Supplementation of Dry Annual Range by Irrigated Pasture[1]

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Highlight

Supplementation of a low protein, high-fiber, dry annual-range forage by irrigated pasture appears feasible. Data indicate that irrigated pasture can be used to increase the amount, or improve the quality, of beef production, and that it can compete economically with cottonseed meal as a supplemental protein source for cattle grazing dry annual-range forage.

El Uso de Pastizales de Riego Como Suplemento en el Pastoreo de un Pastizal Seco de Especies Anuales.

Resumen[2]

El estudio se llevó a cabo en la Estación Experimental de la Universidad de California ubicado en Browns Valley, California, E.U.A. Los tratamientos fueron; (1) pastizal seco solamente, (2) pastizal seco mas harinolina cada tercer día, (3) pastizal seco más ocho horas de pastoreo en un pastizal de riego tres veces por semana y (4) pastizal de riego solamente. El pastoreo se realizó con novillos y el pastizal de riego fué una mezcla de gramíneas y leguminosas. Se encontró que el uso de un pastizal de riego como suplemento dió más ganancias y animales de mejor calidad que el suplemento de harinolina, resultando además más económico.

Supplemental feeding of grazing beef animals has long been a recommended practice (Allen, 1882). The use of cottonseed meal (CSM) as a protein supplement to range forage was reported as early as 1915 by Ward. Guilbert et al. (1944) and Wagnon et al. (1959), using CSM and other protein sources, showed that protein supplementation of beef animals grazing dry annual-range forage increases beef production per acre, percent calf crop, weaning weight of calves, and general thriftiness of the cattle. Further evidence of the need for protein supplementation is based on the chemical composition of dry annual-range forage as related to National Research Council (N.R.C.) crude protein requirements (Wagnon et al., 1942; Weir and Torell, 1959). Hull et al. (1969) have reported that irrigated pasture can supply sufficient protein and other nutrients for reasonable growth when used as a supplement to a synthetic low-protein roughage. Comparative average costs (Federal State Market News Service, 1967) for cottonseed meal and for irrigated pasture production (Raguse et al., 1967) support the approach of using irrigated pasture as an economical protein supplement. Based on these cost data, a unit of protein from CSM could cost as much as three equivalent units from intensively managed irrigated pasture. A 2-year study to investigate the performance of grazing animals when irrigated pasture is used as a supplement to dry annual-range is reported in this paper.

Experimental

The studies were made at the University of California Sierra Foothill Range Field Station, Browns Valley, California, at an elevation of approximately 450 ft and 39° latitude in the foothills of the Sierra Nevada Mountains. The climate is mediterranean, with cold, wet winters and hot, dry summers. Rainfall, generally restricted to the period October 15 to April 15, averages about 24 inches annually. The experimental area consisted of 75 acres of rangeland that had previously been cleared of trees and brush, but not reseeded, and 6.0 acres of irrigated pasture seeded in the fall of 1967 to a mixture of orchardgrass (*Dactylis glomerata* L.), perennial ryegrass (*Lolium perenne* L.), Ladino clover (*Trifolium repens* L.), and strawberry clover (*Trifolium fragiferum* L. 'Salina'). The rangeland was divided into three fields of approximately 30, 25, and 20 acres, and the irrigated pasture into areas of 1.8 and 4.2 acres.

Good to choice yearling beef feeder steers were used. The animals were vaccinated against leptospirosis and infectious bovine rhinotracheitis, treated for intestinal parasites, and individually number branded. During the trials each animal was weighed every 28 days after an overnight stand without feed or water. The steers were randomly allotted to the following treatments: (1) dry range only; (2) dry range plus cottonseed meal fed three times per week; (3) dry range plus irrigated pasture grazed three times per week (8 hours per day); and (4) irrigated pasture only. In treatment (2), CSM containing 20% salt was hand fed to obtain an average consumption of 2 lb./head per day the first year and 1 lb./head per day the second year. Following weighings, animals in treatments (1) and (2) were rotated between the 30- and 25-acre fields. Treatment (3) animals were allowed free access to the range (20-acre field), and limited access to the irrigated pasture (1.8-acre field) 3 days per week. This range was adjacent to the irrigated pasture. Treatment (4) was continuous grazing on irrigated pasture (4.2 acres), irrigated by a wheel-move sprinkler (Fig. 1). The sprinklers ran continuously but were moved daily in an 8-day irrigation cycle. The range was not grazed from January 1 until the dry forage season each year. The irrigated pasture, however, was grazed pre-trial each year but the animal production thus obtained was not credited to the experiment.

The trials were started when rangeland forage was dry, on June 24 and 25 in 1969 and 1970, respec-

[1] Received March 17, 1971.

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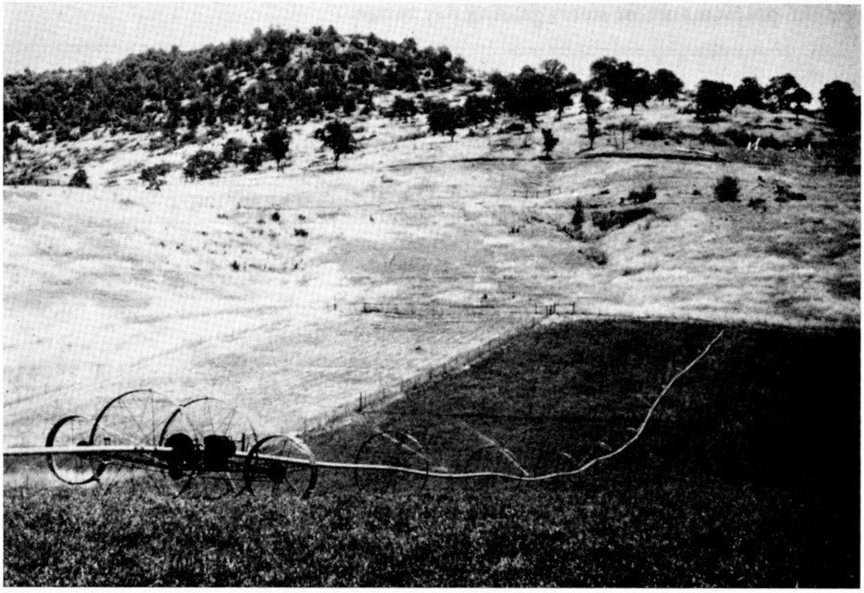

FIG. 1. Irrigated pasture and dry range area.

Table 1. Species composition (%) of irrigated pasture and dry annual range as determined by step-point analysis.

Species	Composition 1969	Composition 1970
Irrigated pasture[1]		
Dactylis glomerata	8	34
Lolium perenne	22	25
Trifolium repens (Ladino)	60	29
Trifolium fragiferum (Salina)	10	12
Dry annual range[2]		
Grasses		
Bromus mollis	20	
Other *Bromus* spp.	10	
Lolium multiflorum	12	
Festuca spp.	5	
Hordeum spp.	4	
Avena barbata	3	
Legumes, forbs, and misc.		
Trifolium dubium	7	
Medicago polymorpha	4	
Erodium spp.	7	
Miscellaneous[3]	18	
Litter, not identified, and bare ground	10	

[1] 1969 data: average over the period June–September; 1970 data: average over the period April–October.
[2] 1969 data only; sampled on May 16.
[3] From 23 other forbs and grasses generally less than 2% each.

tively. Forage samples from the range area were taken during the spring and summer of 1968 and 1969. Botanical composition of the irrigated pasture was determined during the summers of 1969 and 1970. Stocking rates on the irrigated pasture, and the amount of grazing time in the irrigated pasture-dry range treatment (3), were based on previous work by Hull et al. (1969).

Specific gravity of a representative group of animals slaughtered before the experiment began, and of all animals at the end of the trial, was determined as described by Garrett et al. (1959). Empty body weights were estimated by the method proposed by Lofgreen et al. (1962), and body composition was estimated by the method of Garrett and Hinman (1969). Energy gain and components of the gain were calculated by subtracting the average initial body energy or components from the final energy or composition.

Analysis of variance was used for the statistical analysis and the method of least significant difference was used to determine significance between treatments. The data were analyzed separately for each year but due to missing data during 1970 results from treatments 1, 2, and 3 were pooled for both years and only this analysis is reported in Table 2.

Results and Discussion

Crude protein and crude fiber contents of the available dry range forage during the late spring and summer months are indicated in Figure 2. The values were similar to those obtained in the southern Sierra foothills by Wagnon et al. (1942). There was a highly significant decrease in crude protein and an increase in crude fiber as the

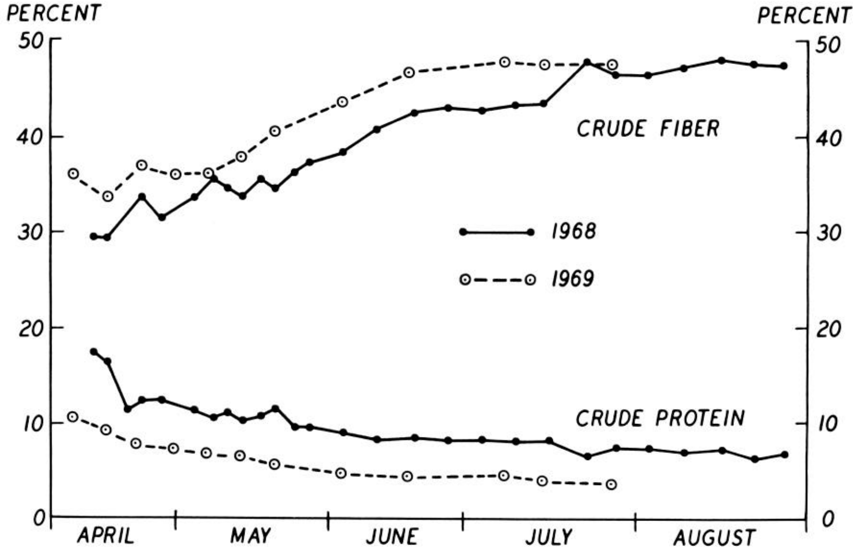

FIG. 2. Crude protein and crude fiber content of the dry range forage.

Table 2. The influence of protein source on the performance of steers grazing dry range.

Item	Treatment No.												Standard error of the mean[3]
	1			2			3			4			
	Dry range, no supplement			Dry range plus cotton-seed meal[1]			Dry range plus irrigated pasture[2]			No range, irrigated pasture			
	1969	1970	Mean	1969	1970	Mean	1969	1970	Mean	1969	1970	Mean	
No. of days	110	104	107	110	104	107	110	110	107	110	104	107	–
No. of animals	8	8	8	8	8	8	8	8	8	8	10	9	–
Initial wt (lb.)	638	671	655	620	664	642	646	664	655	662	564	613	21.73
Final wt (lb.)	651^{a4}	705^{a}	678	717^{ab}	746^{ab}	732	757^{b}	783^{b}	770	808	723	765	32.89
Live wt gain (lb.)	13	32	22.5	97	82	89.5	111	119	115.0	146	159	152.5	–
Avg daily gain (lb.)	0.12^{a}	0.32^{a}	.22	0.89^{bc}	0.78^{b}	0.83	1.01^{bc}	1.13^{c}	1.07	1.33	1.45	1.39	0.105
Avg daily gain/acre (lb.)	0.03^{a}	0.10^{a}	0.07	0.27^{ab}	0.23^{ab}	0.25	0.40^{b}	0.45^{b}	0.43	2.52	–	–	0.092
Dressing (%)	49.9^{a}	51.8^{b}	50.9	50.1^{a}	52.2^{c}	51.4	52.8^{d}	52.8^{d}	52.8	57.1	–	–	0.010
Energy gain/day (Mcal)	0.56	0.41	0.07	0.02	1.14	0.58	0.97	0.94	0.96	2.37	–	–	0.440
Daily energy gain (kcal/wt$^{3/4}$, lb.)	5.05	3.56	0.74	0.07	9.62	4.85	7.93	7.80	7.86	18.39	–	–	3.723
Daily energy gain (kcal/wt$^{3/4}$/acre)	1.51	1.07	6.22	0.02	2.89	1.45	3.17	3.12	3.14	34.94	–	–	1.275
FCC (lb.)	230.90^{a}	292.66^{ab}	261.78	256.76^{ab}	327.83^{b}	292.30	319.51^{b}	320.82^{b}	320.5	404.52	–	–	27.94
Gain in FCC (lb.)	3.92	2.65	0.63	0.63	7.84	4.24	10.25	9.14	9.70	116.37	–	–	3.673
Final grade	Std^{-}	Std^{-}	Std^{-}	Std^{-}	Std^{+}	Std	Std^{+}	Std	Std	Std^{+}	Std^{++}	Std^{+}	–

[1] 1.94 and 1.15 lb CSM consumed/head per day during 1969 and 1970, respectively.
[2] Irrigated pasture 8 hr/day Mon., Wed., and Fri.
[3] For treatments 1, 2, 3 only.
[4] a, b, c, d: treatments on the same line having the same superscript are not significantly different ($P < 0.05$ for treatments 1,2,3 only).

forage matured and the dry season approached. Standard deviations for these samples (1968 and 1969, respectively) were 2.01 and 1.26 for crude protein and 1.52 and 1.83 for crude fiber. Crude protein in the available dry forage generally was well below the 7.8% given by the N.R.C. (1970) as the minimal level for normal growth of beef cattle.

Botanical composition as determined by step-point analysis of the dry-range and irrigated-pasture forages are given in Table 1. The range forage consisted primarily of grasses (54%) and forbs (25%), with the legume fraction being only 11%. The irrigated pasture forage contained approximately 40% legumes and 60% grasses, with over 20% crude protein on a dry matter basis. Available dry matter on the dry range area, as determined in mid-May, 1970, by hand clipping, varied from 1500 lb./acre on the poorer sites to nearly 4000 lb./acre on the better sites, with an average of 2600 lb./acre.

Table 2 gives the annual animal production data. In 1969, average daily gain of animals on irrigated pasture (treatment 4) was significantly higher than for animals on the other three treatments. The average daily gains (ADG) of 1.33 and 1.45 lb./head per day, in 1969 and 1970 were similar to those obtained previously on irrigated pasture (Hull and Meyer, 1967). Response to addition of protein (irrigated pasture or CSM) to the dry range diet was apparent in both years. The decrease in the amount of CSM fed the second year did not result in significant changes in ADG, or ADG per acre, within treatments. However, the ADG for treatments 1 and 3 were slightly higher than those of the previous year. It is possible that differences between years in the feeding value of the dry range accounted for the lack of significant changes in ADG or ADG/acre within treatments, when the amount of CSM fed was reduced from 2 to 1 lb./head per day.

The most striking differences between treatments were in ADG/acre. With supplemental use of the irrigated pasture, the gain was 0.43 lb. as compared to 0.25 lb. for the CSM-supplemented dry range. Even though the cattle had free access to the irrigated pasture 3 days per week, they actively grazed the dry range forage on the other days.

There were no significant differences in the energy content of the gain between treatments. Wide differences in individual animal responses within treatments accounted for this lack of significance. Except for the 1969 CSM-supplemented animals, in which the energy content of the gain was very low, carcass energy responses followed closely those of ADG.

Increases in body weight with the various treatments followed similar

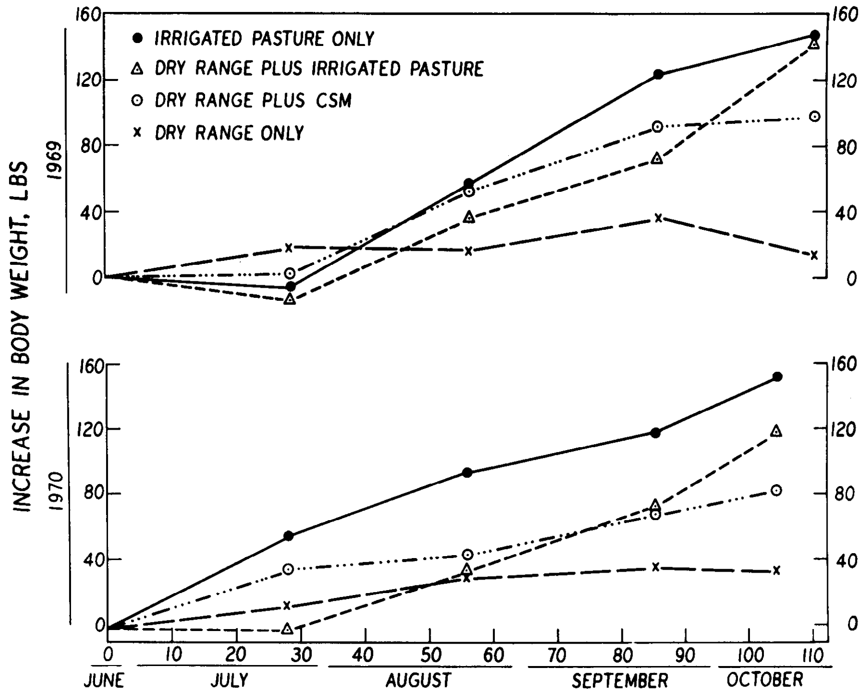

Fig. 3. Influence of grazing treatment on body weight.

general trends in both years (Fig. 3). Composition of the gain was mainly protein for animals exclusively on dry range and those on dry range plus CSM. In contrast, animals receiving irrigated pasture made a considerable part of their gain in fat.

It took over 3 months to get reliable trends when live cattle weights were used as the main criterion for treatment evaluation. Responses at the end of the first weigh period were particularly unreliable; but, even though some of the animals lost weight at the start of the trials, similar end points were reached each year. Low but significantly different dressing percentages (49.9 to 52.8%) resulted for the animals on high-roughage diets (Table 2), even though all cattle had been on the same diet previous to the start of the trials. This emphasizes that live weight results in experiments such as this should be further checked on a carcass basis (Meyer et al., 1960). When live weight gains were corrected to a standard metabolic body size (wt$^{3/4}$), or to a standard energy content of a carcass containing 1.297 kcal/lb., 17.3% protein and 20% fat, the same relationships between treatments were obtained. It was concluded, therefore, that, despite significant differences in dressing percentages, live weight gain can be used to evaluate the effectiveness of dry range supplementation.

The data presented indicate that supplemental irrigated pasture can be used advantageously to increase the amount, or improve the quality, of beef production by cattle grazing dry annual-range forage, provided this management option is economically feasible. Irrigated pasture can also compete favorably with CSM as a supplemental protein source for dry annual-range forage.

Literature Cited

Allen, L. F. 1882 (revised). American Cattle, Orange Judd Co., New York. p. 269.

Federal-State Market News Service. 1967. U.S.D.A. Consumer Market Service, Feed Market News, Weekly Ed. 48. p. 1.

Garrett, W. N., and N. H. Hinman. 1969. Re-evaluation of the relationship between carcass density and body composition of beef steers. J. Anim. Sci. 28:1–5.

Garrett, W. N., J. H. Meyer, and G. P. Lofgreen. 1959. The comparative energy requirements of sheep and cattle for maintenance and gain. J. Anim. Sci. 18:528–547.

Guilbert, H. R., G. H. Hart, K. A. Wagnon, and H. Goss. 1944. The importance of continuous growth in beef cattle. Calif. Agr. Exp. Sta. Bull. 688.

Hull, J. L., C. A. Raguse, D. W. Henderson, and J. H. Meyer. 1969. Supplementation of a dry annual range simulating roughage by use of irrigated pasture. J. Anim. Sci. 28:683–688.

Hull, J. L., and J. H. Meyer. 1967. Irrigated pasture for steers and lambs. Calif. Agr. Exp. Sta. Bull. 835.

Lofgreen, G. P., J. L. Hull, and K. K. Otagaki. 1962. Estimation of empty body weight of beef cattle. J. Anim. Sci. 21:20–24.

Meyer, J. H., G. P. Lofgreen, and W. N. Garrett. 1960. A proposed method for removing sources of error in beef cattle feeding experiments. J. Anim. Sci. 19:1123–1131.

N.R.C. 1970. Nutrient requirement of farm animals. Publ. National Research Council, Washington, D. C. p. 55.

Raguse, C. A., L. J. Berry, and J. E. Street. 1967. Irrigated pastures in California. Calif. Agr. Exp. Sta. Circ. 545.

Wagnon, K. A., H. R. Guilbert, and G. A. Hart. 1942. Experimental herd management. *In* Hutchison and Kotak, Calif. Agr. Exp. Sta. Bull. 663, p. 50–82.

Wagnon, K. A., H. R. Guilbert, and G. H. Hart. 1959. Beef cattle investigations on the San Joaquin Experimental Range. Calif. Agr. Exp. Sta. Bull. 765.

Ward, W. F. 1915. Cottonseed meal for feeding beef cattle. U.S. Dep. Agr. Farmers Bull. 655.

Weir, W. C., and D. T. Torell. 1959. Selective grazing by sheep as shown by a comparison of the chemical composition of range and pasture forage obtained by hand clipping and that collected by esophageal fistulated sheep. J. Anim. Sci. 18: 641–649.