# SOME EFFECTS OF SHADE ON HEREFORD STEERS IN A FEEDLOT

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## SUMMARY

The comparative performance and meat quality of Hereford steers in unshaded and shaded yards were studied in a Queensland feedlot from November 1993 to February 1994. The provision of shade gave no significant ($P>0.05$) advantage in liveweight gain (17 1.6 v. 162.2 kg), feed intake (1.12 v. 1.07 t), feed conversion efficiency (0.153 v. 0.152 kg gain/kg feed intake), carcase weight (282.7 v. 277.7 kg), dressing percentage (53.4 v. 53.4%), P8 rump fat (16.3 v. 14.7 mm), fat content (9.0 v. 7.7%), eye muscle area, fat colour, meat colour, marbling score, sarcomere length, ultimate pH and tenderness compared to the unshaded group. A significant ($P<0.05$) relationship was found between rectal temperature and air temperature. Although the slopes of the regressions were the same in the relationship of rectal temperature against air temperature for treatments, the unshaded steers had a significantly ($P<0.05$) higher rectal temperature than shaded steers for any particular air temperature recording. Similar relationships were found for respiration rate. Unshaded steers displayed a higher incidence of open mouth breathing than shaded steers and were seen to exhibit behaviour intended to reduce heat loads. At 1400 hours steers had a mean shade use rate of 9 1%.

The major implications for industry are that, while shade has little overall effect on production and meat quality, it will markedly improve the thermal status of British breed feedlot cattle during the hot summer period.

*Keywords:* feedlot, climate, heat stress, shade, genotypes

## INTRODUCTION

In recent years there has been substantial growth in the Japanese beef market, especially in the grain-fed segment. Australian feedlots prefer British breed steers for some markets, because it is thought that they meet the specifications better than other breeds. It is also the British breeds which are likely to be susceptible to heat stress and therefore likely to respond to the provision of shade (Fell and Clarke 1993).

Research in Central Queensland in 1992 (Clarke *et al.* 1994) showed that shade significantly ($P<0.05$) reduced the rectal temperature of Brahman cross feedlot steers although the rectal temperature of the unshaded steers was not unacceptably high (39.3$^0$C). Although steers used the shade, acceptable rectal temperature and absence of open mouth breathing in shaded and unshaded steers indicated that steers were unlikely to have been heat stressed. Shade also failed to produce a significant improvement in liveweight gain, feed conversion efficiency or meat quality.

US researchers have reported the benefits of providing shade to British breed feedlot cattle in hot environments in terms of higher liveweight gain, superior feed conversion efficiency, lower respiration rate and lower rectal temperature (Hahn 1985). Australian feedlots are at lower latitudes and altitudes than US feedlots and have higher heat loads (Fell and Clarke 1993). Because of limited information on the effect of shade on British breed cattle in Australian feedlots, an experiment was conducted to study the response of Hereford feedlot steers to the provision of shade.

## MATERIALS AND METHOD

In November 1993, at Brigalow Research Station, Theodore, Queensland (25°S, 148°50'E), 36, two year old Hereford steers weighing (mean±SD) 358±28 kg fasted liveweight were stratified into 6 groups based on their liveweight and randomly allocated to 6 yards. Two treatments (unshaded and shaded) were allocated to the 6 yards, giving 3 replicates.

Medium density, knitted shade cloth (75% sunlight exclusion; manufactured by Rheem Australia Pty Ltd) was suspended 3.75 m above the ground to provide 10 $m^2$ of shade per steer. The steers were fed to appetite from 28 November 1993 to 28 February 1994 on a grain based diet (80% barley, 10% hay and 10% additives) to meet the specifications of the short-fed Japanese market. At the Research Station office (official meteorological site) the following weather data were collected for the feeding period; 0900 hour dry bulb (DB) and wet bulb (WB) temperature, 0900 hour relative humidity (RH), and maximum and minimum DB temperature. Daily DB and WB temperature, measured at a height of 1 metre in the shaded yards (in the centre of the shade) and unshaded yards, were recorded in the feedlot at 1400 hours. Relative humidity (RH) in the yards was derived from DB and WB temperatures using Bureau of Meteorology conversion tables.

Location of steers in yards, respiration rate, open-mouth breathing, and aberrant behaviour (Fell and Clarke 1993), were recorded at 1400 hours daily. Steers were quietly moved to the cattle handling yards at 1400 hours weekly to record rectal temperature and to be weighed. Mean daily feed intake of steers in each yard was recorded as total feed fed less that refused, on an 'as fed' basis.

Individual hot carcase weight, subcutaneous fat depth at the P8 rump site and eye muscle area at the 10th rib were measured at the abattoir. Fat colour, meat colour using a Minolta CR200 Chromameter, fat content using Soxhlet extraction, marbling using the Japanese grading system, tenderness, sarcomere length and ultimate pH of a striploin (*Longissimus dorsi* muscle) sample were recorded for all carcases in the laboratory, as an assessment of meat quality.

The animal production and meat quality data were analysed by analysis of variance. Differences were tested using the protected LSD test and considered to be significant at the 5% probability level. The relationships between rectal temperature (and respiration rate) and a number of climatic measurements were tested using regression analysis with the effect of shading included as a factor.

## RESULTS

Weather conditions during the experiment were variable with a heat wave from 3 1 December 1993 to 9 January 1994 and a cool period from 31 January to 4 February. Whilst Figure 2 shows only weekly temperatures, the highest daily 1400 hour DB temperature in the unshaded feedlot yards was 45.6°C (6 January). The heat wave caused a reduction in feed intake during the heat wave with the unshaded steers worst affected (Figure 1). Reduced feed intake was reflected in liveweight loss during the heat wave.

Over the total feeding period, differences between the unshaded and shaded steers in feed intake, liveweight gain, feed conversion efficiency and meat quality were not significant at the 5% level (Table 1).

**Table 1. The performance and meat quality of unshaded and shaded Hereford feedlot steers**

| | Unshaded | Shaded | LSD ($P<0.05$) |
|---|---|---|---|
| Initial liveweight (kg) | 357.9 | 358.2 | 4.03 |
| Final liveweight (kg) | 520.1 | 529.8 | 37.74 |
| Liveweight gain (kg/head) | 162.2 | 171.6 | 36.06 |
| Feed intake (t/head) | 1.07 | 1.12 | 0.112 |
| Feed conversion efficiency (kg gain/kg feed intake) | 0.152 | 0.153 | 0.020 |
| Carcase weight (kg) | 277.7 | 282.7 | 14.61 |
| Dressing % | 53.4 | 53.4 | 1.47 |
| P8 rump fat (mm) | 14.67 | 16.33 | 3.762 |
| Eye muscle area ($cm^2$) | 61.6 | 60.2 | 4.61 |
| Fat colour (Hunter 'b' value) | 8.23 | 8.13 | 0.660 |
| Meat colour (Hunter 'l' value) | 34.7 | 36.0 | 1.42 |
| Fat content - Soxhlet extraction (%) | 7.69 | 9.03 | 1.42 |
| Marbling score - Japanese grading system | 1.11 | 1.22 | 0.435 |
| Sarcomere length (um) | 1.82 | 1.82 | 0.054 |
| Ultimate pH | 5.62 | 5.60 | 0.052 |
| Warner Bratzler initial yield (kg) | 2.99 | 3.29 | 0.420 |
| Instron compression (kg) | 1.80 | 1.79 | 0.066 |

No significant ($P>0.05$) differences were observed between means.

A significant ($P<0.05$) relationship was found between weekly rectal temperature and: feedlot 1400 hour DB temperature ($R^2$=0.29); feedlot 1400 hour WB temperature ($R^2$=0.30); office 0900 hour DB temperature ($R^2$=0.65, Figure 3); office maximum DB temperature ($R^2$=0.44); but not between other relationships tested.

Although the slopes were the same in the relationship of rectal temperature against the climatic measurements for treatments, the unshaded steers had a significantly ($P<0.05$) higher rectal temperature than shaded steers for any particular climatic measurement.

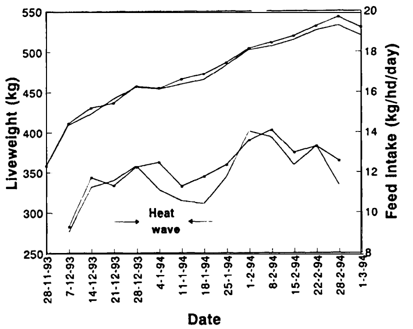


Figure 1. The feed intake (lower 2 lines) and liveweight gain (upper 2 lines) of unshaded (unmarked lines) and shaded (marked lines) Hereford **feedlot** steers

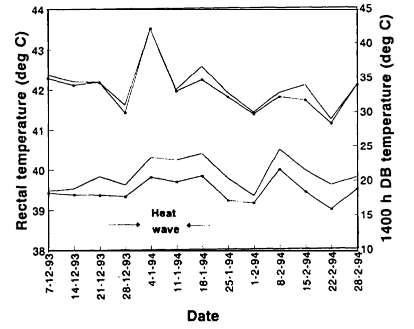


Figure 2. The 1400 hour DB temperature (upper 2 lines) and 1400 hour rectal temperature (lower 2 lines) of unshaded (unmarked lines) and shaded (marked lines) Hereford steers

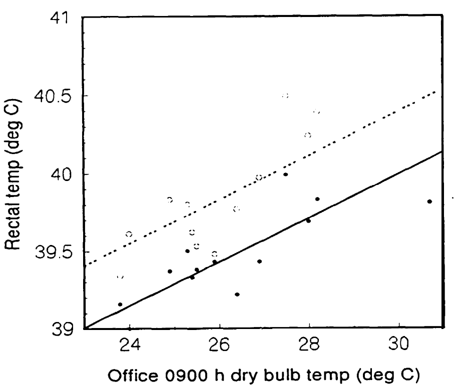


Figure 3. The relationship between 1400 h rectal temperature and **office** 0900 h DB temperature for unshaded (dotted line) and shaded (full line) Hereford steers
**($y=36.2+0.14x$** for unshaded steers)
**($y=35.8+0.14x$** for shaded steers)

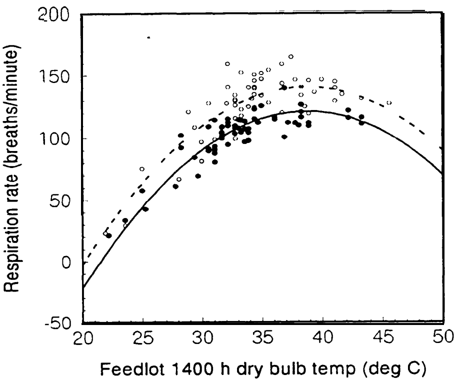


Figure 4 The relationship between 1400 h respiration rate and **feedlot** 1400 h DB temperature for unshaded (dotted line) and shaded (full line) Hereford steers
**($y=-471.5+31.6-0.41x^2$** for unshaded steers)
**($y=-490.9+31.6-0.41x^2$** for shaded steers

A significant ($P<0.05$) relationship was also found between daily respiration rate and: feedlot 1400 hour DB temperature ($R^2=0.77$, Figure 4); feedlot 1400 hour WB temperature ($R^2=0.26$); feedlot 1400 hour relative humidity (unshaded $R^2=0.63$; shaded $R^2=0.69$); office 0900 hour DB temperature ($R^2=0.39$); office 0900 hour RH ($R^2=0.14$); and office maximum DB temperature ($R^2=0.37$). Although the slopes were the same in the relationship of respiration rate against the climatic measurements for treatments (except for feedlot 1400 hour RH), the unshaded steers had a significantly (P<0.05) higher respiration rate than shaded steers for any particular climatic measurement (Figure 4).

Unshaded steers displayed a high incidence of open mouth breathing at 1400 hours (up to 44% of steers affected) while shade virtually eliminated it in shaded yards (1 animal affected on 1 day). Observation of steer location in shaded yards at 1400 hours showed that the mean use of the shade by steers at that time was 91% and was influenced by a range of weather factors..

Unshaded steers were seen to regularly form tight groups and single file formation (aligned to the sun) in an attempt to share body shade and minimise incoming solar radiation, especially during the heat wave. One unshaded steer regularly placed his front feet in the water trough on hot days presumably to reduce body temperature. Another unshaded steer was seen on a number of occasions on hot days to completely submerge his head in the water trough in an attempt to keep cool. Two unshaded steers on a number of occasions on hot days were seen to submerge their tails in the water trough and then swish their tails to create a sprinkling effect for all steers.

## DISCUSSION

The response of steers to the January heat wave in terms of production, welfare and behaviour was what would have been expected and is the same as that reported in a severe heat wave in the US in the summer of 1995 (J. Cavaye, pers. comm.). Both treatment groups appeared to compensate after the heat wave as the weather returned to normal, particularly in feed intake and feed conversion efficiency. A different regime of weather variables would produce different responses and continued experiments would be required to determine these. The trend towards heavier carcases with better finish could mean more carcases meeting the specifications for the higher priced export categories and greater profitability for shaded feedlots. The lack of significant differences between the treatment means in meat quality supports the findings of a similar experiment with Zebu cross cattle (Clarke *et al.* 1994).

The lower rectal temperatures and respiration rates in shaded steers demonstrate the effectiveness of shade in improving the thermal status of feedlot cattle. However, these reductions were not as big as those reported by Garrett *et al.* (1960) for rectal temperature (41.1 °C down to 39.7°C) and respiration rate (15 1 breaths/minute down to 109 breaths/minute). At no stage did mean rectal temperature in shaded steers exceed 40°C, but was found to exceed 40°C regularly in unshaded steers. Blood *et al.* (1979) suggested that the first observable clinical reactions to hyperthermia occur above 39.5°C.

The rectal temperature results indicated that DB temperature measured at the office at 0900 hours was a reasonable indicator of rectal temperature of steers later in the day. The respiration results indicated that 1400 hour feedlot DB temperature and 1400 hour feedlot RH explained a lot of the variation in respiration rate at 1400 hours. Shade was effective in virtually eliminating open mouth breathing and aberrant behaviour in feedlot yards. Hereford steers had a higher mean shade use at 1400 hours than Zebu cross steers (9 1% vs 64.6%) in a similar experiment (Clarke *et al.* 1994).

The major conclusions from this British breed experiment were that, while shade gave no significant (P>0.05) improvement in animal performance or meat quality, it significantly (P<0.05) reduced rectal temperature and respiration rate. There were also positive modifications in some behaviour patterns. Current knowledge suggests that providing shade to British'breed feedlot cattle is unlikely to provide any economic benefit but will improve the thermal status of cattle during hot summer months.

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