

## EVALUATION OF HEAT STRESS IN 4- AND 6-ROW FREESTALL BUILDINGS LOCATED IN NORTHWEST IOWA

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### Summary

A trial was conducted in the summer of 2000 to evaluate the effect of 4- and 6-row freestall barns located in northwest Iowa on barn temperature, barn humidity, and respiration rates of lactating Holstein cows. Temperature, temperature-humidity index (THI), and respiration rates were greater in 6-row than 4-row freestall barns. Respiration rates were greater in 6-row versus 4-row buildings. The magnitude of difference in the temperature and THI variables may not explain the differences detected in respiration rates. It is possible that a relationship between animal density and social interaction could increase respiration rates when animal density is increased. It may also be possible that the level of mechanical ventilation required to keep cows comfortable in 6-row barns may be greater.

(Key Words: Heat Stress, Freestalls, Cow Comfort.)

### Introduction

Animal density is increased when lactating dairy cows are housed in 6-row freestall buildings. Concerns have been raised that the level of heat stress is greater in 6-row than 4-row freestall buildings. A trial was conducted during the summer of 2000 to evaluate the effect of 4- and 6-row freestall barns located in northwest Iowa on barn temperature, barn humidity, and respiration rates of lactating Holstein cows.

### Procedures

Six freestall barns (3, 6-row and 3, 4-row) on five farms were sampled. Temperature and humidity readings were collected every 15 minutes at four locations in each barn. Ambient temperature and humidity were collected at two locations in close proximity to each freestall barn. All temperature and humidity data were collected using HOBO data loggers programmed to collect data every 15 min, 24 hr per day. Temperature and humidity data were collected continuously from June 9, 2000 until September 27, 2000. Respiration rates were collected in the morning between 6 and 8 and in the afternoon between 2 and 4 on three different days. During each observation period respiration rates were collected from 50 cows in each barn.

### Results

Average temperature, humidity, and THI in 4-row and 6-row barns during the 3 days when respiration rates were collected are listed in Table 1. Table 1 also contains average ambient temperature, relative humidity, and THI along with the deviations from these ambient variables for 4- and 6-row barns. Average temperature and THI were greater ( $P<0.05$ ) in 6-row barns during the period when respiration rates were measured. There are also differences ( $P<0.05$ ) in ambient relative humidity and THI between the locations of 4- and 6-row barns. Statistical differences associated with temperature and humidity between 4- and 6-row

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barns exist; however, numerically these differences are minimal and may not be biologically significant.

In Table 2 the average respiration rates, THI, temperatures and relative humidity are presented for morning and afternoon observations for each barn type. Respiration rates were greater ( $P<0.05$ ) in the morning and afternoon in 6-row barns than in 4-row barns.

Average morning and afternoon respiration rates are presented in Table 3. Respiration rates by day of observation are presented in Table 4.

## Conclusions

Temperature, relative humidity, and THI were greater in 6-row than 4-row freestall barns compared to ambient conditions. Respiration rates of cows were greater in 6-row than 4-row buildings.

The magnitude of difference in the temperature and humidity variables do not account for the differences detected in respiration rates. It is possible that a relationship between cow density and social interaction could increase respiration rates when cow density is increased. It also may be possible that the level of mechanical ventilation required to keep cows comfortable in 6-row barns may be greater.

**Table 1. Average Temperature, Relative Humidity and THI of 4-Row and 6-Row Barns for Three Days**

| Variable                                       | 4-Row | 6-Row | Effect of Barn |
|--|-------|-------|----------------|
| Barn temperature                               | 74.1  | 74.4  | 0.03           |
| Barn relative humidity                         | 76.3  | 76.1  | 0.44           |
| Barn THI                                       | 71.6  | 71.9  | 0.01           |
| Ambient temperature                            | 73.2  | 73.0  | 0.08           |
| Ambient relative humidity                      | 79.1  | 78.2  | 0.01           |
| Ambient THI                                    | 70.9  | 70.7  | 0.05           |
| Difference Between Ambient and Barn Conditions |       |       |                |
| Temperature                                    | +1.0  | +1.4  | 0.01           |
| Relative humidity                              | -2.8  | -2.1  | 0.01           |
| THI  | +0.7  | +1.2  | 0.01           |

**Table 2. Average Morning and Afternoon Temperature, Humidity, and THI during Respiration Measurements for 4-Row and 6-Row Freestall Barns**

| Item  | Barn Type |      |       |      | Effect of barn<br>( <i>P</i> value) |
|---|-----------|------|-------|------|-------------------------------------|
|   | 4-Row     |      | 6-Row |      |                                     |
|   | AM        | PM   | AM    | PM   |                                     |
| Barn temperature, °F                            | 68.2      | 79.9 | 68.9  | 80.0 | 0.22                                |
| Barn relative humidity, %                       | 88.4      | 62.1 | 87.1  | 61.8 | 0.27                                |
| Barn THI  | 67.6      | 75.3 | 68.2  | 75.3 | 0.18                                |
| Ambient temperature, °F                         | 66.6      | 79.4 | 66.5  | 80.0 | 0.44                                |
| Ambient relative humidity, %                    | 93.7      | 63.3 | 91.5  | 60.7 | 0.01                                |
| Ambient THI                                     | 66.3      | 74.9 | 66.2  | 75.1 | 0.96                                |
| Differences Between Ambient and Barn Conditions |           |      |       |      |                                     |
| Temperature, °F                                 | +1.6      | +0.5 | +2.4  | 0.0  | 0.49                                |
| Relative humidity, %                            | -5.4      | -1.2 | -4.4  | 1.1  | 0.01                                |
| THI   | +1.2      | +0.3 | +2.0  | .2   | 0.06                                |

**Table 3. Average Morning and Afternoon Respiration Rates of Cows Housed in 4-Row and 6-Row Freestall Barns**

| Barn type                     | Morning           | Afternoon         | Average           |
|-------------------------------|-------------------|-------------------|-------------------|
| -----breaths per minute ----- |                   |                   |                   |
| 4-Row                         | 60.5 <sup>a</sup> | 73.8 <sup>a</sup> | 67.2 <sup>a</sup> |
| 6-Row                         | 65.8 <sup>b</sup> | 78.4 <sup>b</sup> | 72.1 <sup>b</sup> |

<sup>a,b</sup>Means within the same column differ  $P < 0.05$ .

**Table 4. Afternoon Respiration Rates, Barn Temperature, Relative Humidity and THI at Time of Respiration Measurements**

|                       | Barn Style      |      |      |                 |      |      |
|-----------------------|-----------------|------|------|-----------------|------|------|
|                       | 4-Row           |      |      | 6-Row           |      |      |
|                       | ----- Day ----- |      |      | ----- Day ----- |      |      |
|                       | 1               | 2    | 3    | 1               | 2    | 3    |
| Afternoon respiration | 82.1            | 71.4 | 68.0 | 91.1            | 76.4 | 67.6 |
| Barn temperature      | 87.1            | 78.6 | 74.0 | 86.4            | 79.1 | 74.4 |
| Humidity              | 61.3            | 58.3 | 66.7 | 63.0            | 55.7 | 66.7 |
| THI                   | 80.9            | 73.9 | 71.0 | 80.6            | 74.0 | 71.3 |