

Circulation Fans vs. Wind Tunnel for Freestall Barns

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Did you ever wonder if it is wiser to install circulating (mixing) fans for use during hot weather in a naturally ventilated freestall barn or to use a wind tunnel ventilation system? These are very different ventilating systems attempting to accomplish the same results—to provide a comfortable environment for cows in hot weather. Natural ventilation relies on the wind blowing through open sidewalls to accomplish ventilation (air exchange). A one-mile per hour breeze through a 12-ft tall sidewall of a four-row freestall barn causes an air exchange of about 1,000 cfm/cow. This airflow rate will remove animal heat and keep the temperature in the barn from rising more than one or two degrees above the outside air temperature. However, a one-mile per hour breeze through the barn does not provide much comfort for cows when the temperature is high. Consequently, producers have installed mixing fans over the feed alley and freestalls to increase the air velocity past the cows on hot days. Cows have responded by maintaining milk production and conception rates during hot weather.

In a wind tunnel system, large fans are located on one end of the barn, large inlet openings are installed at the other end of the barn, and all other openings (ridge, eave, doors) between barn ends are closed. The fans cause air exchange through the barn and create an air velocity past the cows at the same time. Gooch and Timmons (2000) recommend a design air velocity of 400-500 ft/min for wind tunnel systems in freestall barns, with no less than 1,000 cfm/cow of fan capacity. The total fan airflow rate (Q) needed to provide a 500 ft/min (5.7 mph) air velocity is:

$$Q \text{ (cfm)} = A \text{ (ft}^2\text{)} \times 500 \text{ (ft/min)}$$

where A is the cross sectional area through which the air flows. A barn with a width of 100 ft, a side wall height of 12 ft, and a roof slope of 4/12 has a cross sectional area of 2,050 ft². Thus, the total fan capacity needed is 1,025,000 cfm (500 ft/min x 2,050 ft²). With 4-ft diameter fans rated at 20,000 cfm/fan, 51 fans would be needed on one end of the barn to accomplish this airflow rate. Table 1 shows the airflow rate per cow for this system, based on barn capacity.

TABLE 1. Airflow rate per cow based on barn size assuming 1,025,000 cfm total airflow.

Barn Size (no of cows)	Wind Tunnel Airflow Rate per Cow (cfm/cow)
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100	10,250
200	5,125
400	2,562
600	1,708
800	1,281
1,000	1,025

An air exchange rate of 1,000 cfm/cow should be sufficient to limit temperature rise in the barn (Gooch and Timmons, 2000).

If 4-ft diameter circulating fans are used in naturally ventilated freestall barns, they are often located at 40-ft intervals over the feed alley and the freestall area. Table 2 lists the number of fans needed to satisfy these criteria when four rows of fans are used.

TABLE 2. Number of circulating fans needed based on barn size.*

Barn Size (no. of cows)	Required No. of Circulation Fans
100	12
200	20
400	40
600	60
800	80

*Four rows of fans at 40-ft intervals.

From Table 2, the break-even number of cows is 520 where a circulating system requires about the same number of fans (52) as the wind tunnel system with barn dimensions as assumed in the example. For 520 cows, the wind tunnel system would assure an air exchange of about 2,050 cfm/cow.

The wind tunnel design discussed earlier presumes fans on one end and inlets on the other. All other openings are closed. This may be difficult to retrofit into existing naturally ventilated curtain sidewall buildings. If all other openings cannot be closed (i.e., door to holding area is located at the barn center), it may be best to locate fans on each barn end with air entering the barn through the sidewalls at the barn center. The disadvantage of this design is that it requires twice as many fans (102) as the original wind tunnel system. A natural ventilation barn using circulating fans with fewer than 1040 cows requires fewer fans than this wind tunnel design (Table 2).

There are ways to reduce the number of fans needed for the wind tunnel system. The wall height could be reduced to about 10 ft and plastic sheets could be attached vertically to the roof trusses at about 20-ft intervals along the barn length. This reduces the cross-

sectional area through which air passes. Table 3 shows the effect on the number of fans needed for wind tunnel ventilation.

TABLE 3. Effect on fan numbers needed based on cross-sectional area for a 100-ft wide building.

Building Description	Cross-Sectional Area	No. of 20,000-cfm Wind Tunnel Fans
12-ft wall	2050	51
10-ft wall	1850	46
12-ft wall + vertical plastic	1200	30
10-ft wall + vertical plastic	1000	25

Gooch (1999) reports air movement along sidewalls is often below the design value when freestalls are located next to the walls. Producers have improved cow comfort in these stalls by opening a slot on each wall at cow level. This practice will have the effect of reducing air velocity throughout the rest of the barn, but it will improve cow comfort along the walls.

McFarland (1999) reports obstructions like cows, waterers, and stalls divert air into alleys and toward the ceiling where velocities are higher than the design velocity. Thus, cows do not experience the design velocity. To overcome the lack of air velocity along the walls, McFarland has suggested making the barn wide enough to provide a space between the front of the freestall and the wall.

Conclusion

Wind tunnel ventilation of freestall barns may be a better alternative than a naturally ventilated barn with circulating fans when the barn is very long and has no openings along the sidewall to short circuit airflow. In cases where a freestall barn is located so wind cannot provide natural ventilation (wind blockage by structures, crops, or landforms), consider a wind tunnel design. Also, consider the option of fans located along the barn sidewalls blowing into the barn. There is a lot more to be learned about optimizing ventilation/cow cooling systems. Stay tuned to this newsletter for new information as it becomes available.

References

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McFarland, D. 1999. Personal communication.

Page URL: <http://www.bae.umn.edu/extens/ennotes/enspr00/circulationfans.htm>
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