# ARTIFICIAL LIGHTING FOR CATTLE FEEDLOTS

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## Summary

Four feedlot lighting techniques for steers were evaluated in a fall/winter feeding experiment in North-eastern New Mexico. The control steers exhibited more desirable average daily gain, feed efficiency and cost per kg of gain by as much as 5.7% over the predawn/postdusk, midnight and continuous lighting treatments. Nonsignificant increases in eating and standing of predawn/postdusk treatment steers was observed at 0600 hrs. with less eating observed at 1200 hrs. compared to the other treatments. Steers in midnight and continuous light treatments had increased eating activity at 2400 hrs. compared to the control and predawn/postdusk treatments. Variable cost for lighting per kg of gain was 0.53 mills for the predawn/postdusk and midnight treatments and 1.16 mills for the continuous treatment. These data indicated that steers in open pen feedlots did not respond to supplemental lighting during the fall and winter seasons.

## Introduction

Performance of feedlot cattle is most often measured by feed efficiency and average daily gain. The genetic makeup of each animal combined with the environment in which it lives determines performance. Modifying the environment to allow expression of the animal's genetic potential is one alternative to approach optimum performance. Environment of feedlot cattle includes factors such as nutrition, management and seasonal factors related to pen conditions such as wind, humidity, temperature and light. Season of the year has been found to influence feed intake, average daily gain and feed efficiency of cattle in open pen feedlots (2). Day length may be modified through artificial lighting. Supplemental light has been evaluated and applied by the poultry industry for more than forty years and to most seasonal breeding livestock. Supplemental lighting as a managerial tool in improving the efficiency of feedlot cattle has been widely applied in the Southwest, but rising energy cost have forced producers to reconsider the use of artificial lighting in their feedlots. Therefore a field trial was established to evaluate four lighting alternatives in a commercial feedlot.

## Procedure

Four lighting treatments were established including a control with natural lighting plus supplemental lighting at predawn/postdusk, midnight and continuous night lighting. Lighting for the predawn/postdusk and midnight treatments was limited to 16 hrs. per day. The difference between 16 hrs. and the natural day length represented the hours of supplemental light divided equally before dawn and after dusk, and before and after midnight. The continuous lighting treatment had supplemental lighting from dusk to dawn. Supplemental plus natural light totalled 24 hrs. for the continuous treatment. A sunrise and sunset schedule[a] was utilized to determine day length during the fall and winter of 1980-1981 at American Cattle Feeders, Inc. in Clovis,

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[a]Cannon Air Force Base, Clovis, New Mexico

New Mexico where this experiment was conducted.

The control, predawn/postdusk and midnight treatments each consisted of 275 steers. The continuous treatment consisted of 276 steers. Each herd was placed in a uniform open pen with feedbunks in a North-South orientation located on the West side of each pen. Each of the four pens was located on the Southwestern corner of four different alleys in the feedlot. One 400 watt high-pressure sodium vapor floodlight was positioned on a 9.1 m pole at the Southwestern corner of each lighted pen (figure 1). The floodlights were focused on the area between the feed bunk and the water trough. Timers were used to control the floodlights and were adjusted for varying day length. A computerized simulation was utilized to predict the level of illumination throughout the pens in each treatment.[b] Each light affected the designated pen and portions of the pen to the North which were not involved in this research.

On September 28 and 29, 1980, 2000 mixed crossbred steers were weighed upon arrival at the feedlot, placed in holding pens and fed hay plus a starter ration. The steers were then sorted according to U.S.D.A. frame size (8) on September 29. Eleven hundred and one medium-frame steers were randomly assigned to four lots, one for each lighting treatment. On September 29 and 30, the steers were reweighed and processed. Processing consisted of branding, vaccinations and injections with Tramisol and Vitamins A, D and E. The steers were implanted with Synovex-S; horns tipped, and tails bobbed, dipped in a 2% Prolate solution and placed in their respective pens. The steers

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[b]Floodlighting Analysis Program EL503. 1980. Electrical Design Dept., Brown & Root, Inc., Houston, Texas.

were reimplanted with Synovex-S approximately 60 days later.

All steers were fed on the same ration sequence. An analysis of the rations fed is presented in Table 1. The steers were fed a starting ration for seven days followed by two intermediate rations each fed for seven days. The finishing ration was fed for approximately 123 days (range of 119 to 125 days) depending on the day each lot was sold. Bunks were observed each morning to establish daily feed assignments with half of the feed assignment provided twice daily. Each steer was provided with an average of 15.6 $m^2$ of pen area and 205 mm of linear bunk space.

Steer behavior was observed and recorded over twenty weeks. The number of steers in each pen that were observed eating, drinking and standing was recorded at 0600, 1200, 1800 and 2400 hrs. These times of observation were selected due to their association with major and minor feeding periods identified with steers during the winter in Arizona (5). Observation of cattle activities required approximately ten min. per treatment. A one-way analysis of variance was utilized to evaluate behavior of the steers by treatment. Steer performance was obtained from the feedlot data and carcass data was obtained from the packing plant. Energy and economic budgets were established from current installations and energy costs in the Clovis, New Mexico area assuming a one time feedlot capacity of 25,000 head.

## Results and Discussion

Simulated light intensities in each of the lighted pens is presented in Figure 1. The light intensity along the feedbunk was an average of five lux. Along a North-South line approximately 24.4 m and 45.7 m into the pen, the light intensity was ten lux and one lux, respectively. By comparison, bright moonlight has an intensity of approximately 0.1 lux (1). Each treatment received an average of 10.51 hrs. of natural daylight per day during this experiment. Predawn/postdusk and midnight treatments received an average of 5.49 hrs. of supplemental light per day and the continuous treatment received 13.49 hrs. of supplemental light per day.

Average daily gain and feed efficiency were not improved by any of the three lighting techniques compared to the control (Table 2). Summer trials conducted in Michigan (6) and California (3) reported similar results. A Texas study (4) compared mercury vapor and high pressure sodium floodlights and reported no differences in performance of steers. In all feedlot performance criteria measured, the controls exhibited more desirable responses by as much as 5.7% over the three lighting treatments (Table 2). Dressing percent was similar for the control, predawn/postdusk, midnight and continuous treatments. However, percent U.S.D.A. Low Choice (7) and above carcasses favored the midnight and continuous lighting treatments at 58 and 46%, respectively vs. 29 and 31% for controls and predawn/postdusk lighting treatments.

The means of the 20 week behavior data are given in Table 3. No significant difference was indicated because of wide variation in cattle activity within treatment. However, a shift in behavior was seen in each of the lighting treatments compared to the control. Predawn/postdusk steers were observed to eat and stand more at 0600 hrs. compared to all other treatment steers. The predawn/postdusk steers ate less frequently at 1200 hrs. in the midnight and continuous treatments compared to the control and predawn/postdusk treatments.

Lighting budgets (Tables 4 and 5) established the fixed and variable cost to uniformly light a 25,000 head feedlot. No lighting cost was assumed for the control treatment. Variable cost of lighting per kg of gain was 0.53 mills for the predawn/postdusk and midnight treatments and 1.16 mills for the continuous treatment. Total fixed cost were 4.01 mills per kg of gain for the predawn/postdusk and midnight treatments and 4.04 mills per kg of gain for the continuous treatment.

These data indicated that steers in open pen feedlots in Northeastern New Mexico did not respond to supplemental lighting during the fall and winter seasons.

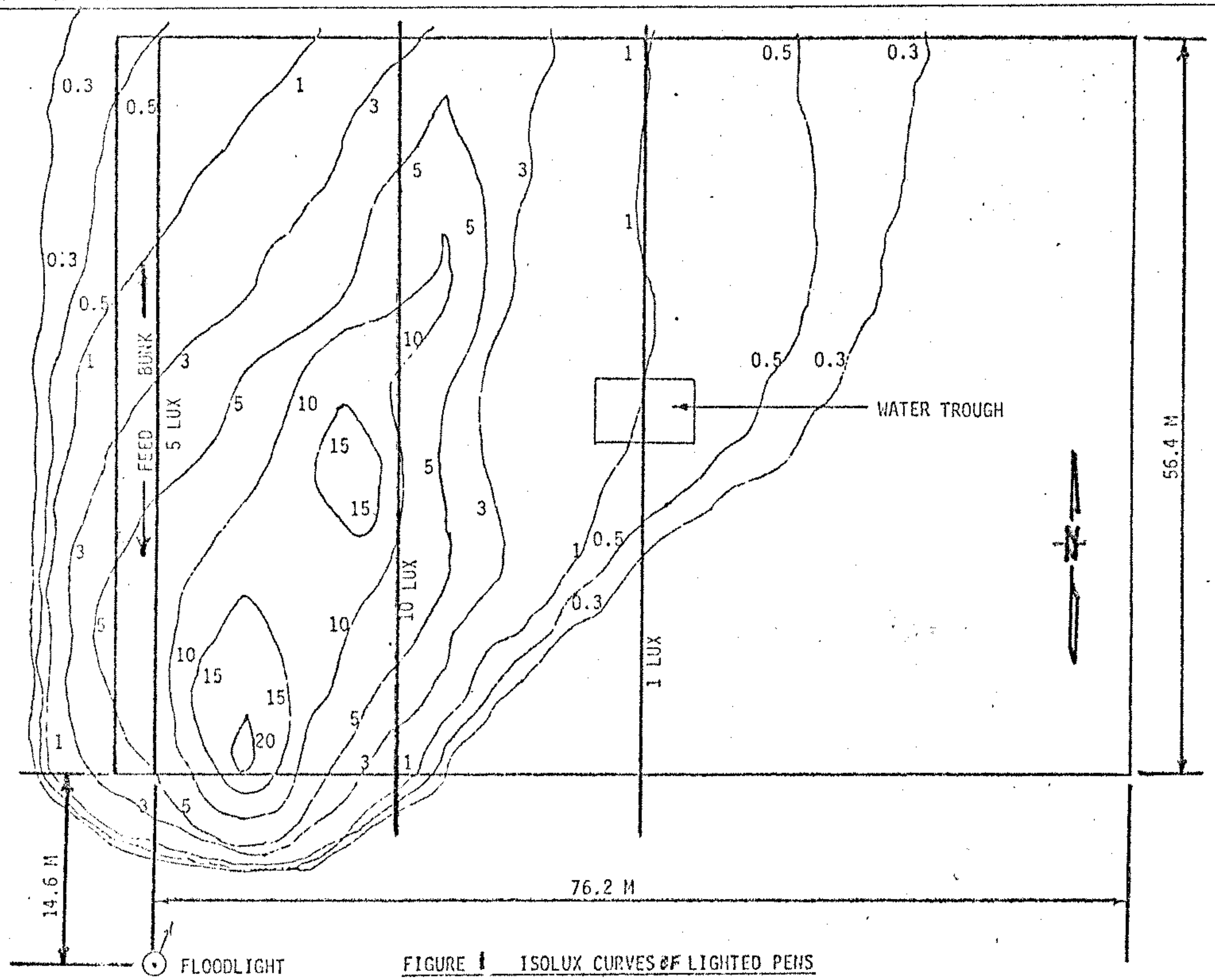


FIGURE 1 ISOLUX CURVES OF LIGHTED PENS

TABLE 1. COMPOSITION OF FEED FED TO EXPERIMENTAL STEERS[a]

| | Ration | | | |
|---|---|---|---|---|
| Item | Starter | Intermediate | Intermediate | Finisher |
| Net energy m, Mcal/kg | 1.76 | 1.87 | 2.00 | 2.13 |
| Net energy p, Mcal/kg | 1.04 | 1.15 | 1.27 | 1.36 |
| Crude protein, % | 12.17 | 12.38 | 12.83 | 12.41 |
| Crude fiber, % | 15.19 | 12.03 | 8.49 | 7.29 |
| Calcium, % | 0.78 | 0.74 | 0.96 | 0.83 |
| Phosphorous, % | 0.29 | 0.30 | 0.33 | 0.33 |

[a]All values are expressed on a dry matter basis.

TABLE 2. STEER PERFORMANCE

| Item | Lighting treatment | | | |
|---|---|---|---|---|
| | Control | Predawn/Postdusk | Midnight | Continuous |
| Number of steers | 275 | 275 | 275 | 276 |
| Average initial weight, kg | 321.85 | 327.43 | 327.76 | 329.81 |
| Days on feed | 147 | 146 | 141 | 140 |
| Average daily gain, kg | 1.28 | 1.26 | 1.26 | 1.25 |
| Feed intake per day (dry matter), kg | 9.43 | 9.50 | 9.63 | 9.62 |
| Feed efficiency (as fed) | 10.17 | 10.27 | 10.41 | 10.58 |
| Feed efficiency (dry matter) | 7.36 | 7.55 | 7.65 | 7.78 |
| Cost of gain, \$/kg[a] | 1.51 | 1.52 | 1.56 | 1.57 |
| Average sale weight (includes 4% shrink), kg | 509.84 | 510.75 | 505.31 | 503.49 |
| Number of deaths | 1 | 0 | 3 | 0 |
| Death loss, % | 0.36 | 0.00 | 1.09 | 0.00 |
| Dressing percent | 63.59 | 62.92 | 63.40 | 62.86 |
| U.S.D.A. Low Choice carcasses or above, % | 29 | 31 | 58 | 46 |

[a]Does not include cost of lighting or interest cost on feed fed or cattle.

TABLE 3. MEANS OF BEHAVIORAL OBSERVATIONS, NUMBER OF STEERS

| | | Lighting treatment | | | | |
|---|---|---|---|---|---|---|
| Activity | Time(hrs.) | Control | Predawn/ Postdusk | Midnight | Continuous | SEM |
| Eating | 0600 | 7 | 14 | 7 | 5 | 1.98 |
| | 1200 | 37 | 28 | 37 | 38 | 4.05 |
| | 1800 | 61 | 61 | 57 | 56 | 2.33 |
| | 2400 | 25 | 23 | 30 | 29 | 2.70 |
| Drinking | 0600 | 7 | 2 | 2 | 1 | .30 |
| | 1200 | 7 | 6 | 5 | 6 | .46 |
| | 1800 | 7 | 8 | 7 | 6 | .51 |
| | 2400 | 3 | 4 | 3 | 3 | .20 |
| Standing | 0600 | 15 | 22 | 17 | 18 | 2.56 |
| | 1200 | 59 | 44 | 59 | 56 | 3.52 |
| | 1800 | 186 | 184 | 193 | 192 | 2.20 |
| | 2400 | 44 | 34 | 31 | 40 | 3.00 |

[a]Observation dates were October 10, 17, 24, 31; November 7, 14, 21; December 9, 28; January 5, 12, 19, 26; February 2, 9, 16. The minimum number of observations per treatment for each activity at 0600, 1200, 1800 and 2400 hrs. was 14, 16, 15 and 10 times, respectively.

TABLE 4. COST OF INSTALLING LIGHTS IN A 25,000 HEAD FEEDLOT.

| | Lighting treatment | | |
|---|---|---|---|
| Item | Predawn/Postdusk | Midnight | Continuous |
| Initial investment, $[a] | 108,000 | 108,000 | 108,000 |
| Loan repayment, $/yr.[b] | 34,536 | 34,536 | 34,536 |
| Fixed cost, mills/kg[c] of gain | 4.01 | 4.01 | 4.04 |

[a]Assuming 72 floodlights were required to uniformly light a 25,000 head feedlot at a cost of $1500 per light.

[b]Represents annual payment of a 5 year loan of $108,000 with 18% interest. Interest computed annually on remaining balance.

[c]Feedlot operating at 75% capacity. Cattle gains are those observed in this experiment.

TABLE 5. ENERGY BUDGET FOR LIGHTING A 25,000 HEAD FEEDLOT[a]

| Item | Lighting treatment | | |
|---|---|---|---|
| | Predawn/Postdusk | Midnight | Continuous |
| Supplemental light hrs./yr.[b] | 144,300 | 144,300 | 345,520 |
| Energy consumption, kwh/yr.[c] | 72,150 | 72,150 | 177,760 |
| Energy cost, $/yr.[d] | 3,608 | 3,608 | 8,890 |
| Maintenance and repair, $/yr.[e] | 1,000 | 1,000 | 1,000 |
| Total variable cost, $/yr. | 4,608 | 4,608 | 9,890 |
| Variable cost per kg of gain, mills | 0.53 | 0.53 | 1.16 |

[a]Assumes 72 floodlights are required to uniformly light a 25,000 head feedlot at the intensity of the treatments utilized in this experiment.

[b]Based on average number of hours of supplemental light supplied to each treatment during this fall/winter trial. Actual hours would differ with natural day length.

[c]Assuming an efficiency of 80% for a 400 watt high pressure sodium vapor floodlight consuming 0.5 kwh of electricity per hour.

[d]Assume electrical cost of $0.05/kwh.

[e]Estimated value.

[f]Assume 25,000 head feedlot operating at 75% capacity. Cattle gains are those observed in this experiment.

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## Acknowledgements

Authors express gratitude to the Texas Cattle Feeders Association of Amarillo and American Cattle Feeders, Inc. in Clovis, New Mexico for their support of this work.