Investment cost and payback period of a modified prototype livestock trailer

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APPLICATION FOR PRODUCERS

The use of a mechanically-ventilated trailer with air filtration is a viable option for producers to protect pigs from airborne transmissible diseases and ensures good welfare during transport. Consider talking to your transporter about possible options for air-filtered trailer transport for high value stock.

SUMMARY

The overall goal of the work conducted was to assess the performance of an improved prototype livestock trailer with ventilation, heating, misting and air filtration systems in maintaining a welfare-friendly and pathogen-free environment during transport. Road and disease-challenge tests showed that the trailer's ancillary system was able to maintain acceptable environmental conditions in the animal compartment during transport. In addition, the air filtration system in the trailer was able to protect pigs from exposure to airborne transmissible diseases such as Influenza A virus. Cost analysis showed financial feasibility of an air-filtered trailer, with an estimated payback period of 2.8 years for an assumed price premium of $5 per pig transported in an air-filtered trailer.

INTRODUCTION

Animal transportation has proven to play a vital role in disseminating airborne viruses. In fact, airborne viruses such as Influenza A, PRRS and PED can be transmitted as far as 9 km downwind from a positive barn. Aside from the biosecurity concerns, public demands for enhanced animal welfare in food animal production has increased significantly. The thermal micro-environment within the transport vehicle poses the greatest risk to the animals' welfare and well-being. Therefore, a new prototype trailer fitted with air filtration, ventilation, heating, and misting systems was developed in a previous project to protect the animals from airborne transmissible diseases during transport and improve the thermal environment in the trailer. The aim of the current project was to evaluate the effectiveness of the enhanced filtered trailer in maintaining a pathogen-free and welfare-friendly environment inside the trailer loaded with pigs under actual transport conditions. Also, an economic analysis was done to calculate the cost of the enhanced trailer and the payback period. Lastly, recommendations for commercialization of the trailer were developed.

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EXPERIMENTAL PROCEDURES

The prototype trailer is a dual (top and bottom) straight-deck trailer, with totally enclosed, positive-pressure fan-ventilated animal compartments. Inlet air must pass through a series of filters before entering the animal compartment. In addition, various features such as hydraulic loading platform, hinged floor and roof, a variety of sensors and electronic controllers, among others, were incorporated into the trailer design (Figure 1). Each deck is divided into two pens (front and rear) by a gate. Each pen has installed pig drinkers, feeders, spray misting nozzles, LED light, and sensors for temperature, relative humidity (RH), air flow, and carbon dioxide gas for environmental monitoring and control system. One video camera was installed on each pen per deck for real-time monitoring of pigs inside the animal compartment. In front of the trailer animal compartment is a separate space which holds the ventilation fans, the bank of filters, electronic controllers, supplemental heaters, power generator set, and data loggers (Figure 2).

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Figure 1. Photos of the prototype trailer showing the exterior of the front and animal compartment (A), its lower and upper decks (B), hinged roof (C) and hydraulic lift gate (D).

Testing and evaluation of the prototype transport trailer comprised of road tests and disease-challenge tests. The disease-challenge tests consisted of two test conditions: 1) with the trailer filtration system in operation (Treatment), and 2) without the filtration system (Control). For each test, a group of 10 pigs were transported to an IAV-positive barn site, and then the trailer was exposed to the exhaust air from the barn for 14 hours by connecting a duct from a nursery room exhaust fan to the trailer air inlet. The two groups (Treatment and Control) were tested on separate trips to the site using the same prototype trailer. After exposure, the trailer was moved to a location away from the IAV-positive barn, and pigs were cared for following standard guidelines and observed for 14 days for signs of IAV infection.

Cost analysis of the mechanical ventilation and air filtration systems installed in the prototype animal transport trailer was carried out following the completion of the road and disease-challenge tests. A list of recommendations to help facilitate the commercial adoption of the new trailer design was then formulated.

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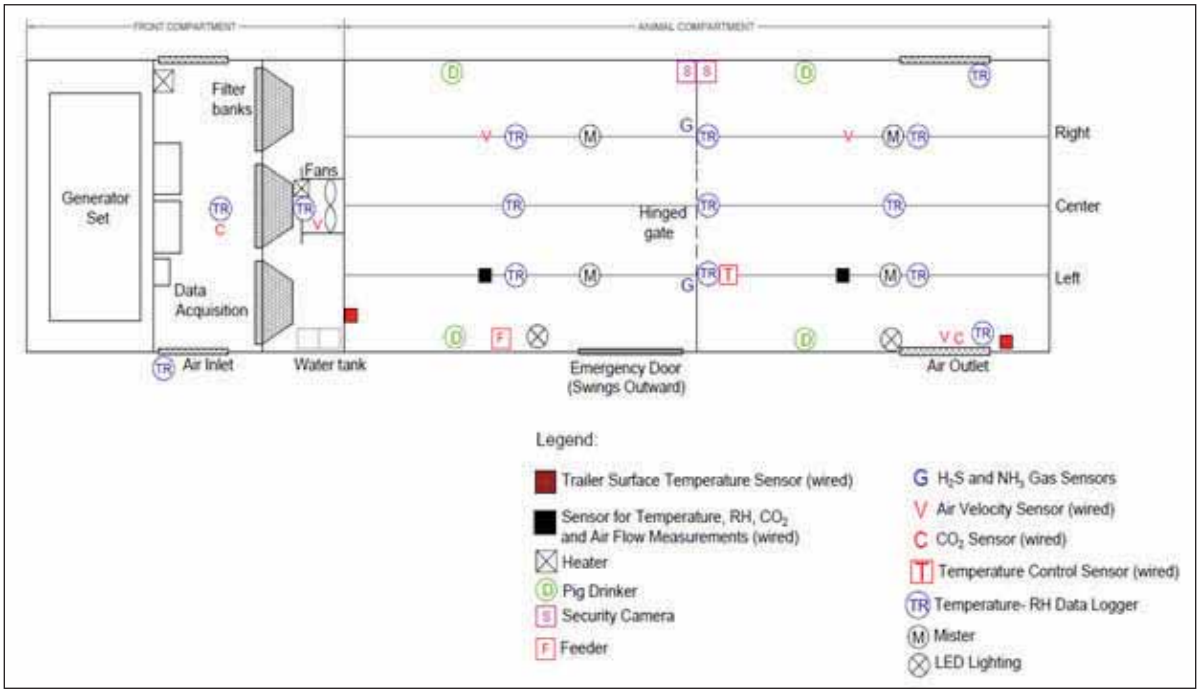

Figure 2. Schematic diagram showing the location of sensors, devices, data loggers and other added features installed in the front and animal compartments of the prototype livestock trailer. Temperature – RH data logger (TR) are portable sensors installed for experimental purposes only.

RESULTS AND DISCUSSION

Road and disease-challenge tests: The 2023 PSC Annual Research Report showed the results of four road tests and two disease-challenge tests. A total of eight road tests and three disease-challenge tests have now been performed. The results were very similar to those presented in last year's Annual Research Report. In short, the trailer's ancillary system was able to maintain acceptable environmental conditions in the animal compartment during the 6-hour transport with 10 pigs on-board the trailer, including temperature, moisture levels and CO_2 concentration. Furthermore, pigs were not under stress and no dead pigs were recorded throughout the eight monitoring trips. Results of the disease-challenge tests showed that the air filtration system in the trailer was capable of protecting the pigs from exposure to airborne transmissible diseases such as Swine Influenza A virus.

Economic analysis: The incremental costs associated with the assembly and operation of a mechanically ventilated trailer fitted with an air filtration system are summarized in Table 1. The major cost components include equipment costs (generator, ventilation control system and fans, filters, heating, misting system, etc.), capital costs associated with trailer assembly, installation costs, filter replacement costs and other operational costs. Actual costs incurred in the construction and assembly of the 20-ft prototype air filtered trailer used in this study served as the basis in the estimation of cost for the full-scale 120-pig (market pigs or gilts) capacity air-filtered trailer. Overall, the estimated total incremental cost for capital, equipment and labor to build and assemble a 120-pig capacity air-filtered trailer is $113,540.

In addition to equipment and installation costs, operational costs related to fuel for the generator set, water for the drinker and misting system, hydraulic oil for the lift gate and data subscription for mobile monitoring of the environment conditions in the trailer, amounted to $14,826. This cost was estimated based on a 10-hr journey (pig transport) conducted at a maximum of two times per week. Another cost included in the analysis was the $657 per year filter replacement cost, which was estimated based on the assumption that the MERV-16 filters will be replaced every 3 years and the MERV-8 pre-filters every 6 months.

Table 1. Costs associated with the assembly and operation of a 120-pig capacity air filtered trailer.

Type of Expense		Estimated Cost
Equipment cost		
Generator set		$15,000
Fans		$3,400
Ventilation system controller		$1,850
Filters and pre-filters		$2,190
Heating system (in-fans)		$1,700
Water and misting system (i.e., drinkers, misters, water lines, tanks)		$3,000
Emergency access/inspection doors		$1,000
Built-in sensors for temperature, RH and CO_2		$1,000
Other material costs for assembly		$3,600
Total equipment cost		*$32,740*
Other capital cost		
Animal container body		$43,300
Hydraulic lift gate and accessories		$11,300
Control compartment		$2,500
Trailer flatbed		$9,200
Total of other capital cost		*$66,300*
Installation cost		
Old prototype trailer		$11,500
Water and misting system		$1,000
Emergency access/inspection doors, feeders		$2,000
Total installation cost		*$14,500*
Total equipment and installation cost		**$113,540**
Filter replacement cost		
Assumed lifespan, yr	10	
Replacement per lifespan	3	
Number of filters	6	
Filter cost, $	$2,190	
Total replacement cost per lifespan, $	$6,570	
Total filter replacement cost per year, $/year		**$657**
Operational cost		
Fuel for genset1, $/year		$13,575
Water for drinker and misting system2, $/year		$51
Hydraulic oil for lift gate, $/year		$600
Data subscription for mobile monitoring, $/year		$600
Total operational cost		**$14,826**

All costs are in Canadian dollar.
1 Diesel fuel cost estimated at $1.81/L. Consumption based on a 5-month heating period and 7-month cooling period (i.e., no heater used, only misting system) per year, and year-round operation of the ventilation system.
2 Water cost was estimated to be $4.24 per 100 cu.ft.

A sensitivity analysis was carried out to determine the payback period for genetic stock transported using the trailer (Figure 3). Payback period calculations were based on a number of assumptions:

1. two trips per week and allowing extra downtime (~10%) for trailer maintenance thus transporting only 90% of the total number of weeks in a year at 120 pigs per trip;
2. cash inflows come solely from price premium received for every pig transported using the air filtered trailer, and;
3. net cash inflows were calculated by subtracting annual operational and air filter replacement costs from cash inflows.

For a premium of $5 per pig delivered, the annual net cash inflow is approximately $40,317 and the resulting payback period for this premium is 2.8 years. Other modest premiums of $3 per pig and $4 per pig will yield payback periods of 6.3 and 3.9 years, respectively.

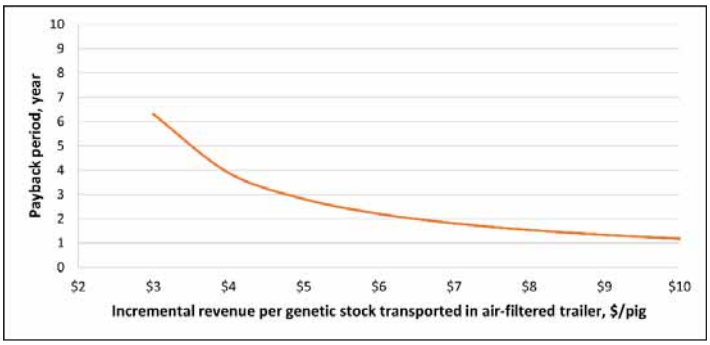

Figure 3. Payback period for investing in a 120-pig capacity mechanically-ventilated trailer fitted with an air filtration system considering a range of premiums (in $/year) for genetic stock transported.

IMPLICATIONS

- Enhancements and modifications to the environmental control and data logging systems in the trailer enabled ease of monitoring the environmental conditions (such as temperature, relative humidity and gases), which allows the operators to assess the real-time conditions of the pigs during transport. The installation of video cameras allowed remote monitoring of pig behavior during transport. This will enable operators to better manage the animal environment, particularly on trips where the trailer may potentially encounter unfavourable environmental conditions.
- The performance of the installed ancillary systems, such as ventilation, heating and misting systems, was proven to be effective in maintaining acceptable air quality and thermal environment for the pigs during transport, even during adverse weather conditions.
- Installing an air filtration system in the trailer can protect pigs from potential exposure to airborne transmissible diseases such as Influenza A virus (IAV) during transport. This study could help pig producers curb the transmission of pathogens and avoid significant economic loss.
- Pigs such as breeding stock transported under biosecure conditions using air-filtered trailers can earn a substantial price premium over conventionally-transported animals, thereby offsetting trailer investment costs. Cost analysis showed financial feasibility of an air-filtered trailer, with an estimated payback period of 2.8 years for an assumed price premium of $5 per pig for every pig transported in an air-filtered trailer.

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