

Cow-calf and Vegetation Response to Heavy Rates of Stocking at the Texas Experimental Ranch



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Cow-Calf and Vegetation Response to Heavy Rates of Stocking at the Texas Experimental Ranch

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Response to any given rate of stocking varies according to geographical region, range site, and time (Hart, 1978), but basic relationships remain relatively constant. At low rates of stocking, livestock performance is maximized on an individual animal unit basis but production per(/)unit area of land is low. As stocking rate is increased above the "critical rate of stocking" (Hart, 1978), production/animal unit slowly declines in conjunction with a simultaneous, gradual increase in production/unit area. The gradual decline in production/animal unit and the concurrent increase in production/unit area of land will continue until the maximum carrying capacity of the land is reached. Further increases in rates of stocking will result in a dramatic decline in individual animal performance. The resultant effect is a dramatic decline in the production/unit area of land.

Many management techniques have been utilized to increase the carrying capacity of rangeland. The success of grazing systems as an effective technique for increasing carrying capacity is the subject of much controversy (Launchbaugh et al., 1978; Pieper et al., 1978; Heitschmidt et al., 1982a). Close examination of previous research suggests that only moderate increases in carrying capacity have been attained following the implementation of any grazing system when compared to those carrying capacities normally associated with continuous grazing (Gammon, 1978). Savory (1978) suggested that a two-fold increase in stocking rate can be anticipated following proper implementation of a short duration grazing system utilizing the Savory Grazing Method. Theoretically, this suggests that maximum production/unit area of land must occur at a stocking rate considerably greater than that normally associated with conventional grazing systems (Fig. 1).

To properly evaluate any extensive rangeland grazing system, large areas of land and large numbers of livestock are required, since several rates of stocking should be monitored simultaneously in both a conventional system (control) and in the system being evaluated (Gammon, 1978). Rates of stocking should range, as a minimum, from slightly below that normally defined as heavy for the region to slightly

above the maximum anticipated in the new system. But in light of the economic risks associated with studies utilizing heavy rates of stocking, it is often difficult to justify the need for such studies to livestock owners. Thus, to reduce economic risk, a series of trials must often be run over a number of years.

The following study was designed as the first step of a two-step attempt to evaluate the response of both cattle and vegetation at heavy rates of stocking under two types of grazing systems. The specific objective of this study was to evaluate cow-calf and vegetation response to yearlong continuous grazing at rates of stocking appreciably heavier than those previously identified as heavy for the local region (Heitschmidt et al., 1982b). The second phase of this study will focus on evaluating these responses in a short duration grazing system stocked at heavier than normal rates of stocking.

MATERIALS AND METHODS

Study Area and Experimental Design

The study was conducted at the Texas Experimental Ranch located (99°14'W, 33° 20'N) in the northern portion of the Rolling Plains. Although the climate of the region varies it is characteristically comprised of hot dry summers, warm moist falls and springs, and mild dry winters. Annual precipitation at the ranch since 1960 has averaged 690 mm (Fig. 2).

The pasture layout was a completely randomized design with two replications of three rates of stocking. Treatment stocking rates were 5.0, 4.2, and 3.4 hectare (ha)/cow/year. Treatment pastures ranged in size from 114 to 130 ha. Each pasture had previously been a part of an eight pasture short duration grazing system. Number of cows in each replicated herd ranged from 23 in the 5.0 ha/cow/year treatment to 38 in the 3.4 ha/cow/year treatment.

Range site composition of the six pastures was similar. The dominant range site in each pasture was Clay Loam. The soils were characteristically deep, fine textured clays and clay loams possessing high water holding capacities and low infiltration rates. Frequency data taken in November 1978 indicated*

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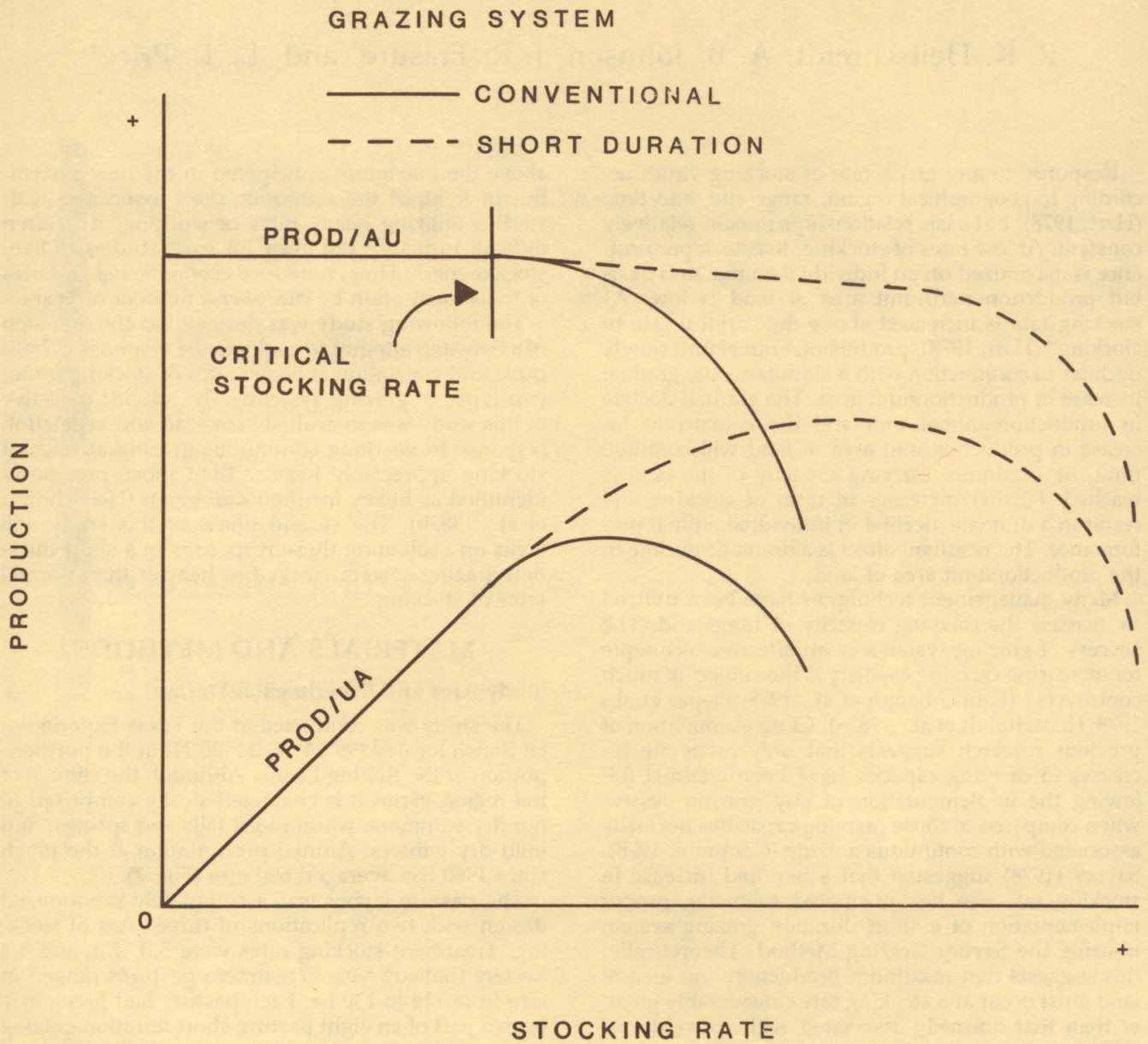


Figure 1. Conceptual model of livestock response and thus production/animal unit (AU) and production/unit area of land (UA) to increasing rates of stocking under conventional grazing systems and hypothesized model of livestock response under short duration grazing system if dramatic increases in rates of stocking are attainable.

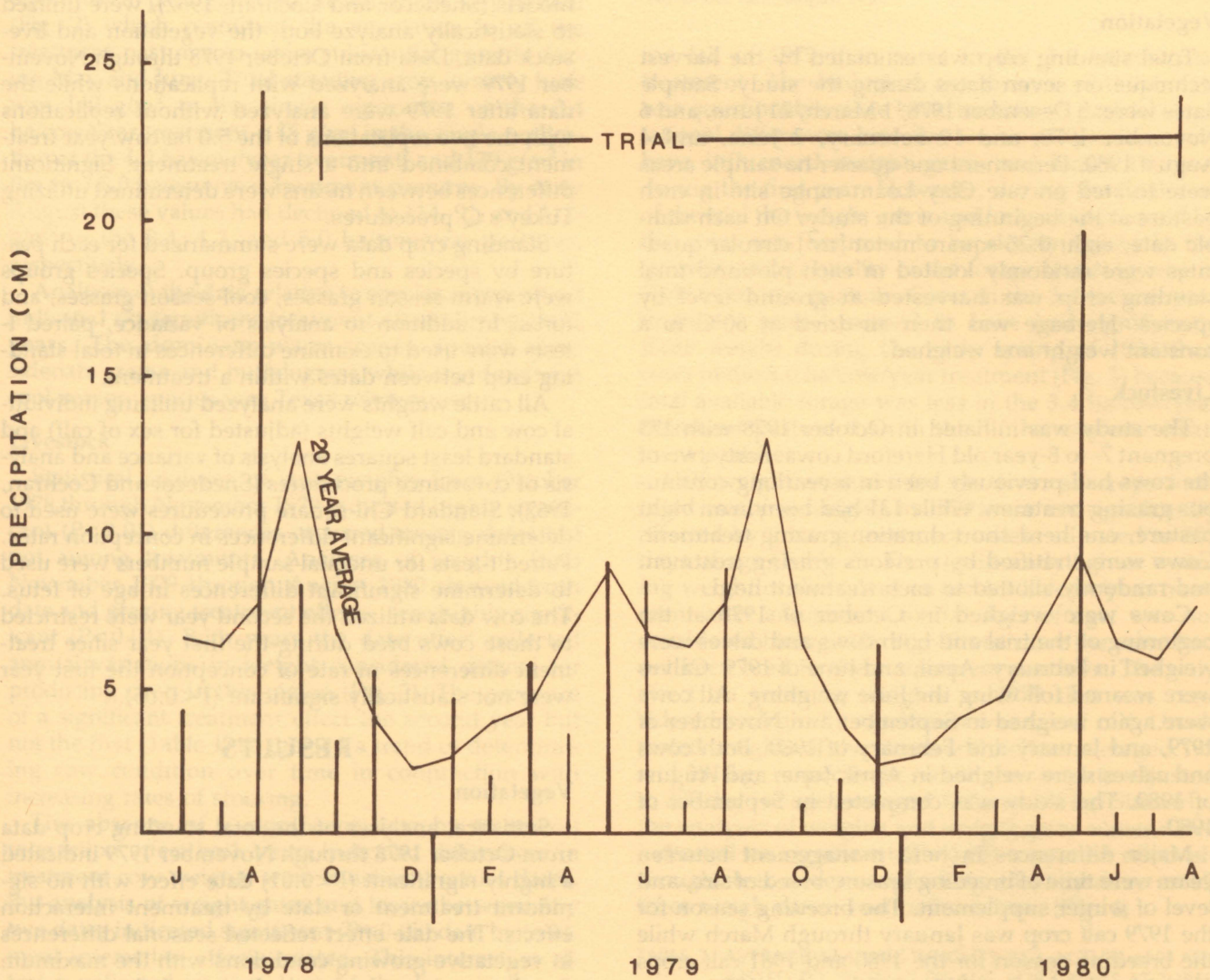


Figure 2. Monthly precipitation (cm) from June 1978 through August 1980 at the Texas Experimental Ranch and 20-year monthly average.

that the most frequently occurring species on this site was sideoats grama (*Bouteloua curtipendula* (Michx.) Torr.). Other frequently encountered species were Texas wintergrass (*Stipa leucotricha* Trin. and Rupr.), buffalograss (*Buchloe dactyloides* (Nutt.) Engelm.), and curlymesquite (*Hilaria belangeri* (Steud.) Nash). Other range sites present in the pastures were Draw, Shallow, Shallow Clay, Deep Redland, and Rocky Hill. The general range condition in all pastures was considered good when the study was initiated with all pastures considered to have nearly equal carrying capacities.

Vegetation

Total standing crop was estimated by the harvest technique on seven dates during the study. Sample dates were: 5 December 1978; 1 March, 21 June, and 6 November 1979; and 19 February, 2 June, and 4 August 1980. Permanent one quarter ha sample areas were located on one Clay Loam range site in each pasture at the beginning of the study. On each sample date, eight 0.25 square meter [m^2] circular quadrates were randomly located in each plot and total standing crop was harvested at ground level by species. Herbage was then air-dried at 60°C to a constant weight and weighed.

Livestock

The study was initiated in October 1978 with 173 pregnant 7- to 8-year old Hereford cows. Forty-two of the cows had previously been in a yearlong continuous grazing treatment while 131 had been in an eight pasture, one herd short duration grazing treatment. Cows were stratified by previous grazing treatment and randomly allotted to each treatment herd.

Cows were weighed in October of 1978 at the beginning of the trial and both cows and calves were weighed in February, April, and June of 1979. Calves were weaned following the June weighing. All cows were again weighed in September and November of 1979, and January and February of 1980. Both cows and calves were weighed in April, June, and August of 1980. The study was completed in September of 1980.

Major differences in herd management between years were time of breeding season, breed of sire, and level of winter supplement. The breeding season for the 1979 calf crop was January through March while the breeding season for the 1980 and 1981 calf crops was March through May. Sires for 1979 were Hereford. Sires for 1980 and 1981 were Angus. In all years, bulls were fertility tested and randomly allotted to each herd at a bull/cow ratio not exceeding 1 to 14. No winter supplement was fed during the winter of 1979-80. Supplement during the winter of 1980-81 was a 20 percent crude protein range cube fed three times a week at a rate of 0.90 kilograms (ka)/cow/day during December and at a rate of 1.36 kg/cow/day during January and February. Although variations in herd management occurred between years, all treatments were managed the same within any one year.

All cows were pregnancy tested each year with fetus age estimated in 1980 when the study was concluded.

Because of the extremely dry fall in 1979 (Fig. 2), total standing crop by early November of 1979 was estimated to be approximately the same as that in late November of 1978. Because the financial risks associated with this study appeared to be excessive at that time, one replication of both the 3.4 and 4.2 ha/cow/year treatments was eliminated.

Statistical Analyses

Two separate least squares analysis of variance models (Snedecor and Cochran, 1967), were utilized to statistically analyze both the vegetation and livestock data. Data from October 1978 through November 1979 were analyzed with replications while the data after 1979 were analyzed without replications with the two replications of the 5.0 ha/cow/year treatment combined into a single treatment. Significant differences between means were determined utilizing Tukey's Q procedures.

Standing crop data were summarized for each pasture by species and species group. Species groups were warm-season grasses, cool-season grasses, and forbs. In addition to analysis of variance, paired t-tests were used to examine differences in total standing crop between dates within a treatment.

All cattle weights were analyzed utilizing individual cow and calf weights (adjusted for sex of calf) and standard least squares analysis of variance and analysis of covariance procedures (Snedecor and Cochran, 1967). Standard Chi-square procedures were used to determine significant differences in conception rates. Paired t-tests for unequal sample numbers were used to determine significant differences in age of fetus. The cow data utilized the second year were restricted to those cows bred during the first year since treatment differences in rate of conception the first year were not statistically significant ($P < 0.05$).

RESULTS

Vegetation

Statistical analyses of the total standing crop data from October 1978 through November 1979 indicated a highly significant ($P < 0.01$) date effect with no significant treatment or date by treatment interaction effects. The date effect reflected seasonal differences in vegetative growing conditions with the maximum standing crop occurring in June and the minimum occurring in early March.

The paired t-tests indicated that total standing crop in the 3.4 ha/cow/year treatment was significantly less in early November 1979 than in late November 1978 having declined from 150 to 123 g/ m^2 . However, in the 4.2 and 5.0 ha/cow/year treatments, total standing crop was significantly ($P < 0.01$) greater in the sample plots in early November 1979 than late November 1978. Average standing crop in November 1979 was 137 g/ m^2 in the 4.2 ha/cow/year treatment and 139 g/ m^2 in the 5.0 ha/cow/year treatment. The decision to

eliminate one replication of each of the two heavier stocked treatments in November 1979 was based on these data and visual appraisal of the entire pastures, in consideration of the ongoing drought (Fig. 2).

During the second year of the study, minimal treatment effects were apparent relative to the effect of stocking rate on total standing crop except in February when total standing crop averaged 74, 86, and 106 g/m² in the 3.4, 4.2, and 5.0 ha/cow/year treatments, respectively. However, results were confounded by the lack of replication in the two heavier stocked treatments. But the lack of any treatment effect was in part related to the abundant May rainfall (Fig. 2) which permitted the vegetation in all the treatment pastures to make substantial growth during May and June. Total standing crop in early June was 140 g/m² in the single replication of the 3.4 ha/cow/year treatment, 145 g/m² in the single replication of the 4.2 ha/cow/year treatment, and 139 g/m² in the two 5.0 ha/cow/year treatment pastures. By early August these values had declined to 114, 91, and 111-g/m² in the 3.4, 4.2, and 5.0 ha/cow/year pastures, respectively.

Analyses of the data relative to species composition indicated no significant treatment effect during the 2 years. The dominant warm-season species were sideoats grama and buffalograss while the dominant cool-season species was Texas wintergrass.

Livestock

Statistical analyses of cow weights from October 1978 through November 1979 indicated highly significant ($P < 0.01$) differences occurred among dates but not among treatments. Analyses of weights from November 1979 through August 1980 showed both date and grazing treatment effects were highly significant ($P < 0.01$). Both years the date effect reflected annual variations in weight considered normal for producing cows in this region (Fig. 3). The presence of a significant treatment effect the second year but not the first (Table 1) suggested a trend of deteriorating cow condition over time in conjunction with increasing rates of stocking.

The absence of a significant date by treatment interaction effect both years indicated differences in treatment cow weights were consistent across dates. But analysis of weight gains and losses between any two dates indicated significant ($P < 0.05$) date by treatment interaction effects existed. This interaction effect is reflected by the slope of the lines in Fig. 3. During the winter of 1979 and 1980, cows in the 4.2 ha/cow/year treatment lost significantly more weight than cows in the 5.0 ha/cow/year treatment, while the loss of weight experienced by cows in the 3.4 ha/cow/year treatment was not significantly different from the weight losses in either the 4.2 or 5.0 ha/cow/year treatment. In addition, cows in the 3.4 ha/cow/year treatment gained significantly more weight during the late spring of 1979 than cows in either of the other two treatments, while cows in the 5.0 ha/cow/year gained significantly more weight in

TABLE 1. AVERAGE WEIGHT (KG) OF COWS AT THREE STOCKING RATES

Treatment ²	Year ¹	
	1978-1979 ³	1979-1980 ⁴
3.4	456 _a	449 _a
4.2	453 _a	451 _a
5.0	465 _a	465 _b

¹Means in a column followed by the same letter are not significantly different at $P < 0.05$.

²ha/cow/year.

³October 1978 - November 1979.

⁴November 1979 - August 1980.

the fall of 1979 than cows in the 3.4 ha/cow/year treatment. The biological significance of these data was questionable since basic undefined pretrial vegetational differences between treatment pastures may have influenced weight gains and losses of cows during the first year. However, during the final year of the trial the weight gains and losses experienced by the cows was assumed to be closely linked to the quantity and/or quality of the forage standing crop in each treatment pasture. Cows in the 3.4 ha/cow/year treatment were assumed to have lost significantly more weight during the early spring of 1980 than cows in the 5.0 ha/cow/year treatment (Fig. 3) because total available forage was less in the 3.4 ha/cow/year treatment pasture than in the 5.0 ha/cow/year treatment pastures.

Calf weight analyses for the two calf crops indicated weaning weights in 1979 were not significantly affected by grazing treatment unless adjusted to 205 days of age (Table 2). The significantly lighter weaning weight of the calves in the 4.2 ha/cow/year treatment after adjustment to 205 days of age, was not considered biologically significant since the cows had not been bred in these treatment pastures. The only effect on weaning weights in 1979 that was considered biologically significant was sex of calf. Unadjusted weights of the steers and heifers averaged 195 and 181 kg, respectively, while the weights adjusted to 205 days of age averaged 187 and 175 kg. Similarly, the analyses of weights and weight gains across dates indicated no significant ($P < 0.05$) treatment effect although steer calves weighed significantly more on all three weigh dates than heifer calves, (Fig. 4).

TABLE 2. AVERAGE WEANING WEIGHTS (KG), ACTUAL AND ADJUSTED TO 205 DAYS OF AGE, FOR CALVES AT THREE STOCKING RATES

Treatment ²	Year			
	1979		1980	
	Actual	205	Actual	205
3.4	188 _a	183 _b	199 _a	196 _a
4.2	185 _a	174 _a	209 _{ab}	197 _a
5.0	188 _a	184 _b	225 _b	215 _b

¹Means in a column followed by the same letter are not significantly different at $P < 0.05$.

²ha/cow/year.

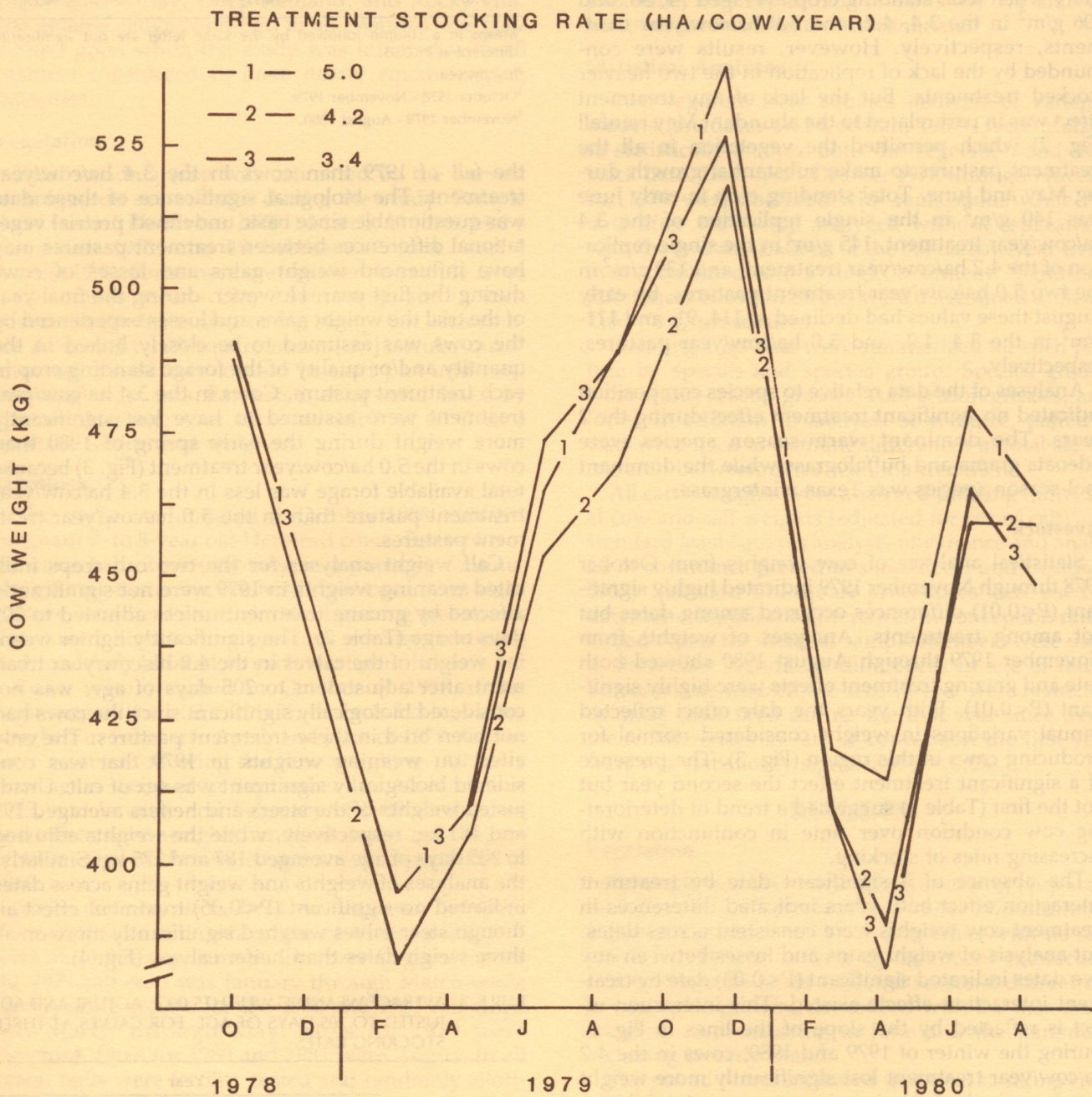


Figure 3. Weights of cows (kg) on 11 dates from October 1978 through August 1980 at three rates of stocking at the Texas Experimental Ranch.

In 1980 both unadjusted and adjusted weaning weights differed significantly ($P < 0.01$) among treatments with the calves in the 5.0 ha/cow/year treatment weighing more than the calves in the 3.4 ha/cow/year treatment (Table 2). Although age of calf at weaning was not statistically different ($P < 0.05$) among treatments, it was economically and biologically important in that calves in the 5.0 ha/cow/year treatment weighed approximately 18 kg more at weaning than calves in both the heavier stocked treatments. Unadjusted weights for steer calves averaged 211 kg at weaning in 1980 as compared to 203 kg for heifer calves while adjusted weights averaged 212 and 194 kg, respectively.

Analyses of calf weights across dates indicated calves in the 5.0 ha/cow/year treatment weighed significantly ($P < 0.01$) more on all dates than calves in the 3.4 ha/cow/year treatments (Fig. 4). Also, calves in the 5.0 ha/cow/year treatment gained significantly more weight between each weigh date than calves in the 3.4 ha/cow/year treatment. Calf weights on each date and weight gains in the 4.2 ha/cow/year treatment were intermediate to the other two treatments.

Conception rates for the 1980 calf crop averaged 90 percent across all treatments with no significant ($P < 0.05$) differences among treatments. However, conception rates for the 1981 calf crop differed significantly ($P < 0.01$) among treatments as did the estimated age of the fetuses (Table 3).

TABLE 3. CONCEPTION RATE (%) AND ESTIMATED AGE OF FETUSES IN SEPTEMBER 1980 (1981 CALF CROP) AT THREE STOCKING RATES

Treatment ¹	Conception Rate ²	Age of Fetus ³
3.4	79	123 _a
4.2	100	151 _b
5.0	100	147 _b

¹ha/cow/year.

²Chi-square = 16.9, $P < 0.01$.

³Means in a column followed by same letter are not significantly different at $P < 0.05$.

DISCUSSION AND CONCLUSION

Various attempts have been made to empirically depict the relationship between livestock perform-

ance and rate of stocking (Hart, 1978; Hart, 1980). But the quantification and validation of any empirical model is extremely difficult since few studies have been completed that evaluated livestock performance at a rate of stocking considerably greater than that normally considered heavy.

For example, we reviewed the results from 15 studies that evaluated livestock performance as a function of stocking rate under either seasonal or yearlong grazing schemes. Livestock performance data were based on either weaned calf crop (Lewis et al., 1956; Reed and Peterson, 1961; McIlvain and Shoop, 1962; Houston and Woodard, 1966; Kothmann et al., 1970; Pieper et al., 1978; Heitschmidt et al., 1982b), steer gains (Black et al., 1937; Sarvis, 1941; Launchbaugh, 1957; Conway, 1963; Walker and Scott, 1968), heifer gains (Johnson, 1953; Klipple and Costello, 1960), or weaned lamb crop (Lang et al., 1956). In all instances, maximum gain or production/animal was attained at the lightest rate of stocking. In two instances (Sarvis, 1941; Reed and Peterson, 1961) the next to the lightest rate of stocking also produced gains or production/animal values equal to that obtained at the lightest rate of stocking. This suggested that the critical rate of stocking (Hart, 1978) was reached at the next to the lightest rate of stocking in these two studies as opposed to the lightest rate in the remaining 13 studies.

In contrast to the production/animal data, maximum production/ha was attained at the heaviest rate of stocking in 13 out of the 15 studies. The two exceptions were the studies by Johnson (1953) and Conway (1963) in which maximum production/ha was attained at the next to the heaviest rate of stocking. In both these instances, the heaviest rate of stocking was approximately 50 percent heavier than the second heaviest rate of stocking.

Of the 15 previously published studies, only two were completed whereby the heaviest rate of stocking was of sufficient magnitude to reduce production/ha values below those attained at a lighter rate of stocking. We conclude that the heavier stocking rates in this study were of similar magnitude relative to the highest rate of stocking, which in turn substantiates the conceptual accuracy of the model proposed in Fig. 1. Hopefully, future research will substantiate its accuracy relative to short duration grazing.

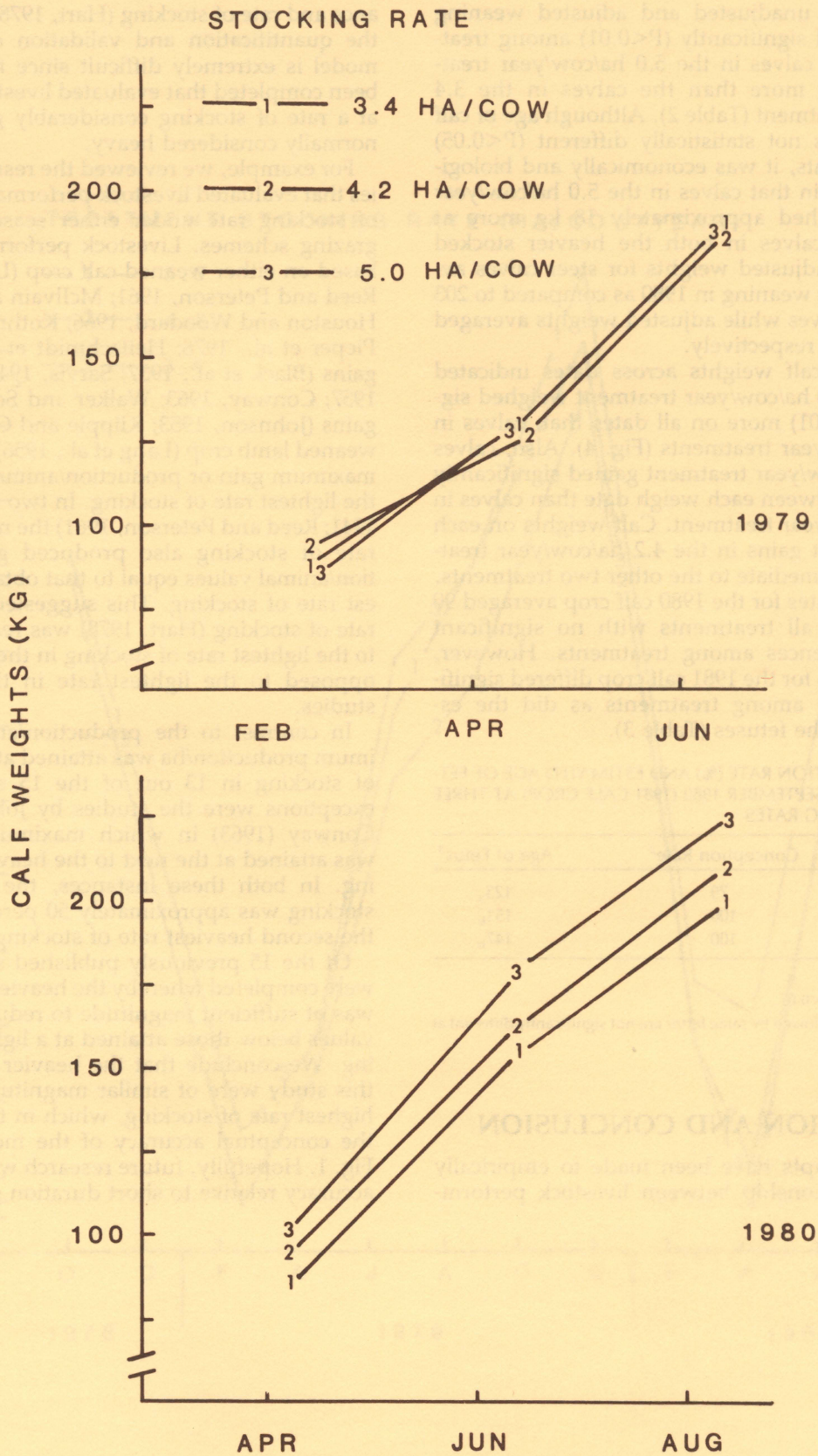


Figure 4. Weight of calves (kg) adjusted for sex of calf on three dates in 1979 and 1980 at three rates of stocking at the Texas Experimental Ranch.

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