PERENNIAL IRRIGATED PASTURES. II. AVERAGE DAILY GAIN AND CARCASS CHARACTERISTICS OF YEARLING BEEF STEERS ON IRRIGATED PASTURE SUPPLEMENTED BY ALFALFA CUBES[1]

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ABSTRACT

Recent high grain prices and other factors have led to a resurgence of interest in greater use of forages in beef production. An experiment was designed to test the effects of combinations of perennial irrigated pasture and alfalfa cubes on gains and carcass characteristics of yearling beef steers. The treatments consisted of irrigated pasture only, three combinations of irrigated pasture supplemented by increasing amounts of alfalfa (*Medicago sativa* L.) cubes, and a fifth treatment consisting of alfalfa cubes only. The pastures were 6-year-old stands of 55% orchardgrass (*Dactylis glomerata* L.), 25% strawberry clover (*Trifolium fragiferum* L.), 15% perennial ryegrass (*Lolium perenne* L.), and 5% Ladino clover (*T. repens* L.), providing a seasonal average grass: legume ratio of 70:30. The soil was the Yolo series of a fine-silty, mixed, nonacid, thermic, typic xerorthent entisol. Stocking rates were 7.7, 9.4, 11.6, and 15.5 animals per ha, respectively, for the above treatments during a 200-day grazing season. Average daily cube intake per animal for the five treatments ranged from zero through 1.7, 2.7, 4.3 and 9.9 kg, respectively.

Average daily gain, daily energy gain, and body weight gain for the irrigated pasture-only and all pasture-cube combinations were significantly different from the cubes-only treatment, but not from each other. Measurements of botanical composition and plant heights indicated that the various stocking rates imposed moderate and similar grazing pressures throughout the season.

The carcass characteristics of percent protein, fat, and water were statistically the same for all cube-pasture combinations, as was energy/kg gain.

Because of the absence of statistical significance (0.01 level) for differences in weight gain, energy gain, and carcass characteristics for the pasture-cube treatments, it was concluded that they were equal in relation to beef production and market quality. These management combinations, over the range studied, are therefore biologically sound and their acceptance would depend on economic and/or other factors.

Additional index words: **Grazing management, Beef steers, Pasture supplementation, *Dactylis glomerata* L., *Lolium perenne* L., *Medicago sativa* L., *Trifolium fragiferum* L., *T. repens* L.**

SUPPLEMENTATION of growing beef animals to meet specific nutritional or feed-volume requirements has long been regarded as both useful and economically sound. This would be true especially where high costs of land, irrigation, water, and labor make animal gain from pasture alone too costly to be economical.

Alfalfa (*Medicago sativa* L.) cubes, a relatively recent forage product, combine the advantage of uniformity with suitability for mechanical handling. Since they are eaten readily by most animals, pasture use and supplement intake are easily regulated.

With proper management, satisfactory gains for growing beef steers can be obtained on unsupplemented perennial irrigated pasture in the Central Valley of California (4). When cost:yield ratios are beneficial, however, supplementation with a high-energy feed or with alfalfa hay is common. Recent large increases in the costs of hay and grain have increased interest in using grazed forages as a larger proportion of the diet, especially if there is little or no effect on carcass composition.

A preliminary experiment, conducted the previous year, had shown a similarity of average daily gains and carcass characteristics of animals provided different combinations of cubes and pasture and indicated the value of an additional experiment designed to provide more detailed information on the effect of cube-pasture feeding on carcass composition. Therefore, the study reported here was done to evaluate plant response and prefinishing growth of beef steers when alfalfa cubes were used to supplement irrigated pasture.

MATERIALS AND METHODS

The pastures used were of established stands of orchardgrass (*Dactylis glomerata* L.), perennial ryegrass (*Lolium perenne* L.), Ladino clover (*Trifolium repens* L.), and strawberry clover (*Trifolium fragiferum* L. 'Salina'). The soil was the Yolo series of a fine-silty, mixed non-acid, thermic, typic xerorthent entisol. A two-field system of grazing management, in which the cattle were rotated weekly, was used. The fields were irrigated weekly with sufficient water to avoid plant moisture stress, but were not fertilized.

Four grazing and one adjacent dry-lot treatment were used. Stocking rates for these five treatments were respectively: 1) 7.7 steers per ha with no alfalfa cube supplementation; 2) 9.4, 3) 11.6, and 4) 15.5 steers per ha, with increasing alfalfa cube supplementation; and 5) alfalfa cubes only, fed *ad lib* in dry lot. The alfalfa cubes were produced locally by a John Deere field cuber with a die size of 3.0 cm. They were fed three times weekly, at an average of 1.7, 2.7, and 4.3 kg/animal daily for treatments 2, 3, and 4, respectively. Stocking rates and the level of cube supplementation were predetermined and based on previous experience (unpublished data) so as to provide adequate availability of forage (as judged by height and rate of growth) for grazing.

Good to choice yearling beef feeder steers were vaccinated against infectious bovine rhinotracheitis, leptospirosis, and bovine virus diarrhea, treated for intestinal parasites, and individually numberbranded. After an initial adjustment period of 3 to 6 weeks on similar pasture, they were allotted at random, seven to each treatment. All animals were weighed every 28 days during the experiment, after being without feed and water overnight.

Body composition of all experimental animals, including a representative group slaughtered before the experiment began, was determined. Carcass density, as described by Garrett and Hinman (3), was used to estimate body composition. Corrected carcass weights and empty body weights were estimated by methods proposed by Meyer *et al.* (7) and by Garrett and Hinman (3). Energy gain by the animals was calculated by subtracting the average initial body energy from the final body energy.

Average body weight, daily cube intake, and average daily gain data for animals in treatment 5 were used to calculate a total net energy value for the alfalfa cubes (6). This value was then used to estimate, by difference from calculated animal requirements, the daily intake of pasture dry matter (Table 1) assuming, for purposes of calculation, a 1:1 pasture:cube energy-exchange ratio and using the net energy principle of Lofgreen and Garrett (6). Net energy values for maintenance (NE_m) and

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Table 1. Feed consumption and liveweight gains by yearling steers fed pasture only, cubes only, and three combinations of pasture and cubes.

Item	Treatment				
	Pasture only 1	Pasture + cubes 2	Pasture + cubes 3	Pasture + cubes 4	Cubes only 5
No. days	200	200	200	200	200
No. animals	7	7	7	7	7
Animals/ha	7.7	9.4	11.6	15.5	---
Alfalfa cubes consumed, dry basis					
kg/head per day	---	1.7	2.7	4.3	9.9
kg/head, total	---	340	540	860	1,980
kg/ha, total	---	3,196	6,264	13,330	---
Pasture consumed, estimated*					
kg/head per day	8.6	6.8	5.9	4.1	---
kg/head, total	1,720	1,360	1,180	820	---
kg/ha, total	13,244	12,784	13,688	12,710	---
Total dry matter consumed, kg/head per day	8.6	8.5	8.6	8.5	9.9
Avg daily gain					
kg/head per day	0.75	0.70	0.70	0.70	0.90
kg/head, total	150	140	140	140	180
kg/ha, total	1,155	1,316	1,624	2,170	---

* Pasture dry matter consumption was calculated by using the net energy principle of Lofgreen and Garrett (6) and the assumption of 1:1 dry matter exchange of alfalfa cube and pasture dry matter.

Table 2. Initial and final liveweights and carcass characteristics of yearling beef steers fed pasture only, cubes only, and three combinations of pasture and cubes determined by stocking rate and amount of cubes fed.

Item	Treatment				
	Pasture only 1	Pasture + cubes 2	Pasture + cubes 3	Pasture + cubes 4	Cubes only 5
Initial liveweight, kg	214a*	219a	228a	213a	219a
Final liveweight, kg	364a	358a	366a	355a	399a
Initial empty body wt, kg	191a	195a	203a	189a	195a
Final empty body wt, kg	311a	307a	309a	301a	342b
Avg daily gain, empty body, kg	0.60a	0.56a	0.53a	0.56a	0.74b
Dressing percentage	57a	57a	56a	56a	58a
Fat corrected carcass, kg	185a	188a	184a	176a	239b
Energy gain/day, empty body, megacal	2.2a	2.3a	2.1a	2.0a	3.4b
Energy gain/day, kcal/wt$^{3/4}$	35.0a	36.0a	32.5a	32.8a	50.8b
Percent protein in gain	15.4a	14.7a	15.0a	15.7a	13.5a
Percent fat in gain	30.4a	34.2a	32.4a	29.1a	40.4a
Percent water in gain	50.6a	47.8a	49.1a	51.7a	43.0a
Energy/kg gain, megacal	3.7a	4.0a	3.9a	3.6a	4.6a

* Means on the same line followed by the same letter do not differ significantly at the 0.01 level (Duncan's new multiple range test).

production (NE_p) obtained from pasture dry matter were 5.46 and 2.94 megacal, respectively.

Analysis of variance was used to determine within-treatment animal gain and carcass differences, with Duncan's New Multiple-Range Test used to indicate significance among means.

Botanical composition of the pastures was determined with a modified step-point procedure (2). Pasture heights were measured before and after grazing, and averaged for all pasture treatments.

RESULTS AND DISCUSSION

Neither liveweight nor empty body gain per head per day differed among the treatments in which pasture provided part or all of the total intake (Tables 1 and 2). Similarly, dressing percentage, and weight of fat-corrected carcass were not significantly different for these treatments.

The significantly greater average daily gains of animals in treatment 5 (Table 1) were as expected, since intake and daily gains are increased by feeding cubes or wafers (1). While empty body gain, fat-corrected-carcass gain, and energy gain per day, on either an empty body or metabolic size basis, were improved with the cubes-only treatment, the characteristics of that gain (protein, fat, water, and energy content) were very similar for all treatments. Although the ratio carcass gain:maintenance was significantly larger for treatment 5 than for the other treatments, as shown by energy gain/day, kcal/wt$^{3/4}$, utilization of this additional energy did not change; although energy gain/day kcal/wt$^{3/4}$ was significantly greater in treatment 5 than in treatments 1 to 4, energy/kg gain, Megacal was not.

Estimated total energy (dry matter) consumption was very nearly equal for treatments 1 to 4, as was average daily gain (Table 1). In addition (Table 2), there were no significant differences in liveweight, empty body weight, or carcass characteristics, indicating that even when the intake of growing steers consists of about equal parts of dry and succulent forages, their energy gains and carcass characteristics are similar to those produced by animals on pasture alone.

Figure 1 indicates that the pastures were neither overgrazed nor undergrazed, as evidenced by the fact that 70 to 90% of the forage in all pastures fell into the height classes of 5 to 20 cm. Further evidence of moderate grazing emerges from the pattern of pasture heights observed before and after grazing. The proportion of tall plants was generally less after grazing, whereas that of short plants increased; the pivotal height class appeared to be 10 to 15 cm, i.e., plants of intermediate height. The overall pattern of before and after grazing heights was very similar for all pastures for the 3-month period measured. The increase in percentage of forage in the 1 to 5 cm height class, with a concurrent decrease in percentages of the 10 to

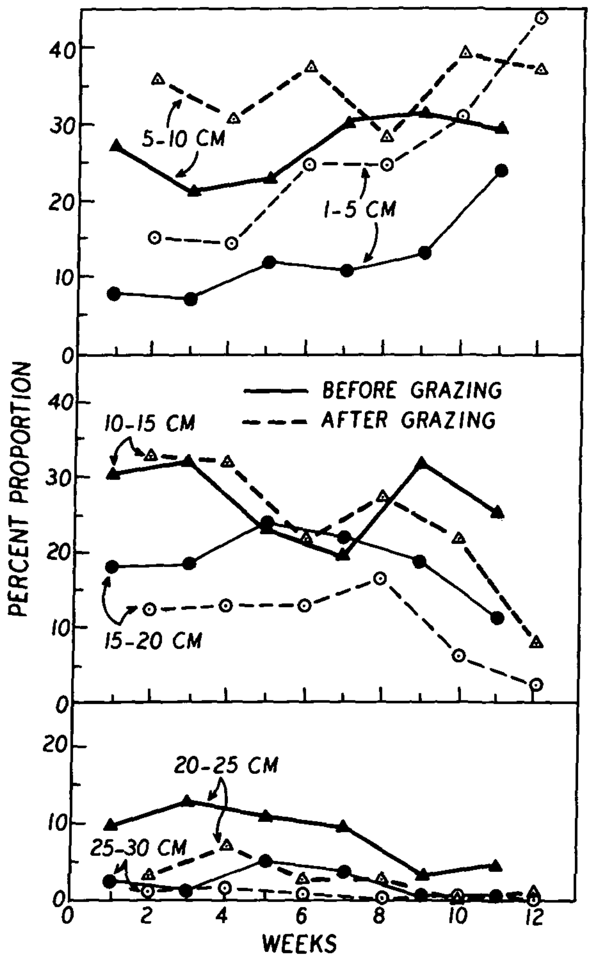

Fig. 1. Seasonal changes in several height classes of pasture forage before and after grazing.

15 and 15 to 20 cm height classes, indicates that grazing pressure probably increased seasonally as pasture growth slowed and animal intake increased. In an earlier experiment (5) comparing six grazing treatments over a period of 3 years, the most productive pastures also were those in which an average height of 10 to 15 cm was maintained.

The seasonal trends of botanical composition were determined by weekly point-quadrat analysis. Within-season changes in botanical composition were small, and very similar in the four pasture treatments. The proportions of the four species were: orchardgrass, 55%; strawberry clover, 25%; perennial ryegrass, 15%; and Ladino clover, 5%; they remained almost constant from treatment to treatment. It has been shown that, for this four-species mixture, botanical composition is a sensitive indicator of differences in grazing management (8). Therefore, forage height and botanical composition responses both indicated that grazing pressures were very similar for all treatments involving the use of pasture.

Alfalfa cubes are easily handled and are readily eaten when fed at various intake levels in combination with high-quality pastures. Their efficient conversion to animal product favors their use as a management tool for maintaining uniform grazing pressure throughout the growing season while maintaining animal performance at a desired level. Whether this practice is economically attractive will depend on the comparative costs of producing a unit of pasture dry matter vs. feeding a unit of dry matter as cubes.

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MOUNTED WEIGHING SYSTEM FOR FORAGE PLOT HARVESTER

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ABSTRACT

A one-man operated forage harvester was constructed by attaching a weighing basket from a hydraulic load cell to the self-propelled Farmers Forage Research Plot Harvester. This new design allows the researcher to harvest a wide range of plot lengths and several different forage species with one machine. The weighing system was designed to reduce labor cost and harvesting errors accompanying alternative methods. The one-man harvester was tested in the 1973 growing season on approximately 12,000 experimental plots and it demonstrated adequate precision, speed, and durability. We feel the initial cost and maintenance of this machine is completely justified and that it is a significant contribution to our forage program.

Additional index words: **Research equipment, Hydraulic load cell.**

A ONE-MAN operated forage harvester (Fig. 1) was constructed by attaching a weighing basket suspended from a hydraulic load cell to the self-propelled Farmers Forage Research Plot Harvester.[2] This machine is capable of harvesting a variety of species and plot lengths.

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