Latest on Tunnel Barns for Cow Comfort

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Hot Humid Weather causes heat stress in dairy cows which leads to a decline in feed intake, milk production, and fertility. Somatic cell counts also increase for herds in the Southeast in the summer months. In the past fifteen years, much work has been done in reducing the effects of heat stress on dairy cattle. These include the use of shade, consisting of hard roofs and shade cloths. Fans and low pressure sprinklers in feed and free stall barns, high pressure foggers and fans in barns, and cooling ponds (Bucklin et al, 1991).

Tunnel Barns in the Southeastern United States

The poultry and swine industries have used tunnel ventilation for many years in the south. These barns are usually low and long with side curtains and large fans on one end of the barn. Cooling was provided by evaporative cooling of the air to reduce air temperature and raising humidity in the barns. This cooling was provided by running water over “cool cells” or fiber pads in the opposite end of the barn from the fans.

Early work on this technology was done in Florida in a small barn using a small number of cows. It provided adequate cooling to keep cows in the thermo-neutral zone, but it was very hard to keep running due to air loses in the ill- designed barn (Taylor et al, 1986). A small tunnel barn was built in Mississippi with cool cells and they reported that these cows stayed cooler and produced more milk than cows housed in an open free stall with both fans and sprinklers (Chapa et al, 2003).

2001 Florida Study: Fan and Sprinkler Tunnel Free Stall Barn vs. Fan and Sprinkler Open Free Stall Barn

In 2001, an open free stall barn was converted to a tunnel barn. The barn is 100 feet wide by 400 feet long with an eave height of 15 feet, 4:12 roof slope with a closed ridge vent. The underside of the metal roof was sprayed with insulating foam. The barn has canvas curtains on the side walls and an open front. It is a four row, tail to tail, free stall barn with a drive through feed alley (Figures 1&2). Evaporative cooling was provided by sprinklers mounted above the feed face. Ventilation was provided by 30 belt driven, 48” exhaust fans with 1 hp motors. One half of the fans were activated when the barn temperature exceeded 72? . At 75? all fans were activated. The sprinklers were also activated at 72? and ran for 1.5 minutes every five minutes.

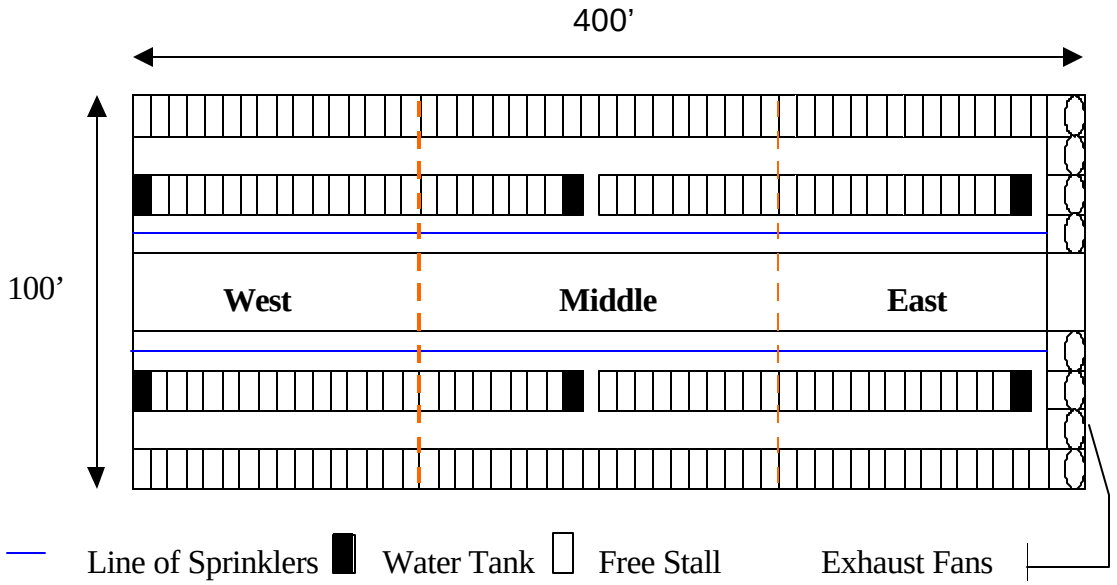

Figure 1.

Environmental conditions were read hourly by data-loggers located next to the exhaust fans (east), in the center of free stalls and at the end opposite the exhaust fans (west) as shown in Figure 1. Ambient dry bulb temperature and relative humidity were recorded and was used to calculate THI as a comfort index.

Environmental conditions observed in the tunnel ventilated barn were compared to conditions in another free stall barn 500 Feet away. Dimensions of both barns were the same. The second barn was open sided with a roof ridge vent one yard wide. Roof slope was 4:12 (33%), the same as the first barn, but the metal roof was not insulated. The second did not have exhaust fans. Instead, it was ventilated with three 23 Foot diameter, ten blade, ceiling fans driven by 0.75 hp motors. The fans were mounted in the middle of the barn over the feed alley (Figures 2 & 3).

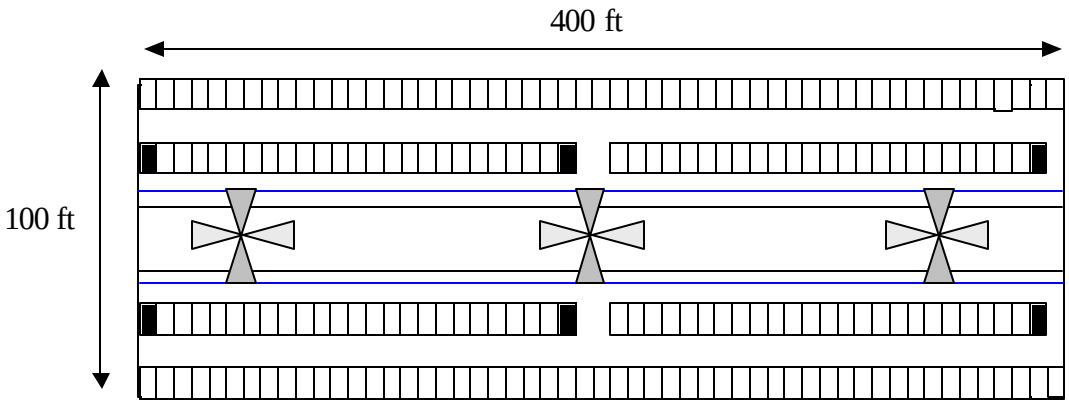

Figure 2.

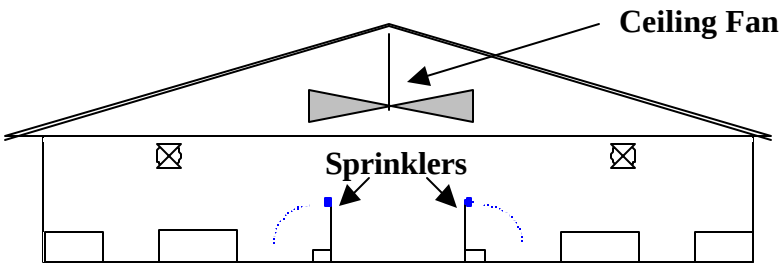

Figure 3.

In addition to ceiling fans, forty- 36" diameter, (0.5 hp) fans were located over the free stalls. These fans were located 16 Feet apart, 10 Feet above the floor. The sprinklers were identical to those in the tunnel barn using same timing and temperature set points.

Temperature and relative humidity were measured manually each hour from 11am to 4 pm. Data was collected at three locations inside the barns and the average of the three values was used with Equation 1 to calculate THI values. SAS (SAS Institute, Inc.) was used to analyze results using randomized block design and Tukey's Test at 5% probability.

As shown in Table 1 and Figure 4, environmental conditions in both the barn equipped with the sprinkler evaporative cooling system and in the barn equipped with ceiling fans were more comfortable for cows than conditions observed outside.

Table 1. Comparison of hourly averages of dry bulb temperature, relative humidity, and THI for sprinkler evaporative cooling (TUN) combined with tunnel ventilation, ceiling fans (CF), and the outside environment.

Time Observed	Temp? Out	TUN	CF	RH (%) Out	EVAP	CF	THI Out	TUN	CF
11 am	88.3a	80.4b	82.0ab	61.4a	66.6a	65.1a	82a	76b	77ab
Noon	92.0a	82.9b	83.5b	53.2a	60.1a	60.7a	83a	77b	78b
1 pm	94.6a	85.2b	85.1b	49.7b	53.8ab	56.8a	84a	78b	79b
2 pm	95.9a	85.5b	87.8b	43.3b	51.3a	50.2ab	84a	78b	79b
3 pm	94.5a	86.0b	88.5b	47.2a	52.8a	52.5a	83a	78b	79b
4 pm	91.6a	84.9b	86.0b	45.5a	51.4a	47.0a	81a	78b	78b

Averages followed with equal letters for the same parameter; do not differ among themselves for Tukey Test at 5% probability.

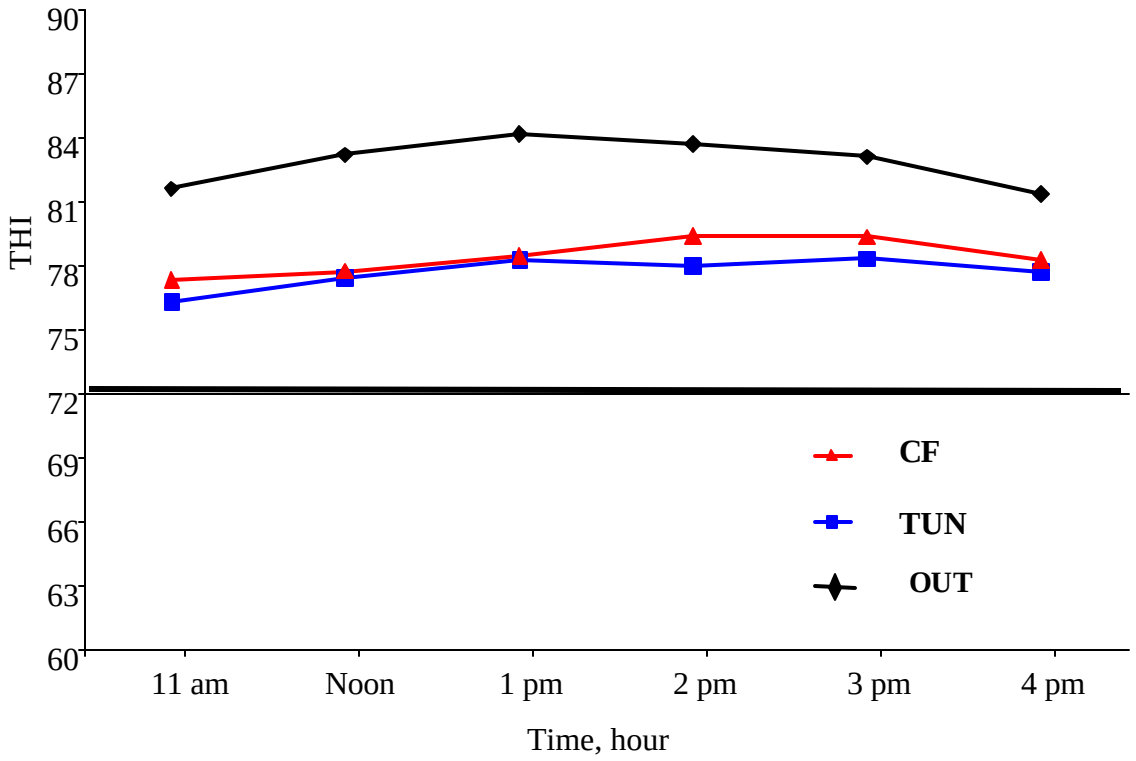

Figure 4. 64-day average values of THI for each treatment. TUN- sprinkler cooling with tunnel ventilation; CF- sprinkler cooling with ceiling fans; OUT- outside.

Environmental conditions inside the two barns were not statistically different. THI values above 72 are considered to produce heat stress for producing cows (Armstrong,1994). The average THI value was 83 for the external environment and 78 for the two barns.

Body Temperatures

Cow body temperatures were taken at various times in the barns. There was no difference in cow temperatures in various barns.

Summary of 2001 Study

In this initial study, there was no difference in THI between a tunnel barn and an open free stall barn.

2002 Study: North Florida Holsteins

In this study, we compared three different barns: the original tunnel barn, the original open free stall barn, and added another tunnel barn.

The third barn was a converted free stall barn. 100 Feet wide by 600 Feet long, 12.5 Feet at the eaves and a 1:12 roof pitch. This barn had the identical sprinkler system with thirty-eight, 50"belt driven, 1hp fans. These barns are designed for at least one air change in the barn per minute. This longer barn had 1,000,000 Cfm's capacity.

Barn Data

Temperatures and relative humidity were recorded every 15 minutes, from the open end, middle, and fan end of the barn, and outside of the barn. There was no difference in the temperature or relative humidity by location inside the barn.

Cow Temperatures

Cow body temperature was taken every 15 minutes by sensors placed in the cows ears. There was basically no difference in body temperature of the cows by barn because the method of cooling the cows was wetting the cows back with water and using air flow to evaporate the water and cool the cows. In the tunnel barns, we used big fans at one end of the barn, in the open free stall many small fans were used (Figure 5).

The only data collected on the large ceiling fans was one day when all the small fans were shut off and only three large ceiling fans were used to evaporate the water from the cows' backs. The result of this study was that these fans did not have enough air movement to evaporate the water off the cows' backs and the cows exhibited open mouth breathing. The little fans were turned back on.

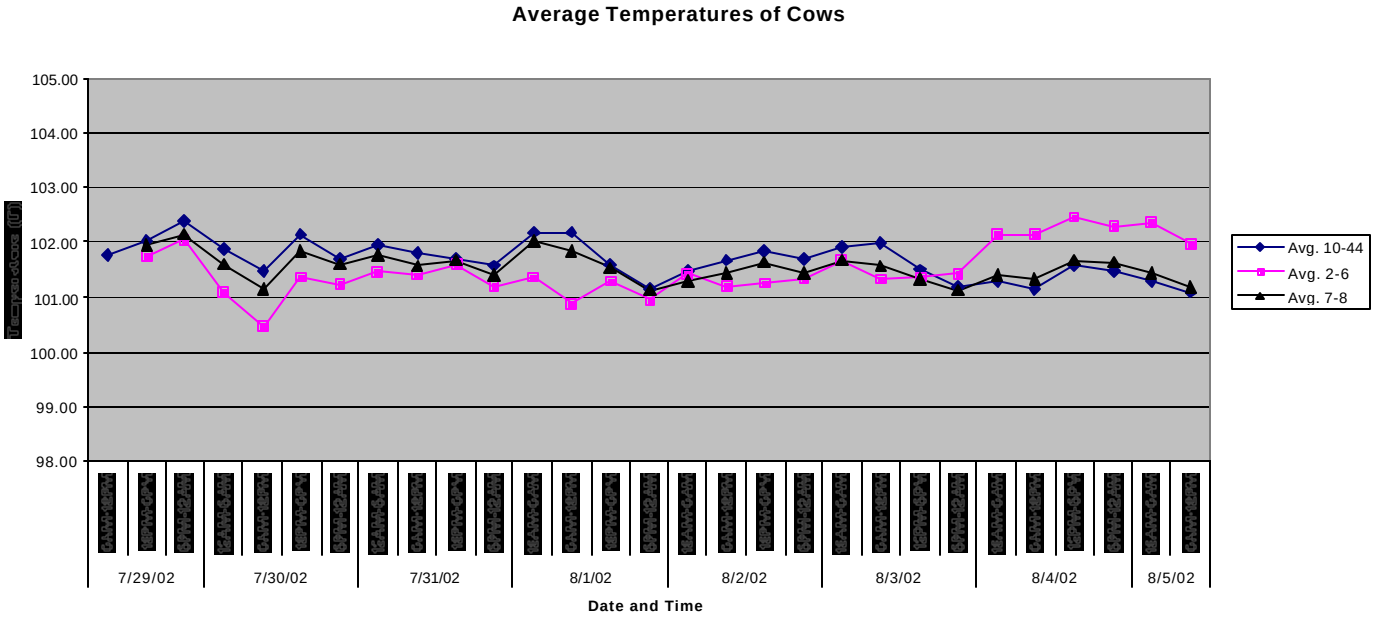

Figure 5.

Other Observations of These Studies

1. Cows got over heated at night if the sprinklers were not run. No matter what type of barn you have, on hot summer nights in Florida run sprinklers all night. Set thermostats in barns to 70-72? .

2. The greatest drop in cow body temperature occurred at milking time. These cows were run through a cow wash pond. They were washed with floor mounted cow washers, then were fanned and sprinkled in the holding area. Many cow temperatures dropped to sub normal, 99? ; therefore cow washing is a good thing.

3. One of the problems with fan and sprinkler systems is keeping the fans clean. In the open barn systems we have natural air movement even if the fans were shut off or dirty. This air movement will dry some water off the cows back and aid in the cooling process in warm weather. In cold weather conditions, this natural air movement and an open ridge vent will remove heat, moisture, and gasses from the barns. In tunnel barns we need 5-8mph air movement where cows are located,(laying and eating). If fans are not cleaned within six months air movement will drop to 3mph or less. This leads to hot cows and ammonia filled barns.

4. Tunnel barns need to be ventilated all year around. Fan thermostats temperature should be set by more than just temperature. A few fans may keep barn temperature at a desired level, but the humidity and ammonia in the barn will make it uncomfortable for cows and humans.

5. Tunnel barns are only effective if the barn doors are closed. Care must be taken when feed cleanout is done and during the actual fed delivery process, also during the manure scraping process if done. If not monitored the back door maybe kept open and no cooling will take place.

6. Rear-door technology needs to be improved. It takes a good garage type door to withstand a million Cfm's. Thoughts of an enclosed turn around in the fan bay area might be in order.

7. Tunnel barns might allow southeast dairymen the opportunity to use modified daylight schemes because of the enclosed barn.

8. If tunnel barns are to be used only as fan and sprinkler barns, before building one compare the price between that and an open free stall barn. Open barns are usually much less expensive.

9. It seems that "cool cell" technology is too expensive to purchase and maintain. The new high pressure fog systems may give the opportunity to cool the air in tunnel barns. This would give cows a cool environment any where in the barn and eliminate sprinkler water mess, except at night when sprinklers may be needed to cool cows at night.

Summary

1. Cool cows.
2. Tunnel barns need more maintenance of fans since it is the only way to get air in the barn.
3. Visit, visit, visit.
4. Build what you like.

References

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Notes