Summary
The activities of randomly selected individual steers within lots with self feeders were studied in Iowa during two summer trials and one winter trial over a 3-year period.

Total daily eating time of approximately 2 1/3 hr. was unaffected by season. Time spent eating was significantly affected (P < .01) by period within day in all trials. In summer, the greatest activity occurred in late afternoon (3 to 6 pm) and early evening (6 to 9 pm) and a smaller peak occurred near sunrise (6 to 9 am). In winter, the greatest eating activity occurred in the late afternoon (3 to 6 pm).

Both water consumption (P < .001) and time spent drinking (P < .10) were greater during the summer than during the winter (30.7 vs. 19.2 liters; 15.4 vs. 12.2 min.) and varied with temperature within day.

Cattle spent significantly more (P < .001) time in shelter during summer than winter (46.8 vs. 21.8% of the day). For periods within day in summer cattle used shelter to the greatest extent between 9 am and 6 pm which was the time of highest daily temperatures.

Total lying time was approximately 12 hr. per day and was unaffected by shelter and season. Cattle spent significantly more time lying under shelter in summer than in winter (P < .05) and, inversely, significantly less time lying outside in summer than in winter (P < .005). Approximately 55.0% of the total lying time within day occurred between 9 pm and 6 am regardless of season.

Activities recorded as a percentage of the total animals per lot at regular hourly intervals indicate that observations for shelter utilization and lying time gave similar results to those obtained by continuous observations on randomly selected individual steers within a lot.

Frequencies of eating, drinking, entering shelter and lying down inside and outside of shelter corresponded in magnitude with the actual observed activity for each criterion.

Introduction
Most of the reported data concerning the behavior of beef cattle relates to their activity while grazing. Cory (1927) reported on the activities of livestock on the range in Texas, and Tribe (1950) presented a review of the behavior of grazing animals. Others reporting on the grazing behavior of cattle were Compton and Brundage, 1971; Gary, Sherritt and Hale, 1970; Herbel and Nelson, 1966; Hull, Lofgreen and Meyer, 1960; Kropp et al., 1971; Larsen, 1963; Lofgreen, Meyer and Hull, 1957; McDaniel and Roark, 1956; and Sheppard, Blaser and Kincaid, 1957.

During the last decade, a limited amount of information has been reported on the behavior of beef cattle in the feedlot. Schake and Riggs (1969, 1970) studied the activities of lactating beef cows and beef calves reared in confinement in Texas. Putnam and Davis (1963), of the U.S.D.A. in Maryland, reported on the behavioral patterns when steers were fed individually. More recently, Ray and Roubicek (1971) reported on the behavior of feedlot cattle during summer and winter in Arizona.

Very little information has been reported on the behavior of steers under Midwest feedlot conditions. The purpose of this study was to investigate the eating, drinking and lying times and time spent under shelter by feedlot steers under midwestern climatic conditions.

Materials and Methods
These investigations were conducted at the Allee Experimental Farm located near the center of the northwestern quarter of Iowa.

Steers of predominantly Hereford and Angus breeding or crosses of these breeds were used in all three trials. The lots were concrete-surfaced,
provided approximately 17.2 sq m per steer. Data on individual steers were recorded on a per-lot basis, and data on water consumption and activity per lot were recorded hourly. All data were categorized into eight 3-hr. intervals within each day (12 midnight to 3 am = period 1, 3 to 6 am = period 2, etc.) and analyzed by least-squares procedures.

**Results and Discussion**

Total average time devoted to eating was similar for the three trials and constituted approximately 10.0% of each day; 145.4, 143.7 and 142.1 min. for the three trials, respectively. This is considerably less time than that reported by Putnam and Davis (1963) where a similar ratio of a concentrate-to-roughage ration (75:25) was fed to smaller steers penned individually. In their study, 270- and 374 kg steers spent 190 and 216 min. eating per day. Putnam, Lehmann and Davis (1964) reported that lighter-weight cattle require more eating time, and this may reflect some of the difference. The discrepancy between their study and ours may be exaggerated somewhat in that the eating pattern of individually fed steers may differ from that of steers fed in groups. No significant difference existed among the trials in our study for time spent eating per day, which suggests that season and (or) temperature did not have an effect upon total eating time per day.

The amount of time spent eating differed significantly (P<.01) among periods within day in all three trials. Very little eating occurred between 12 pm and 6 am in any trial, indicating a preference for eating during daylight hours. Similar findings were reported by Schake and Riggs (1970) with beef calves in confinement in Texas, Ray and Roubicek (1971) in Arizona with feedlot cattle and Putnam and Davis (1963) in Beltsville, Maryland, with steers penned individually. In trials I and II (summer), a significant quintic effect (P<.01) was noted, with the first peak of eating activity occurring between 6 and 9 am followed by a slight decline between 9 and 12 noon. There was a period-to-period increase during the first three afternoon periods, followed by a decline in activity between 9 pm and midnight. In trial III (winter), a significant cubic effect (P<.01) existed, with a gradual increase in eating activity from the low in period 2 through period 6 (3 am to 6 pm), followed by a decline during the rest of the nighttime hours. In these tests, cattle tended to do most of their eating during the cooler part of the daylight hours in summer, while in winter, they tended to do most of their eating during the afternoon daylight hours, which is the warmest part of the day. These findings are in general agreement with reports of Ray and
Roubicek (1971) where Arizona feedlot cattle in summer did most of their eating at sunrise and sunset. In the Arizona studies similar daily eating patterns were observed for both winter and summer, although the two peaks of greatest activity were closer together in winter probably because of the shorter daylight hours and also were of less magnitude, evidently as a result of more time spent eating during midday. Individual steers observed by Putnam and Davis (1963) also followed this pattern in winter, but the peaks were not as extreme. They found that approximately 75.0% of the eating time occurred between 6 am and 6 pm.

The data in Table 1 demonstrate that cattle spent significantly more time (P < .10) drinking in summer than in winter (15.4 vs. 12.2 minutes per day). This ratio of drinking time activity between the winter and summer seasons is less than the ratio of actual water consumption by seasons (Hoffman and Self, 1972; 31.2 vs. 19.0 liters per day), which indicates that cattle drink more rapidly in summer than in winter. This might be due to the discomfort caused by rapid ingestion of water with a lower temperature in winter. Most of the drinking activity occurred during daylight hours, regardless of season, which is also the time of greatest feeding activity. This agrees with reports of Schake and Riggs (1970) in Texas, and Putnam, Lehmann and Davis (1965). The significant quintic affect (P < .01) of periods for all three trials illustrates that the greatest drinking activity in the summer occurred between 12 noon and 9 pm and during the winter, between 12 noon and 6 pm. This agrees with a previous report (Hoffman and Self, 1972) where water consumption varied with temperature within the day. In general, the data in summer agree with the observations of Ray and Roubicek (1971), but these workers noted a drinking peak in winter nearer to midday. This deviation may be due to the warmer morning winter temperatures in Arizona than in Iowa.

Considerable variation in the use of shelter by steers was noted among the three trials (Table 1). When the two summer trials (trials I and II) were combined and compared with the winter trial (trial III) the cattle spent significantly more time under shelter in summer than in winter (674.1 vs. 314.5 min. per day or 46.8 vs. 21.8%, respectively; P < .001). In summer a quintic effect (P < .01) existed for periods, with the greatest utilization of shelter occurring between 9 pm and 6 am and between 9 am and 6 pm in trial I. These were also the periods with
the least eating activity. In trial II, less time was spent in shelter during the periods of darkness and more time during the periods between 9 am and 6 pm. During trial II, the average daily temperature exceeded that of trial I by 3 C, which may be why the cattle spent more of the midday hours under shelter. In winter, period within day had no effect on the time spent in shelter. The data from the summer tests differ from those of Ray and Roubicek (1971) in that they reported only about 5% of the cattle used shades between 6 pm and 7 am and that, during the remainder of the day, over 80% of the cattle were under shades at all times. They surmised this to be more of an effect of light intensity than temperature, since most of the cattle started migrating to the shades when the temperature was near the 24-hr low. There was a more consistent use of shades in winter than summer, although a small peak was observed around noon. Although the cattle in our studies utilized shelter less frequently in winter, they seemingly were able to reap greater benefits from it. In an earlier study (Hoffman and Self, 1970), cattle with shelter in winter gained significantly faster (P<.01) and required significantly less (P<.01) feed per unit gain than cattle with access to shelter in summer. The full interpretation of these interrelationships is not known, but it is suggested that cattle in winter derive most of the benefit from shelter during periods of very low temperatures or during times of severe changes in the weather, which may not be reflected in the shelter-time utilization in our study.

A method of measuring quiescence is to determine the amount of time spent lying down. These data are presented in table 2 for the three trials. In trial I, in which only cattle without access to overhead shelter were observed continuously for this activity, a total of 717.3 min. per day (49.8%) were spent lying down. In trials II and III where shelter was provided, approximately the same amount of time was spent lying down as in trial I (50.1 and 53.6%), thus suggesting that neither shelter nor season affected total daily lying time. Schake and Riggs (1969) found that nursing beef cows in confinement spent approximately 39% of the day lying down; however, since eating by the cows and nursing by the calves were not usually done simultaneously, this probably lengthened the standing time of the cows. The calves spend 60.0% of their time lying (Schake and Riggs, 1970).

Time spent lying under shelter in summer was significantly more than in winter (323.2 vs. 180.0 min. per day; P<.05), but significantly less time was spent lying outside in summer than in winter (398.7 vs. 591.3 min. per day; P<.005). This contrast in lying activity by season is probably a reflection of the lesser time spent under shelter by cattle during the winter (46.8 vs. 21.8%).

In trial I (summer), about 58.3% of the lying time of cattle without shelter occurred during the hours of darkness (9 pm to 6 am). The period with the lowest percentage of lying time was 12 noon to 3 pm, which was also the period of greatest heat intensity. During those periods when the ambient temperature was greatest, the cattle usually stood as a group near the waterer. In trial II, the cattle during the 12 noon to 3 pm period again showed a decrease in

### TABLE 2. LEAST-SQUARES MEANS AND STANDARD ERRORS (IN MINUTES) FOR LYING BY PERIODS

<table>
<thead>
<tr>
<th>Trials</th>
<th>No shelter</th>
<th>Under shelter</th>
<th>Out of shelter</th>
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<tr>
<td></td>
<td>I&lt;sup&gt;c&lt;/sup&gt;</td>
<td>II&lt;sup&gt;a&lt;/sup&gt;</td>
<td>III&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>Periods</td>
<td></td>
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<tr>
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<td>28.6±4.1&lt;sup&gt;d&lt;/sup&gt;</td>
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<tr>
<td>2</td>
<td>147.0±9.4</td>
<td>50.4±3.6</td>
<td>34.3±4.1</td>
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<td>46.7±3.6</td>
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<td>58.2±3.6</td>
<td>12.9±4.1</td>
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</tr>
<tr>
<td>8</td>
<td>148±9.1</td>
<td>15.6±3.6</td>
<td>29.2±4.1</td>
</tr>
</tbody>
</table>

Total per day: 717.3 323.2 180.0 398.7 591.3

<sup>a</sup>Effect of season significant (P<.05).
<sup>b</sup>Effect of season highly significant (P<.005).
<sup>c</sup>Effect of period highly significant (P<.01).

<sup>d</sup>Lying time for cattle without shelter.
lying time (quintic effect, $P<.01$); however, most of the under-shelter lying time (58.4%) was between 9 am and 6 pm, and most of the outside lying time was between 6 pm and 9 am (92.5%). In winter (trial III), about 51.2% of the lying time under shelter occurred between 9 pm and 6 am and approximately 52.3% of the outside lying time, between 9 pm and 6 am. Ray and Roubicek (1971) noted that, in general, during the evening hours 80 to 90% of all cattle were lying down, and between morning and afternoon eating periods, 60 to 80% were lying down. Although only small differences existed in lying patterns between seasons in their studies, they concluded the differences were primarily a reflection of the differences in eating patterns.

The pooled data for the two summer trials indicated that 58.0% of the total lying time in summer occurred nocturnally (9 pm to 6 am). In winter, 61.7% of the total lying time occurred during darkness (6 pm and 6 am). These findings concur with those of Schake and Riggs (1969, 1970) who found that beef cows and calves spent more time lying at night than during the day.

Cattle with access to shelter in summer require significantly less ($P<.01$) water than cattle without shelter (30.1 vs. 32.6 liters per day), and cattle drink significantly more ($P<.01$) water in summer than in winter (31.2 vs. 19.0 liters per day) according to Hoffman and Self (1972). The data presented in table 3 follow the same trend. The data and results in table 3 also support the possibility that drinking time may be measured on a relative basis by monitoring the rate of water consumption (table 1). In figure 1, data for all cattle in a lot are presented for trials II and III regarding the percentage of steers observed under shelter and whether they were standing or lying. The same observations were made simultaneously for those steers not under shelter. This was done by observing all cattle in all four lots at regular hourly intervals (24 observations per day). In trial II (summer), during periods 4, 5 and 6 (9 am to 6 pm) approximately 70.0% of the cattle were under shelter at the time observations were recorded. As discussed earlier, observations on individual steers indicated that they spent 66.5% of their time under shelter during these periods. In trial III (winter), at least 64.0% of the cattle were observed outside at the time of any observation. Earlier comments on individual steers indicate that the minimum time spent outside for any one period was at least 72.7%.

The data in figure 1 and in table 2 for lying time inside and outside the shelter suggest that observations made at regular hourly intervals for certain kinds of cattle behavior may be an acceptable method for obtaining such data.

To further define activity of feedlot steers, frequencies (i.e. number of successful attempts) of the various criteria were studied. In figure 2, the number of successful attempts by periods within day for eating, drinking and times
periods 5 through 7. Previous observations agree that the greater eating, drinking, shelter entering shelter are shown for each of the three trials. The activity for all factors was higher in steers in trial III (winter) than for steers in trials I and II (summer).

The frequencies of lying down are shown in figure 3 by periods for all three trials. Trial I steers did not have access to shelter and, with the exception of periods 6 and 7, lay down fewer times during the day. The reason is not clear for the relative restlessness of these trial I cattle during periods 6 and 7 (3 pm to 9 pm) in summer. The periods of highest temperature and, thus, the periods of greatest discomfort had passed. No data were collected on lot-surface temperature, but observations during time and water consumption occurred during these periods. Without exception, the combined frequencies for these activities were less for periods 6 and 7 suggested that heat accumulated during the day by the concrete surface created a zone of discomfort sufficient to cause individual animals to seek a cooler location on which to lie down. In trials II and III, where shelter was available, the cattle migrated frequently between the shelter and no shelter areas of the lot, which may have resulted in their greater frequencies of lying down. As noted previously, cattle in summer with access to shelter spent most of the time lying under shelter between 9 am and 6 pm and little time outside. This is reflected in their frequencies of lying down in periods 4 through 6.
Figure 2. Frequencies of eating, drinking and entering shelter by periods.

Figure 3. Frequencies of laying down inside and outside by periods.
Literature Cited


