Final Report
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Prepared for: **Texas Cattle Feeders Association**

Research project: **Improving Ventilation in Commercial Cattle Trailers to Reduce Stress and Disease**

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(1) Introduction

The concept behind this project is that creating cross-ventilation (across compartments) in commercial cattle trailers would increase the well-being of millions of cattle yearly through decreased weight loss and shipping fever (bovine respiratory disease) and increased footing within trailers, and reduce the transmission of *E. coli* O157:H7, *Salmonella*, and *Pasteurella*. Cross-ventilation would more rapidly clear aerosolized bacteria and aerosol droplets expelled by shedding animals, decrease ammonia, greatly accelerate drying and desiccation of urine, manure, and bacteria, and lower temperature and humidity in the trailer.

Although there are a large number of recent reviews on various aspects of transporting livestock, there is little to no mention of ventilation, other than a call to make sure it is adequate (e.g., Broom et al., 2002; Cannon et al., 1995; EC Working Group, 1992; Eicher, 2001; Smith et al., 2004; Tarrant and Grandin, 2000). Ventilation in modern punch-sided commercial livestock trailers has not been previously studied, although the vast majority of livestock are transported in such trailers.

The Texas Cattle Feeders Association (TCFA) provided $5,000 to conduct a preliminary study using cattle during November of 2005. Collaborators for the study included Texas Beef Producers (Dwayne Thompson) and Dr. Robin Anderson (USDA/ARS microbiologist). The Wilson Trailer Company (Sioux City, Iowa) also fabricated and donated 56 aluminum scoops for the initial study.

The funding from TCFA was not available until October, 2005, so hot weather and the period when "at-risk" cattle were shipped to Texas feedyards was missed, but trials were conducted in early November.

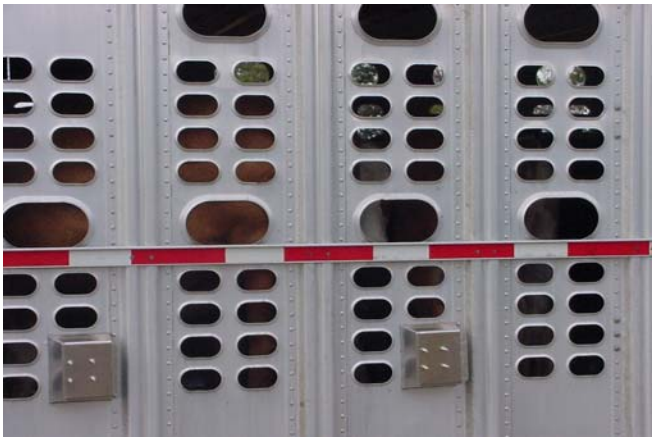
(2) Procedure

Two of seven trucks hired to transport cattle averaging 580 pounds from western Arkansas to Texas Beef Producers feedyards in the Texas panhandle were each paid $750 to allow the researchers time to mount equipment on the trailers and to collect data on two back-to-back shipments of cattle. Wilson trailers, the most common brand in the cattle hauling

industry, were used with the scoops mounted on one trailer (Vented) and the other functioning as the Control. Immediately after unloading the first two loads and allowing the researchers an hour to replace the environmental sensors in the trailers, the trucks headed back to Arkansas for the second load. Unfortunately the researchers did not have enough funding to delay the trucks on the return so that the orientation of the scoops could be adjusted because of changing weather conditions for the second trial (shipment). Because there were no funds for additional scoops, the 56 scoops were mounted on alternate panels (Figure 1 & 2) to create cross-ventilation only in the zone between the cattle and the deck. This was hypothesized to be the most important zone, and there were not enough donated scoops to also ventilate the zone above the cattle.

Figure 1. The Wilson scoops mounted to create cross ventilation in the zone between the cattle and the deck. The scoops on the passenger side of the trailer were mounted as intakes on alternate panels while an equal number of scoops on the driver side were reversed to serve as exhaust scoops. The mounting system is visible in the photo on the right. Although the U bolts protrude slightly into the compartments, they are well below the body of the cattle, minimizing the risk of injury to the cattle.

Figure 2. The position of the scoops relative to the 580 lb cattle (one steer is visible inside the trailer) used in the TCFA trials is shown in this photo. Scoops in “exhaust” orientation were mounted on alternate panels at the low level to ventilate the zone below the cattle.



During the initial processing after arrival at the feedyard, blood, fecal and nasal swab samples were obtained from 20 subjects in each trailer. All of the cattle also received unique ear tags so that their 30-day health records could be obtained while in the feedyards. The first trial (two truck loads) went to Texas Beef Producers' Palo Duro Feedyard, while the second trial (two truck loads) went to Texas Beef Feedyard. Both feedyards are located near Dumas, Texas.

Temperature. An indirect measure of ventilation rate was the temperature differential between the two trailers. For the initial three hours of the first trial, the prevailing wind was calm and the vented trailer was 1^{o} to 1.5^{o} C cooler than the control trailer (Figure 2). As the afternoon progressed, a strong wind built up out of the south, decreasing the efficiency of the scoops. Most of the trip was westerly and the intake scoops were placed on the north side of the trailer the night before the shipment in anticipation of a northern front that was forecast to arrive early the day of the shipment. The front arrived later than forecast, so the scoops were working against the strong south wind for approximately 68% of the trial. The temperature was still approximately 0.5^{o}C cooler in the vented trailer during this period, indicating a benefit from cross ventilation. The wind shifted to the intake side of the trailer at approximately 19:00 h and the differential increased to 2^{o} to 3^{o}C.

The cold front moved east, resulting in a strong southerly wind working against the scoops for the entire second trial. Temperature data from the second trial is not shown because it was very consistent, with the vented trailer 0.2^{o} to 0.5^{o}C below the control.

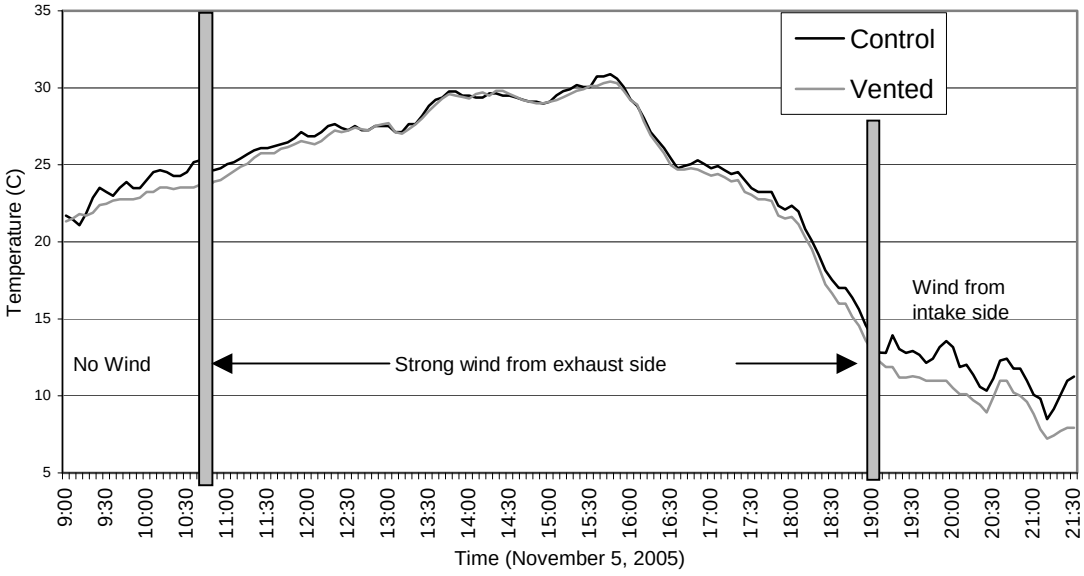


Figure 3. Mean temperatures within the control and vented Wilson cattle trailers during the first trial. The cattle were loaded in Arkansas at 9:00 and unloaded at the Palo Duro Feedyard in Texas at 21:20.

Weight Loss. Although prevailing wind conditions were poor for a rigorous test of cross-ventilation, and only the lower zone of the cattle compartments were ventilated, weight loss was reduced by 1.4% in the vented trailer during the first trial (Table 1). This is especially encouraging because conditions were relatively cool and there was a strong counter-wind for 68% of the trial. Although cross-ventilation was greatly reduced by the strong counter-wind during the entire second trial (mean temperature data not shown), the cattle in the vented trailer lost 0.6% less weight than the control cattle.

Table 1. Means for weight loss and ammonia, sodium and chloride concentrations collected during the two preliminary trials conducted in early November, 2005. Each trial consisted of one control and one cross-ventilated trailer containing 80 feeder cattle. Ammonia was sampled at the center of the "front" and "back" gates of the center lower-deck compartment.

		Ammonia, ppm/hr			
	Weight loss, %	Front	Back	Sodium	Chloride
Trial 1					
Control	5.8	4.875	1.778	147.0	102.2
Vented	4.3	3.649	0.946	145.0	102.1
Trial 2					
Control	5.7	6.045	2.110	146.8	103.6
Vented	5.1	5.943	2.000	146.8	102.9

Ammonia. Reductions in ammonia concentrations were especially encouraging for the first trial (Table 1). Cross ventilation reduced ammonia in the forward part of the center lower compartment by 25%, and by 46% in the rear part of the compartment. This could be very significant because the high concentrations of ammonia common in livestock trailers compromises the integrity of lung tissue, predisposing cattle to respiratory disease. If these were recently weaned, at-risk cattle, the difference in ammonia would be expected to have a major influence on their health. However, these cattle had been on pasture for over four months and were the least likely of cattle transported to feedyards to develop complications from transport.

Electrolytes. There was a very slight trend for the ventilated treatments to have lower Sodium and(or) Chloride (Table 1), which implies less dehydration. Again, this is only a very slight trend, but it supports the weight loss data and is worth examining in future studies.

E. coli O157:H7, *Salmonella*, and *Pasteurella*. Although these cattle were on pasture for four months and were not likely to be at risk for pathogenic bacteria, 20 head from each trailer were tested for *E. coli* O157:H7, *Salmonella*, and *Pasteurella* to evaluate our methodology. At the completion of the first trial, four of 40 head tested were positive for *E. coli* O157:H7 (three from the vented trailer and one from the control trailer). *E. coli* O157:H7

was more prevalent during the second trial in which seven of the 40 head tested were positive in both the vented trailer and controlled trailers. *E. coli* O157:H7 was too infrequent and variable during the first trial to be of value. The general increase observed in the second trial could reflect the handling stress that occurred when those cattle were brought in and sorted with the cattle that were transported during the first trial, three days earlier. No animals were positive for *Salmonella* or *Pasteurella*, and none have yet needed veterinary treatment at the feedyards, emphasizing the importance of using recently-weaned "at-risk" cattle in future trials.

Liquidity of Manure. The summer grazing season was long over and the cattle essentially had no forage for a week or more prior to transport. Our truck drivers even commented that these cattle produced very little manure. Dry matter of the manure was highly variable, a problem related to the relatively small amount of manure.

Post-transport Health. The cooperating feedyards provided 30-day health data on the cattle. However, these cattle were very healthy, with only one animal treated for an unrelated eye injury.

(3) Future Plans

If cross ventilation consistently reduces shrink by 25% or more, as observed in our preliminary study, cross ventilation technology will be readily adopted by the transport industry. Of course, the long-term health benefits would also be extremely valuable to the industry. However, additional trials are needed to accurately determine if cross ventilation is useful, and if is has benefits during both cool and hot weather conditions.

We did not have funding to conduct additional trials during the summer of 2006, nor did we receive renewed funding from TCFA for trials in 2006. Proposals are being sent to a wide range of potential funding agencies, including USDA's NRI Competitive Grants program. Those proposals will first determine the optimum arrangement of the scoops needed to create cross-ventilation below and above the bodies of the cattle – which can easily be done using instruments. The researchers only had enough funds during the preliminary TCFA study to create cross ventilation below the bodies of the cattle. That arrangement of the scoops was hypothesized to be the best given the limits of funding. After the initial engineering trials, it is hoped that there will be funding for at least three trials utilizing recently weaned (at-risk) cattle being transported long distances to Texas feedyards during May/June, followed by a second set of three trials in August/September. Each trial will consist of two matched loads of calves, one "cross-ventilated" and one "control." Temperature, humidity, ammonia, carbon monoxide, aerosolized bacteria during transport, and complete blood cell counts, serum chemistry profiles, electrolytes, *E. coli* O157:H7, *Salmonella, Pasteurella* and health after transport, will be determined.

References

Broom, D.M., P. Barton Gade, A. Ferlazzo, J. Hartung, X. Manteca and P. Warriss. 2002. The Welfare Of Animals During Transport. Report of the Scientific Committee on Animal Health and Animal Welfare. European Commission, Brussels, Belgium.

Cannon, J.E. J.B. Morgan, J. Heavner, F.K. McKeith, G.C. Smith and D.L. Meeker. 1995. Pork Quality Audit: A review of the factors influencing pork quality. J. Muscle Foods 6: 369-402.

EC Working Group. 1992. Report Of The Working Group On Transport Of Farm Animals; Report of the Scientific Veterinary Commission on Animal Welfare Section. VI/3404192. Brussels, Belgium.

Eicher, S.D. 2001. Transportation of cattle in the dairy industry: Current research and future directions. J. Dairy Sci. 84(E. Suppl.):E19-E23.

Smith, G.C., T. Grandin, T. H. Friend, D. Lay and J. C. Swanson. 2004. A compilation of research and literature and best practices information related to animal welfare concerns in land transport of animals. International Meat Secretariat, Paris, France.

Tarrant, V. and T. Grandin. 2000. Cattle Transport. pp. 151-173. (In: Livestock Handling and Transport. Ed. T. Grandin). CABI Publishing, New York, NY.