954				
Harding	12	17	25	30
Sub-clover	22	10	5	19
Annuals	66	73	70	51
1955				
Harding	20	25	25	30
Sub-clover	10	5	1	8
Annuals	70	70	74	62

In the system of harvest that simulated continuous use there was always more subterranean clover than in the other treatments. More than 50 per cent of the forage was clover in some years. When the clover content was high, the grasses in the plots were observed to have a deeper green color after early April, when mean daily temperatures exceeded 56°F.

The percentage of Hardinggrass decreased and the annual grasses increased under the continuous use treatment. The data are not shown, but foxtail fescue (*Festuca megalura*) increased markedly in plots that were frequently clipped.

In the rotation-deferred system of management, the percentage of clover decreased, annuals increased, and Hardinggrass was reduced to 25 per cent. The data in Table 3 show that the clover was always reduced more following the season when the seeded plots were deferred. There was a marked increase in the percentage of ripgut brome (*Bromus rigidus*) when the modified rotation-deferred system was used.

The early-late method of harvest resulted in the highest percentage of Hardinggrass and a desirable percentage of clover. The stand, vigor, and yield of the Hardinggrass were remarkably uniform with this treatment. This method favored the maintenance of soft chess (*Bromus mollis*) and wild oats (*Avena fatua*) among the annuals which are always present on seeded areas. These grasses are regarded as good forage. Very little ripgut brome or foxtail fescue occurred on this plot.

Discussion

The objective of this study was to determine the effect of systems of grazing management on the yield, vigor, and composition of a seeded Hardinggrass-subterranean clover mixture in the foothill range area of California. Such seedings can be made successfully on selected sites in this area (Miller *et al.* 1953). They yield well and are outstanding in increasing the green feed period. Little is known about management requirements when these seeded pastures are rotated with pastures of fertilized annual range and of untreated annual range.

It is commonly known that systems for grazing perennial grasses in the winter wet-summer dry climates of the West must be designed to allow adequate food storage (Sampson, 1951). It is also known that systems of grazing may affect the grass-legume balance in mixed seedings.

In the present study the best management of the Hardinggrass-subterranean clover mixture was the early-late system. The early cutting was made when the adjacent plots of fertilized annuals were ready to graze. This was about 6 weeks after the seeded mixture had reached range readiness. The late cutting was made at the end of the green feed period of the annual range. This early-late treatment retained the vigor of the perennial Hardinggrass, maintained a desirable percentage of clover, did not retard range readiness, and prevented the invasion of ripgut brome and foxtail fescue. This favorable result was unexpected since other studies have shown that harvesting perennials at the same growth stage each year tends to reduce their vigor, especially on sites of relatively low capability. Perhaps the annual application of ammonium-phosphate-sulphate (16-20-0) and the favorable response to it compensated for

the effects of the harvesting method. Also, the presence of a desirable percentage of subterranean clover may have been of benefit in maintaining the vigor of the Hardinggrass.

The satisfactory result with the early-late system of management simplifies the application of the Three-Point Range Improvement Program, since the seeded area does not require cross fencing for rotation-deferred grazing.

The early-late system of management is well adapted to the Three-Point Range Improvement Program used in the annual range area. This program combines the use of fields of unfertilized annual range, fertilized annual range, and seeded perennials. It extends the green feed period 6 weeks to 6 months and increases total forage production by at least 66 per cent. When grazing is withheld until range readiness, the forage is properly utilized, and the seeded areas are grazed by the early-late system, forage production is more uniform among years, desirable species are maintained, good-quality hay can be harvested, and there is sufficient residue for soil, water, and plant conservation.

The early-late system of management produced a large amount of forage at the late cutting, an average of about 4,200 pounds per acre. In designing a grazing management system on a ranch, at least one-half of this forage could be used as hay. The quality would be good if the hay were cut at the end of the green feed period of the annuals. The hay could be used in late summer, fall, and early winter. This would reduce the need for feeding the supplements usually required during these periods. The remaining half of the area could be grazed for 6 weeks. The forage contained 30 per cent by weight of Hardinggrass during this period. In actual experience on ranches, cattle have continued to gain on this forage without supplements.

The modified rotation-deferred system of management used in this study resulted in reduction of the clover in the mixture and in the invasion of ripgut brome. The stand of Hardinggrass was somewhat reduced, and its vigor, though satisfactory, was not superior to that in the early-late system. It was shown that the rotation-deferred system resulted in higher yields in early cuttings than the early-late system but did not advance the date of grazing readiness or increase total per-acre production. As the stands increased in age they gave evidence of decline in yield under this treatment. This suggests a possible interaction between total yield and percentage of clover in the stand. It was observed that plots containing 20 per cent or more of clover were darker green, beginning about midseason, than those with little or no clover.

The continuous use system was used in this study as a check against the other two systems and not because it has application in the Three-Point Range Improvement Program. The continuous use system gave low yields, retarded the date of grazing readiness, and allowed the invasion of foxtail fescue. The percentage of Hardinggrass was the lowest of any of the three treatments. However, the frequent clippings used in the continuous system resulted in the highest percentage of subterranean clover.

Summary

Seedings of perennial grasses and legumes on selected sites in the annual range area can successfully be used to extend the green feed period. Seedings of perennials reach range readiness an average of 4 to 6 weeks sooner than fertilized annuals and they provide green feed for 6 weeks after the annual forage range is dry. Seeded perennials aid conservation of annual forage range when they are worked into a grazing management plan with fertilized annuals and non-fertilized annuals.

Management of Hardinggrass-legume seedings to maintain good stands, vigor of the plants, and desirable composition was studied for 5 years. Three methods of management were used. Data on yield, floristic composition, and range readiness were obtained.

Methods of management to simulate continuous use gave the lowest per-acre yield, greatly delayed grazing readiness, allowed the encroachment of foxtail fescue, but resulted in the highest percentage of clover. The system reflecting a modified rotation-deferred use resulted in high per-acre yields but almost eliminated the self-seeding legume and allowed the most encroachment of undesirable ripgut brome. A system that exemplified early-late use gave the highest yield, maintained a desirable percentage of legume, and allowed invasion of only slight amounts of undesirable annual grasses.

The early-late system of use fits well into the Three-Point Range Improvement Program. This program provides for the planned management of the range using three kinds of pasture—Hardinggrass-legume mixtures, fertilized annuals, and unfertilized annuals. The stand and vigor of the seeded mixture which was fertilized annually were unimpaired under the early-late use system.

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