INTAKE, DIGESTIBILITY, AND GROWTH BY STEERS COMPARED UNDER CONTINUOUS AND FRONTAL GRAZING

H. Lippke, T.D.A. Forbes, E. Rivera, P.G. Soderstrom, R.V. Machen, and B.G. Warrington
Texas A&M University Agricultural Research and Extension Center, Uvalde, TX

Summary and Application

Dry matter intake (DMI), dry matter digestibility (DDM), and average daily gain (ADG) by stocker steers on irrigated annual ryegrass pastures were compared at three stocking densities under continuous grazing and with three grazing management systems: continuous, continuous plus mechanical harvest, and frontal. We created a grazing front by attaching an electrified break wire to the machinery of a center-pivot irrigation system and advancing the system (without irrigation) 3 – 7 in./min. for 6 hr. daily. Advance rate was set so that frontal grazing steers would leave about 30% leaf in the aftermath. Heavy stocking reduced ADG from 2.40 lb. to 1.96 lb. compared to medium stocking, but increased gain per acre from 589 to 737 lb. Heavy stocking also reduced DDM and DMI in late winter. Frontal grazing and lighter continuous grazing both reduced the risk of imminent pasture collapse due to drought stress. Mechanical harvest to remove excess forage in early spring extended the productivity of the grazing season. Adding cattle in spring also extended the grazing season, but ADG by added steers was 0.5 lb. less than for resident steers in a comparable time frame.

Introduction

Stocker cattle gains per acre in continuous grazing systems on cool-season annual grass pastures reach only 60% of potential. Plant tissue loss and reduced photosynthetic rate due to trampling and mismatches between forage growth rate and animal requirements are the primary factors in system losses. Rotational grazing generally provides no improvement unless management systems are compared at stocking rates so high that gain per acre is reduced.

Modern pivot irrigation systems, used increasingly in stocker operations in southwest Texas, lend themselves to adaptation as the primary tool in a modified, controlled, frontal grazing system. This experiment was conducted to compare forage intake and digestibility and average daily body weight gain (ADG) under frontal grazing to responses by steers grazing under traditional continuous stocking of ryegrass pastures. Light stocking rate with and without mechanical harvest of excess forage was also compared.

Methods and Materials

Three quadrants of a 50-A center pivot irrigation system (five 160-ft spans + 33-ft overhang), located on a silty clay loam site in Uvalde County, were used for this experiment. Fertilizer (80-20-0) was applied and incorporated into the soil prior to planting TAM90 annual ryegrass (*Lolium multiflorum* L.) on September 30. One additional 30-lb/A increment of nitrogen (N) was applied to all pastures in late January to maintain crude protein level above 20% in leaf tips.

Four pastures for continuous grazing (2.2, 3.1, and two 4.0-A) were fenced in the band of land between the fourth irrigation tower and the end of the irrigation boom

(Figure 1). One of the 4.0-A pastures was designated to be subdivided for hay harvest if forage accumulation became excessive during the spring. Two bands of pasture for frontal grazing, each 240 ft wide, were established between three concentric fences located 2 ft inside the tracks of the first and fourth irrigation towers and at the midpoint between the tracks of the second and third towers. These two bands were grazed serially with one group of steers (Figure 1).

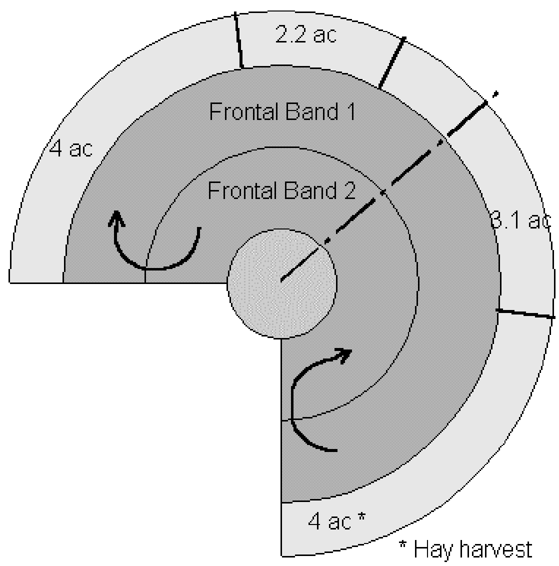

Figure 1. Pasture locations under center pivot irrigation.

For frontal grazing, we mounted electrified break wires on the center-pivot system between the first and fourth towers to create a grazing front. A back fence, which was advanced manually every other day, completed a partial wedge-shaped enclosure that allowed the frontal grazing group access to a 15 - $20^{?}$ arc of the circle at any time. The irrigation system was fitted with a programmable controller, which was set to advance the system automatically (without applying water) in four sessions for a total of 6 hr daily. The rate of advance of the grazing front (3 – 7 in./min.) was adjusted so that the cattle would leave about 30% ryegrass leaf blades in the herbage aftermath. When the center pivot machinery was required for irrigation, the frontal grazing group of steers was moved out of the system for a day, and they grazed the irrigated perimeter of the circle and the dryland corners (also ryegrass) of the field.

The frontal-grazing steers drank from a small trough on a trailer hitched to the second or third pivot tower. Water was supplied via an auxiliary water line mounted on the pivot machinery from a 2500-gal storage tank located at the pivot center

All pastures were stocked with yearling steers on December 14. Groups of five Angus steers, balanced for weight and sire effects, were placed, one in each of the four pastures designated for continuous grazing. A matching set of five steers was placed in the frontal grazing group, along with 20 other Angus, 14 Braunvieh crossbred, and 12 Bonsmara crossbred steers. All steers were weighed into the experiment on December 20 after an overnight without feed or water. Individual weights were measured at about one-month intervals, and final weights were obtained on May 21, all after an overnight period without feed or water.

In January, February, and April, the Angus steers in each of the continuously grazed pastures and the matching steers in the frontal grazing group were each dosed with slow release capsules containing alkane markers. Hand-plucked leaf, total sward, and fecal samples were collected for 5 days in each trial. Analysis of these samples for dosed (C_{32} and C_{36}) and naturally occurring (C_{33}) alkanes allowed estimation of the amount and digestibility of forage consumed by each steer at three different times during the season (Lippke, 2002). Crude protein and fiber contents of forage samples were also measured to obtain additional estimates of forage quality.

Results and Discussion

Estimates of herbage mass (HM) were taken from the dry weight of clippings of total sward during the intake and digestion trials (Table 1). The high stocking rate on the 2.2-A pasture reduced its HM significantly below ($P < .05$) that of the adjacent 3.1 and 4.0-A pastures for all sampling periods. However, stocking rate does not explain the difference ($P < .05$) in HM between the two 4.0-A pastures, which was visually apparent within a month after planting. The results of soil tests rated both 4.0-A pastures "low" in N and "very high" in phosphorus, although the concentrations of both nutrients in the soil of the weaker pasture were only 2/3 of the levels in the other. Thirty pounds/A of N were applied only to the weaker 4.0-A pasture in November to try to alleviate the disparity.

Table 1. Means§ of herbage mass for five pastures in three trials.

Pasture	Trial Date		
	Jan. 10	Feb. 16	Apr. 17
	- - - - - - - lb/A - - - - - - -		
Frontal	3270[a]	4230[a]	4019[b]
Cont. 2.2-A	1910[b]	2430[c]	2740[c]
Cont. 3.1-A	2790[a]	3450[ab]	6000[a]
Cont. 4.0-A	3310[a]	4230[a]	6690[a]
Cont. 4.0 A+har.	2550[ab]	3160[bc]	3850[b]

§ Means are based on clippings from 15 sites.
Means in the same column with different superscripts are significantly different ($P < .05$)

The steers in the 4.0-A+harvest pasture were restricted to 2 A from March 2 until April 8. On March 26, 7230 lb. of forage DM were harvested from the deferred half of that pasture. We used FORAGVAL (Lippke and Herd, 1990) to estimate that the harvested forage would have produced 933 lb. of steer gain.

Initial stocking density was 1227 lb. steer live weight/A for the frontal grazing group and 1123, 799, 640, and 610 lb./A for the 2.2, 3.1, 4.0, and 4.0-A+harvest pastures, respectively. On January 31, one Braunvieh crossbred steer was added to the high stocked, continuously grazed pasture and one Bonsmara crossbred and six Braunvieh crossbred steers were added to the frontal grazing system to control forage accumulation, bringing those pastures to 1610 and 1628 lb. live weight/A. At the beginning of March, five more Braunvieh crossbred and four Bonsmara crossbred steers were added to the frontal grazing system for a total of 2133 lb. live weight/A. At the same time the continuously grazed pastures had 1807, 1108, 857, and 823 lb. live weight/A for the 2.2, 3.1, 4.0, and 4.0-A+harvest pastures, respectively.

Table 2. Means§ of estimated DDM of ryegrass consumed from five pastures in three trials.

Pasture	Trial Date		
	Jan. 10	Feb. 16	Apr. 17
	- - - - - - - - % - - - - - - - -		
Frontal	77.9[a]	75.8[a]	68.0[b]
Cont. 2.2-A	77.8[a]	65.0[b]	69.2[ab]
Cont. 3.1-A	74.0[b]	74.7[a]	71.0[a]
Cont. 4.0-A	77.3[a]	77.3[a]	68.0[b]
Cont. 4.0-A+har.	77.9[a]	74.7[a]	70.8[a]

§ Means are based on five animals.
Means in the same column with different superscripts are significantly different ($P < .05$)

Table 3. Means§ of estimated ryegrass DMI from five pastures in three trials.

Pasture	Trial Date		
	Jan. 10	Feb. 16	Apr. 17
	- - - - % of body weight - - - -		
Frontal	2.42	2.04[bc]	1.73[b]
Cont. 2.2-A	2.46	1.93[c]	1.88[b]
Cont. 3.1-A	2.18	2.52[a]	1.94[b]
Cont. 4.0-A	2.22	2.30[ab]	1.73[b]
Cont. 4.0-A+har.	2.18	2.53[a]	2.24[a]

§ Means are based on five animals.
Means in the same column with different superscripts are significantly different ($P < .05$)

In the January intake and digestion trial, estimates of digestible dry matter (DDM) of diets consumed in all pastures were very high and nearly identical, except the mean for the 3.1-A pasture, which was more than three percentage units lower ($P < .05$) (Table 2). The cause for the lower DDM value is not apparent; levels of crude protein and fiber in hand-plucked samples were similar for all pastures (Tables 4 and 5). There were no significant differences in dry matter intake (DMI) in the January trial (Table 3).

Table 4. Means[§] of crude protein in ryegrass plucked from five pastures in three trials.

Pasture	Trial Date		
	Jan. 10	Feb. 16	Apr. 17
	- - - - - - - - % - - - - - - - -		
Frontal	19.6	21.7	21.3
Cont. 2.2-A	20.9	28.4	25.3
Cont. 3.1-A	21.0	26.7	19.1
Cont. 4.0-A	21.2	27.7	19.3
Cont. 4.0-A+har.	21.3	26.7	22.8

[§] Means are based on samples from five days.

Table 5. Means[§] of acid detergent fiber in ryegrass plucked from five pastures in three trials.

Pasture	Trial Date		
	Jan. 10	Feb. 16	Apr. 17
	- - - - - - - - % - - - - - - - -		
Frontal	14.2	19.1	21.4
Cont. 2.2-A	15.0	18.1	18.1
Cont. 3.1-A	14.7	17.0	23.5
Cont. 4.0-A	14.1	17.3	23.9
Cont. 4.0-A+har.	14.1	16.4	19.1

[§] Means are based on samples from five days.

By mid-February, amount of leaf in the 2.2-A pasture had declined, although total HM in that pasture increased somewhat since the beginning of January (Table 1). This situation is reflected in lower mean DDM and DMI ($P < .05$) for the steers in that pasture compared to steers in the other continuously grazed pastures. Among the animals in the 2.2-A pasture, different strategies were apparently used to deal with the shortage of desirable leaf. One steer maintained diet quality, but greatly reduced intake. Two steers apparently opted to consume the increasing stubble component of the HM, reducing the DDM of their diets to 60%, and two steers selected an intermediate strategy. Compared to the 3.1 and 4.0-A pastures, the frontal grazing group also demonstrated a reduced intake ($P < .05$) (Table 3) but not the collateral decrease in DDM (Table 2). Overall, DDM for all pastures showed a characteristic decline from January to February.

Effectively doubling the stocking rate on the 4.0-A+harvest pasture during March and early April had positive effects on DDM and DMI measured in mid-April (Tables 2 and 3). Intake was higher ($P < .05$) than for all other pastures and DDM was higher ($P < .05$) than for the other 4.0-A pasture. By mid-April, ryegrass in the 3.1 and 4.0-A pastures was rank and maturing except in numerous small patches where almost daily grazing kept the forage short and in a vegetative state. The DDM and DMI estimated for these pastures in April (Tables 2 and 3) indicate that the problem was not as severe in the 3.1-A pasture. Results for the 2.2-A and frontal grazing pastures were similar in the April trial. Generally, animals tried to hold diet DDM above 65% and sacrificed intake to do that.

Table 6. Means[§] of ADG and sums of gain per acre for five pastures.

Pasture	ADG	Gain/A
	- - - - - - - - lb. - - - - - - - -	
Frontal	2.02^{ab}	-
Cont. 2.2-A	1.96^{b}	737
Cont. 3.1-A	2.40^{a}	589
Cont. 4.0-A	2.23^{ab}	424
Cont. 4.0-A+har.	2.34^{ab}	678

[§] Means are based on five animals.
Means in the same column with different superscripts are significantly different ($P < .05$)

Table 6 shows means of ADG for the five Angus steers in each pasture that formed the balanced comparison among pastures. Steers in the 2.2-A and frontal grazing group had similar ADG means that were lower ($P < .05$) than the means for the 3.1-A and 4.0-A+harvest pastures. Figure 2 shows that the patterns of weight gain for frontal grazing and 2.2-A pastures were also similar. Figure 3 compares the weight gain patterns of steers on the two 4.0-A pastures. The pasture with the greater HM appeared to have a slight advantage for most of the season. That advantage disappeared in the last 3 wk of the experiment, when the rank sward in that pasture was completely mature. The DDM and DMI data (Tables 2 and 3) indicate that the high ADG for this group in April was a reflection of greatly increased gut fill at the early May weighing.

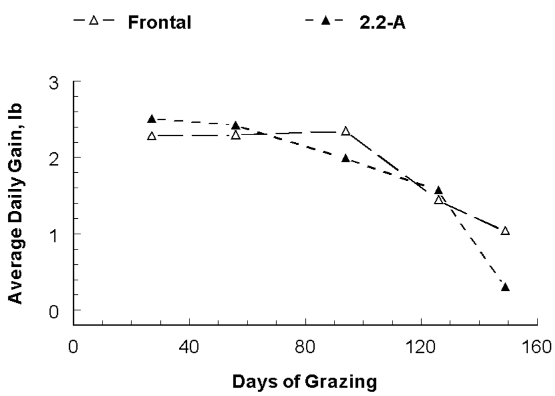

Figure 2. Patterns of weight gains by Angus steers in balanced groups on frontal grazing and the 2.2-A pasture.

Beef yield per acre for the continuously grazed pastures is also shown in Table 6. The ADG for full-season Bonsmara and Braunvieh steers in the frontal grazing group (1.65 lb.) was significantly lower ($P < .05$) than ADG for all Angus steers in that group. Because the Angus steers came from one source and all other steers came from a second source, we do not know if this difference was caused by sire breed or by differences in pre-grazing management. For steers that were added in early March, ADG was 0.5 lb. lower ($P < .05$) than for steers of the same breed type in a comparable time frame. This was apparently caused by the lack of social acclimation for a considerable period after joining the resident animals. These subgroup differences in ADG within the frontal grazing group invalidate a comparison of beef yield (685 lb./A) with the balanced groups of Angus steers in other pastures. We calculate that if all steers on frontal grazing had performed as the Angus, beef yield would have been 820 lb./A.

Initially, the results of this experiment appear to support the use of continuous grazing with very high stocking rates. However, the data do not convey the high level of risk attendant to high stocking rates. For example, an irrigation system failure would have placed the 2.2-A pasture in a

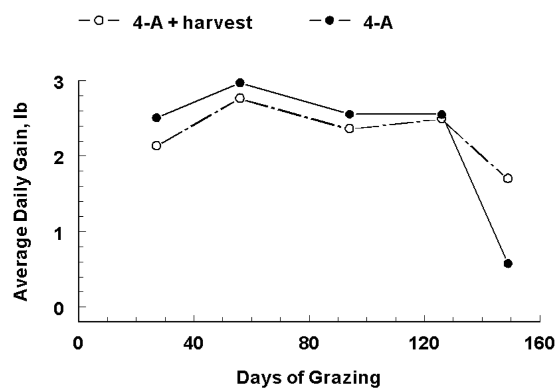

Figure 3. Patterns of weight gains by Angus steers on the 4.0-A+harvest and 4.0-A pastures.

condition of drought-stress collapse in less than a week throughout much of the experiment. This risk augers heavily against very high stocking rates in non-irrigated grazing systems, irrespective of the average annual rainfall. While responses to frontal grazing were similar to those in the 2.2-A, continuously grazed pasture in most respects, the considerable forage buffer with frontal grazing decreased the risk from imminent pasture collapse.

On non-irrigated pastures where the risk of drought is substantial or where the production history of pastureland is not known, a lesser stocking density coupled with the potential for hay harvest in early spring appears prudent. Although traditional hay harvest is difficult in early spring, we have successfully harvested high-moisture ryegrass hay (Lippke et al., 2002). Utilizing excess forage with additional animals is another option, but the reduced performance of animals added at mid-season may exceed the losses of mechanical harvest and feeding.

Finally, we note that steers in the 2.2-A pasture spent much less time walking in search of forage than we have observed for steers in large pastures grazed to similar levels of HM. To the extent that these subjective observations are real, we would expect greater forage trampling losses and lower intake on large pastures. Lower intake together with higher energy expended in walking might reduce ADG as much as 0.4 lb. relative to our results from the 2.2-A pasture.

Conclusion

High stocking rates on winter pastures reduce dry matter intake and average daily gain. In extreme cases, dry matter digestibility of the grazed diet is also reduced. Gain per acre is likely to be increased with increasing stocking rates. However, the risk of pasture collapse is also increased. Frontal grazing and lower stocking rates coupled with mechanical harvest of excess forage reduce risk while maintaining a relatively high level of productivity.

Literature Cited

Lippke, Hagen. 2002. Estimation of forage intake by ruminants on pasture. Crop Sci. 42:869-872.

Lippke, H., T.D.A. Forbes, E. Rivera, P.G. Soderstrom, R.V. Machen, and B.G. Warrington. 2002. Frontal grazing for cattle management on winter pastures. http://uvalde.tamu.edu/pdf/2002/005-frontal1.2a.pdf.

Lippke, H., and D.B. Herd. 1990. FORAGVAL: Intake and gain by cattle estimated from acid detergent fiber and crude protein of the forage diet. Texas Agric. Exp. Sta. MP-1708.