Table 3. Intake and cow performance for the 1976-77 trial

	Treatment		
	High	Medium	Low
	lb	lb	lb
Initial weight (10-20-76), lb	1127	1123	1123
Final weight (1-12-77), lb	1199	1137	1069
Weight change, lb	72	14	-54
Hay intake, lb	20.2	16.8	13.4
Cost of feed/hd/day[1], $	.61	.50	.40

[1] Alfalfa-grass hay @ $60 a ton.

PARAQUAT PLUS MEADOW EQUALS WINTER GRAZING

Forrest A. Sneva and H. A. Turner

Chemical curing of grasses is a potential alternative method of haying some of our flood meadows. Currently, this method, using Paraquat has not been approved by the Environmental Protection Agency. Clearance for this use, however, is being sought, but the outcome is uncertain.

Paraquat (1,1' dimenthyl - 4,4' bipyridinium bis (methylsulfate), is a nonvolatile, moderately toxic chemical used as a contact herbicide and crop dessicant in many areas of modern agriculture throughout the world. As a chemical for curing grasses, it is the rapid dessicating action that is important. Drying the plant rapidly prevents the nutrients in the herbage from being translocated. As long as the crop treated is not subjected to numerous heavy rains, which will leach some nutrients, the forage quality can be retained in the standing crop for 6 to 8 months with only minor losses. Thus, chemical curing is ideally suited to those haylands within the semiarid region where summers and falls are dry. These haylands occur throughout the area bounded by the Rockies on the east and the Cascade-Sierra Nevadas on the west and extend from northern Arizona to central Washington.

Research on chemical curing at the Squaw Butte Experiment Station began in 1960. Initially, and in the following 10 years, the studies concentrated on the curing of desert grasses for late season grazing. Results of those studies were published. With the cost of labor, machinery, and fossil fuel driving the cost of haying to exceptional high levels in the earlier 1970's, we diverted the research effort to the meadows. This report summarizes the results of studies conducted in 1974 through 1976.

PROCEDURES

In the summer of 1974, meadow hayland was treated as follows: (Pasture 1) mowed, baled, and stacked (13.5 ac) on July 19; (Pasture 2) treated with 0.5 lb Paraquat[1/], active ingredient/ac plus 0.5% X-77 (wetting agent) in 17 gallons water (14.4 ac) on July 24 and (Pasture 3) left standing to cure naturally (19.1 ac). Seventy head of spring calving cows were stratified by weight and age and randomly allotted to the three hay treatments on November 5, 1974. Pastures 1, 2 and 3 were assigned 16, 24 and 30 head, respectively. The feeding-grazing schedule is shown in Table 1.

Table 1. Spring cow feeding and grazing schedule - winter 1974-75

	Hay treatment		
	Baled	Paraquat cure	Natural cure
	(Pasture 1)	(Pasture 2)	(Pasture 3)
11/5/74-12/3/74	Pasture aftermath	Pasture	Pasture
12/3/74-1/10/75	Baled hay	Pasture	Pasture
1/10/75-2/13/75	- - - - Common pasture	- stacked long hay - - -	
2/13/75-2/25/75	Baled hay	Pasture	Pasture

In 1975, during the first days of August, all 3 pastures (60.5 ac) were treated with Paraquat at the same rate as in 1974. Pasture 2 (14.4 ac) was cross-fenced into 3 smaller pastures. On November 11, 63 head of spring calving cows were stratified by weight and age, with 28 being allotted to Pasture 2 and 35 to Pasture 3 (19.1 ac). The cattle remained in these pastures until January 7. By that time cattle in Pasture 2 had utilized 2 of the 3 small pastures. At this time 2 early calving cows were removed, the remaining 61 head were transferred to the unused Pasture 1. On the fourth day of February, cows due to calve were again removed and the remaining 29 head were transferred back to the unused portion of Pasture 2. These cattle were removed on the third day of March. During the period of March 9 to April 23, 39 head of replacement heifers cleaned up the remaining forage in the three pastures.

Pasture production was estimated from clipped plots at normal haying time and prior to grazing in the fall. The average bale weight and number of bales were used to estimate the production of Pasture 1. Crude protein concentrations were determined from field grab samples, compositing 20 locations per sample. Hay samples for determining Paraquat residue were obtained 131 and 159 days after treatment. Each sample consisted of 3 pounds of oven dry hay obtained from 12 random locations within each field. Residue analyses were conducted by the Chevron Laboratories in Richmond, California.

1/ Paraquat has not been registered by the U.S. Environmental Protection Agency for this use. The use of a trade name does not imply its endorsement above that of similar products.

Cattle were individually weighed onto the pastures following an overnight shrink off feed and water. They were weighed thereafter at approximately 28 day intervals. Records were maintained on calf birth weight and calf drop date. These cows were bred during June and July and were pregnancy checked in the fall by rectal palpation.

In 1975 plots of meadow vegetation were treated July 31 with 0, 0.2, 0.3, 0.4, and 0.5 lb Paraquat per acre plus 0.5% X-77 in 19 gallons of water. Application was with a standard, tractor mounted, crop spray boom. On half of the boom the spray was released above the canopy and on the other half it was released within the vegetation using 18" drop tubes. Treatments were replicated 4 times. Vegetation within each plot was sampled on July 28, September 8, October 3, and November 5 and crude protein concentrations of all samples determined.

RESULTS AND DISCUSSION

Crude protein concentrations of standing hay treated with Paraquat in 1974 was equal to that of the baled hay at the start of grazing (Table 2). Concentrations 1975 (Table 3) were not as high as they were in 1974. The lower hay quality in 1975 was caused by delayed harvesting due to a long flooding season. Good retention of crude protein in the plant is an expression of chemical effectiveness and favorable weather following application. In both years the small amount of rain received during August, September, and October (Table 4) caused very little leaching of crude protein. Physical loss of cured vegetation is minimized when the herbage remains dry and retards biological breakdown of plant tissue. A declining trend in crude protein through the winter of 1974-75 is evident but this was the result of sampling unused vegetation during a grazing period. Thus, by the 21st of February the remaining forage left ungrazed contained only 4.4% crude protein. The rapid decline in crude protein concentrations in standing meadow grasses left to cure naturally (Table 2) is convincing evidence that this is not a good management technique. Crude protein can be effectively retained by chemically curing for 6 months or longer. This was evident in 1975-76 when samples from the ungrazed sub-unit of Pasture 2 sampled on February 25, 1976 was somewhat higher than samples taken 7 months earlier.

Table 2. Crude protein concentrations in forage-hay samples, winter 1974-75

	Hay treatment		
Date	Baled	Paraquat cure	Natural cure
	%	%	%
7/24/74	---	7.8	6.8
11/4/74	6.8 1/	7.6	3.6
12/2/74	7.7	6.6	3.2
12/30/74	6.8	6.4	2.8
2/21/75	---	4.4 2/	2.2

1/ Crude protein concentrations of pasture aftermath.
2/ Crude protein concentrations of forage remaining in grazed fields.

Table 3. Crude protein concentrations in Paraquat cured hay, 1975-76

Date	Pasture no. 1	Pasture no. 2	Pasture no. 3
	%	%	%
August 5, 1975	6.6	7.0	6.3
November 4, 1975	---	7.6	6.8
December 10, 1975	---	5.1 1/	6.1
January 16, 1976	5.9	---	--- 1/
February 4, 1976	---	---	5.8
February 25, 1976	---	7.8 2/	---

1/ Crude protein concentrations of available herbage in pastures being grazed.

2/ Sample from ungrazed sub-unit pasture.

Table 4. Precipitation, snowfall, and mean temperature in the test years 1974-75 and 1975-76

Period	Precipitation 1974-75	Precipitation 1975-76	Snowfall 1974-75	Snowfall 1975-76	Temperature 1974-75	Temperature 1975-76
	Inches		Inches		°F	
Aug. - Oct.	0.45	1.61	----	----	----	----
November	0.11	0.82	0.1	5.2	37	34
December	1.36	1.64	9.9	9.9	25	28
January	1.54	1.49	15.9	11.8	25	30
February	1.78	1.46	13.0	10.5	30	30

Forage production, animal performance, and hay treatment costs are presented for the 1974-75 study in Table 5. Pasture 1, on the basis of past production is the most productive pasture with Pasture 3 being the lowest. The low yield of Pasture is in part due to a loss of cured plant parts and cessation of growth shortly after the plant was treated with Paraquat. In the 2 years, it was estimated that this loss ranges from 10 to 15%. The yield of Pasture 3 is also high relative to Pasture 2 because growth continued after Pasture 2 was treated with Paraquat.

Table 5. Summary of hay treatment costs and returns 1974-75

	Hay treatment		
	Baled	Paraquat cure	Natural cure
	Pasture 1	Pasture 2	Pasture 3
Number of cows	16	24	30
Mean pasture yield, t/ac	3.58	2.01	2.39
Average daily gain, lb 1/	0.47	0.38	-0.38
Intake, lb/hd/dy 2/	28.1	27.8	22.3
Cost/ton of hay, $	20.0 3/	6.91 4/	---
Animal unit days	72.3	71.9	89.7
Cost/animal unit day, $	0.28	0.10	0.20 5/

1/ Mean from 11/5/74 to 2/25/75.
2/ Computed from pasture yield & days of grazing.
3/ Estimate of 1974 contract costs of harvesting and feeding out.
4/ Paraquat at $44.50/gal, X-77 at $12.00/gal and $1.70/ac application cost.
5/ Supplement cost in final grazing period of 20% protein at $150/t and daily intake of 2.7 lb/hd.

Cows gained weight on forage alone from all pasture treatments during the first 28 days. Cows on Paraquat cured hay and natural cured hay lost weight thereafter except when fed long hay during the month of January. The average daily gain for cows grazing Paraquat cured forage, however, was only 0.1 lb/day less than cows fed baled hay (Table 5). The poor quality of natural cured hay is clearly shown by the 0.38 lb daily loss even when supplemented in the final period. In the 1975-76 wintering period of 144 days the average daily loss of cows on Paraquat treated forage was -0.04 (Table 6). The average daily gain ranged from a +3.1 in the late fall period to a negative loss of -1.9 lb during the winter period.

Table 6. Average daily gain of cows wintered on Paraquat cured standing meadow hay, 1975-76

Period	Pasture no.		
	1	2	3
	lb	lb	lb
11/11/75 - 12/10/75	---	2.1	3.0
12/10/75 - 1/7/76	---	-0.9	-1.3
1/7/76 - 2/4/76	-1.0	---	---
2/4/76 - 3/3/76	---	-1.9	---
114 day mean	- - - - - - -	-0.04	- - - - - - -

The high positive gains in the fall period is evidence that the forage quality is adequate and that these cows are getting a full feed. The weight losses are all occurring after climatic conditions worsened, i.e., colder temperatures and the occurrances of cold rains or snowfall (Table 4). The presence of snow interfered with the availability of forage and intake was reduced. Diurnal thawing and freezing at the ground surface level further complicated grazing. Cold wet weather also increases the animals' nutrient requirements and the wet frosty forages may require more energy for conversion inside the rumen. Greater negative gains in the 1974-75 winter would have occurred in cows on the Paraquat cured and natural cured forage if emergency feeding of long hay had not been done. The winter of 1974-75 was colder and snow depth greater and more continuous than in 1975-76.

If cows go into the winter in a fleshy condition, as the above animals on study, little or no gain or even negative gains are acceptable. This is a decision that must be made based upon the condition of the cows and feed resources which are available prior to and after claving. Weight loss of 100-200 pounds for fat cows during the early winter period is acceptable as long as the cow is fed to place her in a positive gain status a few weeks prior to calving to prepare her for milk production. Adequate post calving feed levels are important to allow for cycling and breeding back within the desired breeding season.

Grazing Paraquat cured meadow hay in the winter caused some problems that a rancher needs to consider. These problems are related more to assuring adequate intake rather than hay quality. The degree to which these problems affect cow performance will depend greatly on weather conditions and thus the magnitude of the problem will fluctuate from year to year. In those areas where snow is light, there may not be a problem. A wise rancher, however, will maintain an emergency forage supply or be ready to purchase outside forage if and when climatic conditions shut off a hay grazing program.

We believe that the reduced cost of treating meadow hay by chemical curing is great enough to offset the management problems one might encounter (problems that may also be reduced as we become more adept in management of such a system). Management of cured forage would be similar to that of bunched hay in that it would be beneficial to have large numbers on a small area to assure rapid cleanup and improved livestock performance. The local contracting cost in 1974 for swathing, baling, stacking and feed-out was estimated at $20.00/ton (Table 5). The total cost of chemical curing these pastures was $6.90/t. The cost of chemical curing in 1975 was estimated at $6.43/t, the difference being due to slightly greater pasture yields in 1975 than in 1974. The cost of an animal unit day during winter for the chemical curing treatment was approximately 1/3 that of the conventional method ($0.10 vs $0.28). It is also important to recognize that this reduction in cost reduces directly the annual operating cash expense.

In the two years of testing, Paraquat treated forage has not influenced calving date, birth weight or the ability of the cow to recycle and conceive. However, numbers of cattle for these kinds of information were limited and definite conclusions are not warrented at this time.

The initial study on rate of Paraquat suggests that 0.2 lb/ac Paraquat (active ingredient) is sufficient. No difference in crude protein concentration content resulted from any of the Paraquat rates tested (0.2, 0.3, 0.4, and 0.5 lb Paraquat, a.i./ac).

Dispensing the spray solution within the canopy was equally as effective as dispensing above the canopy. These results are important but need to be confirmed with additional testing. These results indicate that the cost of chemical curing may be further reduced by using lower application rates, consequently the residues of the chemical in the forage could be reduced, and the chance of spray drift and contamination to off-site areas would be reduced.

Residue analyses for Paraquat in standing cured hay for the 1974-75 have been completed. Paraquat residues from hays treated with 0.5 lb Paraquat/ac in 1974 ranged from 16 to 21 ppm at 131 and 159 days after treatment. The acceptable safe level of Paraquat in grazed forages is not known at this time. We would like to see it as low as possible. Should a rate of 0.2 lb Paraquat be proven suitable, a significant reduction of Paraquat residue in forage should occur. Also, the residue level in forage may not be as critical for animals that are not being fed for market as long as the residues are not transmitted to the fetus and accumulated therein.

IMPLICATIONS

Over 50% of the native hay produced in the Great Basin area is used for wintering the beef cow. The results so far indicate that cows can be wintered satisfactorly grazing hay cured with Paraquat. The potential exists, therefore, to reduce the annual cash outlay for haying costs in the region by about 25%. In Harney County alone, a small unit of this large area, the use of Paraquat on a portion of its 211,000 acres of meadow could effect a savings of over $1 million annually.

Money, of course, is not everything. Paraquat is a toxic chemical. If taken orally, it can cause death. The Environmental Protection Agency has tentatively classified Paraquat as one of the restricted use chemicals. Its final fate for agricultural use is yet to be determined. However, the toxicity of Paraquat is only one of the hazards a rancher might face. Ranching and farming by conventional means also risks life and limb. On western ranches the activities

associated with harvesting and feeding the hay to animals constitutes a large percentage of the total ranch equipment operation time. Mowers, swathers, balers, and farmhand equipment by necessity require, open, moving parts. As such they contribute heavily to deaths and accidents. Chemical curing would reduce the operation time of these kinds of equipment and should reduce significantly the overall safety problem on ranch operations.

The U.S. is currently facing an energy crises and is striving to become independent of foreign based energy supplies. Conventional haying mehtods require from 3 to 4 separate operations over the same field, each requiring considerable draft power. Paraquat curing is accomplished with a single operation which requires very little draft power. Thus chemical curing can effectively reduce energy needs on the ranch.