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A financial evaluation of PRRSv introduction risk mitigation attributed to air filtration of pig production sites

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"Restlessness and discontent are the first necessities of progress."

Thomas A. Edison

Introduction and background

At the beginning of every discussion about filtering incoming air for pig production sites, we need to define expectations for long term success. Some key questions need to be pondered:

- What needs to happen during the construction/installation phase to ensure air filtration will function as expected?
- What kind of ongoing maintenance will be required to maintain optimal filtration effectiveness?
- Who will be committed to doing weekly the needed inspections to detect any problems as early as possible and resolve them quickly?

Of paramount importance is whether all other basic biosecurity practces are right. It makes little sense to install air filtration if the farm is not committed to maintaining all necessary basic biosecurity principles. Likewise, it makes little sense to limit risk mitigation through basic biosecurity and yet overlook other relevant PRRSv introduction risks, e.g., via incoming air. When it comes to most effectively managing the entire spectrum of relevant PRRSv introduction risks, air filtration picks up where basic biosecurity best-practices leave off.

Experimental evaluation of the potential for air filtration to reduce exposure and infection rates has been done and looks promising. In a long-term side-by-side evaluation, Dee et al. [Scott Dee, *personal communication*] observed a 43% infection rate in non-filtered control groups as compared to a 0% infection rate in filtered treatment groups. These data suggest that filtration of incoming air has merit that may translate to a useful long-term tool on a commercial/industrial scale.

A picture of the operational potential for the reduction of clinical breeding herd PRRS breaks via a method like air filtration is reflected in the PADRAP v2 risk assessment database. For 773 breeding herd/farm entities, the mean value for reported breeding herd PRRS breaks was 1.713 per 5 years (0.343 breaks per farm per year, or one break per breeding herd per 2.92 years) [*Derald Holtkamp, personal communication*].

Filtration of incoming air has been utilized for a number of years in pig production and, in particular, has become increasingly used for boar studs due to their extensive direct influence on the health of their many recipient breeding herds (and, indirectly, further downstream pig flows) for disease agents transmitted via semen, PRRSv in particular (Polson and Reicks, 2009).

More specifically, incoming air filtration for breeding herds has been utilized in some herds for several years now and is being installed on an increasing number of breeding herd sites. A picture of the observed operational benefit following installation of air filtration is reflected in filtered sow farms, where reports have been made of an 85% reduction in the break rate of farms after filtration when compared to the 5 years prior to filtration [Darwin Reicks, Gordan Spronk, and Paul Ruen, *personal communication*]. In most all of these filtered sow farms, basic biosecurity procedures were already implemented throughout the period prior to and following filtration, so the filters themselves are believed to be responsible for reduction.

Clearly it would be unrealistic to expect air filtration to prevent all clinical PRRS breaks; however, based on the above experimental and field-based observational data it would be reasonable to expect the method to prevent a portion of clinical PRRS breaks in areas where the swine site and pig density as well as PRRS prevalence is "high enough" to constitute a meaningful virus introduction risk.

The objectives of this work are to:

1. Estimate any long-term financial value for whole-site incoming air filtration
2. Assess the long-term potential value of air filtration at multiple stages of a vertical production flow

Materials and methods

Using a previously developed stochastic net present value model (Polson, 2008; Polson and Reicks, 2009) and values calculated from an updated filtered farm database, net present value distributions were generated to assess the long-term financial impact of site-level air filtration.

A commercial spreadsheet was used to run the filtration NPV model template (Microsoft Office Excel 2007, Microsoft Corporation, `http://office.microsoft.com/en-us/excel-help/office-excel-2007-product-overview-HA010165632.aspx`). A monte-carlo stochastic modeling spreadsheet add-in (@Risk 5.7, Palisade Software, `http://www.palisade.com/risk/`) was used to incorporate additional stochasticity for filtration cost, pig performance and margin-over-variable cost variables. For relative simplicity, triangle (rather than beta) distribution functions were utilized for these monte-carlo variables added to the base stochastic model (Kotz and van Dorp, 2004).

Two basic breeding herd/farm site facility types were modeled:

1. conventional ventilation
2. tunnel ventilation

The expected installation and operating cost per animal space of air filtration will depend on the choice of:

- FULL (year-round) or PARTIAL (seasonal) filtration (Note: This choice may impact the expected probability of post-filtration clinical breaks)
- Installation of NORMAL or HIGH-FLOW filters

The following cost and replacement frequency assumptions for air filtration installation and maintenance/replacement were used (Tables 1-5).

Non-resident PRRSv introduction rates were modeled using actual data compiled from an existing database of filtered farms (Table 6). Annualized PRRS clinical break rates were calculated and compared pre-filtration vs post-filtration.

For the direct consequence for introduction of new non-resident virus in to a breeding herd, previously published estimates (Polson et al., 1990; Holck and Polson, 2003) of the average breeding herd performance impact were used (Table 7).

Table 1: Estimated air filtration installation cost (USD) per breeding animal space.

	Conventional				Tunnel	
	Partial		Full		Full	
	Normal	High-flow	Normal	High-flow	Normal	High-flow
High	$90	$75	$170	$140	$250	$210
Average	$80	$65	$150	$110	$200	$150
Low	$70	$55	$120	$90	$180	$120

Table 2: Estimated pre-filter replacement cost (USD) per breeding animal space.

	Conventional				Tunnel	
	Partial		Full	Full	Full	Full
	Normal	High-flow	Normal	High-flow	Normal	High-flow
High	$3.00	$2.00	$3.00	$2.00	$3.00	$2.00
Average	$2.25	$1.50	$2.25	$1.50	$2.25	$1.50
Low	$1.50	$1.00	$1.50	$1.00	$1.50	$1.00

Table 3: Estimated filter replacement cost (USD) per breeding animal space.

	Conventional				Tunnel	
	Partial		Full		Full	
	Normal	High-flow	Normal	High-flow	Normal	High-flow
High	$68	$45	$68	$45	$68	$45
Average	$64	$40	$64	$40	$64	$40
Low	$60	$35	$60	$35	$60	$35

Table 4: Estimated pre-filterreplacement interval (months).

	Conventional				Tunnel	
	Partial		Full		Full	
	Normal	High-flow	Normal	High-flow	Normal	High-flow
High	4m (3×/yr)	4m (3×/yr)	4m (3×/yr)	4m (3×/yr)	3m (4×/yr)	3m (4×/yr)
Average	6m (2×/yr)	6m (2×/yr)	6m (2×/yr)	6m (2×/yr)	6m (2×/yr)	6m (2×/yr)
Low	12m (1×/yr)	12m (1×/yr)	12m (1×/yr)	12m (1×/yr)	9m (1.33×/yr)	9m (1.33×/yr)

Table 5: Estimated filter replacement interval (years).

	Conventional				Tunnel	
	Partial		Full		Full	
	Normal	High-flow	Normal	High-flow	Normal	High-flow
High	5	4	5	4	5	4
Average	4	3	4	3	4	3
Low	3.5	2.5	3.5	2.5	3.5	2.5

Table 6: PRRSv infection and clinical outbreak rates (percent of farms per year).

	All		Sow farms		Boar studs	
	Partial	Full	Partial	Full	Partial	Full
Pre-filtration	29.8%	67.7%	45.8%	92.2%	19.0%	18.0%
Post-filtration	6.6%	11.8%	32.3%	15.8%	5.5%	0.0%
Percent Difference	23.2%	55.9%	13.5%	76.4%	13.5%	18.0%
Percent Change	-77.9%	-82.6%	-29.5%	-82.9%	-71.1%	-100.0%

For the indirect consequence for introduction of new non-resident virus in to a breeding herd, previously published estimates (Holck and Polson, 2003) of the average breeding herd performance impact were used (Table 8).

A value of 9% was utilized as the discount rate and a 10 year time period was used in the NPV model. Pre-filtration and post-filtration clinical PRRS break percents (Table 6) were used as the basis for clinical break probabilities used in the model. For each model simulated iteration the NPV was calculated for parallel model farms – one without filtration and one with filtration – and the difference between the filtered and non-filtered NPV was used for all further descriptive analysis.

Results and discussion

The model was used to estimate the NPV for various scenarios of interest. The model's stochastic NPV output will be described and summarized during the presentation.

The decision of which sites to filter incoming air (or not) is a function of:

- prior experience (i.e., clinical break history prior to filtration)
- the cost of installing and sustaining filtration
- an expected reduction in clinical breaks following filtration for an extended period of time (e.g., over a 5-10 year period)

- the long-term estimated financial value of the difference between pre-filtration and post-filtration clinical breaks
  - for the filtered site
  - for the sites in the operational flow that are connected down-stream as well as upstream from the filtered site
  - for the area/neighborhood sites unrelated to flow to/from the filtered site

Even though the decision (and related costs) to install and operate air filtration applies to a specific site, the benefit can also apply to both neighboring/area sites as well as connected sites (e.g., sites in the upstream and downstream operational flow). Additionally, where justifiable by level of virus introduction risk and risk preference, filtration of an upstream site (e.g., a genetic breeding herd and related gilt developer) or laterally connected site (e.g., a boar stud) can support virus introduction risk management for more of a flow and potentially a production system. As you move further down the commercial end of pig flow towards market pigs, the per pig cost of filtration would be expected to increase dramatically and be much more challenging to justify as part of an overall PRRSv management plan.

To illustrate, using the cost estimates for air filtration installation and maintenance/replacement along with the NPV model, the non-discounted per commercial pig cost of filtration are estimated in the following table (Table 9).

Although filtration of incoming air holds excellent potential to advance the control and elimination of PRRS for the North American swine industry, it also must be appropriately evaluated and justified in terms of value. To that end, continuing to accumulate actual cost, risk and PRRS introduction/break data from farms is essential.

Table 7: Impact on pigs weaned per sow per year (PSY) for the 12 months following a clinical break (Holck and Polson, 2003).

	PSY
High	-8
Average	-4.72
Low	-2

Table 8: Impact on MOVC per pig produced for the 12 months following a clinical break.

	Cost/pig
High	-$15.25
Average	-$13.68
Low	-$6.25

For financial analysis, the net present value method is well suited for evaluating the value of air filtration for individual sites, pig flows and across productions systems.

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Table 9: Per market pig cost estimates of air filtration for an entire pig flow (Note: The non-discounted cost per sow per year used for these estimates was $40.93 USD for a conventional ventilation scenario and $52.66 USD for a tunnel ventilated scenario).

	Conventional ventilation scenario		Tunnel ventilation scenario	
	Cost per commercial pig	Percent	Cost per commercial pig	Percent
Gilt source breeding herd	$0.033	1.8%	$0.042	1.8%
Gilt developer	$0.110	6.0%	$0.142	6.0%
Boar stud	$0.046	2.5%	$0.059	2.5%
Commercial sow farm	$1.637	89.7%	$2.106	89.7%
Total (weaned pig)	**$1.826**	**100.0%**	**$2.349**	**100.0%**
Weaned pig	$1.826	24.9%	$2.349	24.9%
Wean-to-finish	$5.500	75.1%	$7.076	75.1%
Total (market pig)	**$7.326**	**100.0%**	**$9.425**	**100.0%**

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