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Maximising the Chances of Success for PRRSV Area-Regional Control and Elimination Programmes: A 5-Step Process in Practice

Poul H Rathkjen[1]* and Johannes Dall[2]

[1]*Boehringer Ingelheim Vetmedica GmbH, Binger Straße 173, 55216 Ingelheim, Germany*
[2]*Porcus ApS Svinefagdyrlæger, Odense, Denmark*

Abstract

Porcine reproductive and respiratory syndrome virus (PRRSV) causes substantial economic losses to the worldwide swine industry and effective long-term control measures are greatly needed. Strategies exist for controlling PRRSV in individual herds, but these can be expensive due to losses of production time, and are frequently undermined by inadequate biosecurity practices and reinfection from surrounding areas. Regional initiatives, involving cooperation between owners of multiple farms, have been shown to achieve long-term PRRSV control and are more likely to result in sustained elimination that is difficult to achieve in individual farms. One year ago the authors published results from an area regional control project, in which PRRSV was eliminated from 12 Danish swine herds in just over 18 months. Underlying this initiative was a novel, 5-step process that provided a robust framework for cooperation between participants and helped contribute to the project's success. This paper describes the 5 step process in detail using examples from the Danish elimination study, discusses its usefulness for future area regional control projects and explains how it can be adapted to meet the needs of diverse swine production systems.

Keywords: 5-Step process; Area regional control; Porcine reproductive and respiratory syndrome virus; Elimination

Background and Rationale

Porcine reproductive and respiratory syndrome virus (PRRSV) causes a devastating disease that results in substantial economic losses to the worldwide swine industry [1,2]. Among other symptoms, PRRSV induces reproductive failure: late-term abortions, dead and mummified piglets in litters, sow and piglet mortality and reduced farrowing frequency [1]. Reproductive failure has profound economic implications, thus developing effective measures to control PRRSV has become an important topic in swine husbandry [3].

PRRSV is difficult to control at both the herd and regional levels. Vaccines confer only partial protection against PRRSV; they relieve clinical symptoms, reduce viral load and limit production losses, but they do not prevent the infection from occurring in the first place [4]. Indeed, using vaccines alone is insufficient to eliminate PRRSV from a herd: Stringent biosecurity measures are also required [5]. Other control strategies are often needed, such as herd closure, depopulation or load-close-homogenise programmes, which aim to interrupt transmission of the virus between animals, but disrupt productivity to varying degrees [6]. While these strategies can effectively control PRRSV in individual herds, they can be undermined by inadequate biosecurity practices, or because of subsequent re-infection from PRRSV positive neighbouring farms [7].

PRRSV is thought to spread among farms through a variety of routes. Movement of animals, semen, vehicles, personnel and equipment may play a role, as may airborne transmission among nearby PRRSV positive farms [8,9]. Programmes that coordinate PRRSV control activities among multiple farms and producers can help minimise area spread via these routes and thus stand a better chance of achieving long-term control of PRRSV [10].

Various regional control programmes have shown promise in simultaneously eliminating PRRSV from multiple farms within defined geographical regions. In 2004, a voluntary regional control programme involving nearly 90 farms was initiated in Minnesota, US. Using a combination of herd closure and depopulation, PRRSV was eliminated from almost all participating farms by 2010 [6]. In 2006, Chile confirmed nationwide freedom from PRRSV following a national surveillance programme and depopulation of infected farms [11]. In 2009, Sweden also declared that PRRSV had been eliminated from the whole country following a programme of depopulation, and strict cleaning and disinfection of infected farms [12].

We have recently published detailed results from a successful European regional control programme, which aimed to eliminate PRRSV (as defined by an absence of pigs with detected PRRSV and corresponding antibodies) from all herds on the Horne Peninsula, Denmark [12,13]. This objective was successfully achieved in just over 18 months by combining load-close-homogenise, strict biosecurity management and optimised pig flow techniques. Nearly 4 years after the project began; all herds remain free from PRRSV. Underlying the methodology of this project was a simple, 5 step processes providing a framework for cooperation between participants, allowing them to coordinate their efforts to maximise the chances of success.

In this report, we describe this 5-step process in detail and explain how it may be useful in underpinning other PRRSV regional control programmes. Using specific examples from the Danish elimination project described above, we will show how the 5 simple steps can be adapted to meet the needs of diverse swine production systems with different objectives, characteristics and limitations.

***Corresponding author:** Poul HR, Boehringer Ingelheim Vetmedica GmbH, Binger Straße 173, 55216 Ingelheim, Germany, Tel: +4915115021489; Fax: +49 613277182638; E-mail: Poul_henning.rathkjen@boehringer-ingelheim.com

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A 5-Step Process to Control PRRSV

The 5-step process was developed to help producers and veterinarians on different farms work together, share information and align their activities so that all involved stakeholders are working towards the same goals in PRRSV control. The 5 step process is founded on the principles of the 'Six Sigma' continuous process improvement philosophy, and was developed using DMAIC (Define, Measure Analyse, Improve and Control) methodology, adapted for use in the context of PRRSV control [14]. The 5 step process is shown in Figure 1.

The 5 step process encourages collaboration among participants to optimise the multiple PRRSV management tools available to them and to share and contribute to each other's successes. The process provides a framework that can be adapted to suit small groups of farms, large production systems and even farms distributed across large geographical areas. The process encourages stakeholders to focus on whole populations, rather than individual pigs and to identify long-term objectives for PRRSV control, such as maximising immunity, reducing exposure, and preventing new infections.

Step 1: Identify desired goals

The first step in a regional control programme should be to establish common goals for all participating producers. Participants must openly communicate to identify shared desires and agree to goals that are achievable and appropriate for all stakeholders. Sharing information among producers leads to more effective disease control and while different participants may be competitors, sharing is crucial to ensure unity and to manage expectations [10,15].

Agreed goals will likely vary depending on the production type and characteristics of individual farms. For example, a breeding herd owner may wish to improve reproductive performance, while a producer of finishers may wish to prevent the introduction of PRRSV from surrounding farms. Common goals include: Minimising symptoms and improving health and performance outcomes; eliminating PRRSV entirely from some or all herds; and preventing the introduction or re-introduction of PRRSV from other sites.

In the Danish elimination project, all seven farm owners met at the beginning to confirm their willingness to take part and to contribute equally towards the cost of interventions. The participants agreed on one shared goal: to eliminate PRRSV from all herds on the Horne Peninsula.

Step 2: Determine the current PRRS status

Before changing existing practices, the PRRSV infection status of each herd must be identified. Knowing the status of each herd will help participants to decide which interventions to apply and highlight priorities and potential concerns.

PRRSV infection status is usually measured by evaluating PRRSV shedding and exposure status, and herds are classified as either positive-unstable (ELISA positive and actively shedding PRRSV), positive-stable (ELISA positive but not actively shedding PRRSV), or negative (ELISA negative and not actively shedding PRRSV), according to the American Association of Swine Veterinarians (AASV) terminology [16]. Using a shared terminology ensures harmony and understanding between all participants, and provides a system by which change can be objectively measured [16].

At the beginning of the Danish elimination project, representative samples of animals from all herds had their blood and serum tested by polymerase chain reaction (PCR) and enzyme linked immunosorbent assay (ELISA), and herds were classified according to AASV terminology. All herds were initially classified as PRRSV positive-unstable, except two breeding herds, which were positive-stable [13].

Step 3: Understand the current constraints

After agreeing on the goals of a regional control programme, participants must identify any constraints or problems that may make implementing changes difficult. Such constraints may include known biosecurity weaknesses, such as inadequate quarantine of newly introduced animals, or sub-optimal pig flows. During this phase of the Danish elimination project, the different sites were mapped according to their location, type of production and PRRS status using mapping software (Google Maps).

Ideally, constraints should be addressed and removed to minimise the chances of failure due to unforeseen problems. At the beginning of the Danish elimination project, participants identified inconsistencies in the way the biosecurity protocol (the '10 Golden Rules' [13]) was applied between farms; particularly, the rule that piglets must not be retained in the farrowing house to improve their quality before weaning. To remove this biosecurity concern, a veterinarian delivered training on the 10 Golden Rules to all farm staff.

In some cases, constraints may not be easily removed, so ways to work around them have to be devised. For example, some sharing of equipment between batches, or transport between farms, may be inevitable. Providing these potential limitations are identified, these constraints need not jeopardise PRRSV regional control attempts; additional precautions can be taken to minimise risks. In the Danish elimination project, participants identified complex pig flow protocols in two wean-to-finish herds that meant avoiding contact between age groups was impossible. Participants decided to undertake partial depopulation of some nursery rooms, which helped limit the persistence of PRRSV despite the biosecurity weakness.

Step 4: Develop solutions

Solutions must be achievable, appropriate for each participating farm, and must address current constraints as fully as possible. Farmers and veterinarians from all participating farms should work together to identify appropriate interventions that best meet the shared goals.

Options for PRRSV control include optimisation of pig-flow

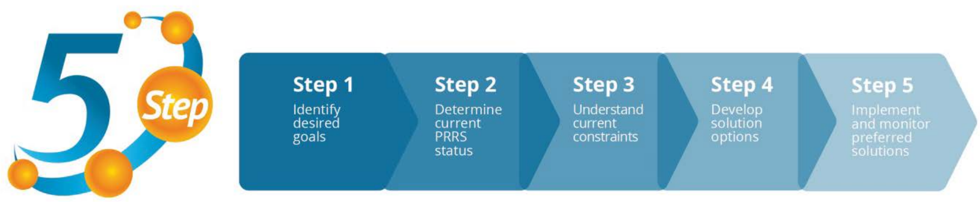

Figure 1: 5-step process for PRRS control.

management, vaccination protocols, and improvements to biosecurity measures: The suitability of these will depend on the characteristics, constraints and PRRSV status of the individual farms involved. For example, of the four breeding herds involved in the Danish elimination project, two were weaning PRRSV-positive piglets at the start of the project and two were weaning PRRSV negative piglets that were subsequently infected in late nursery rooms. Owners of both herds shared a desire to eliminate PRRSV, but the interventions needed to make this happen were different. In the first two herds, load-close-homogenise was employed to disrupt viral transmission and eliminate PRRSV circulation among the sows. This was accomplished by loading the gilt quarantine with gilts down to 10 weeks of age. Sites with sows and gilts were then closed to new animals for 29 weeks. All existing sows, gilts, boars and piglets (older than 1 week) on all sites were vaccinated twice 4 weeks apart with 2 mL PRRS modified-live Type 2 vaccine (Ingelvac®, Boehringer Ingelheim Vetmedica Inc., St. Joseph, MO, USA) to homogenise its PRRSV status. In the latter two herds, no intervention was necessary in the sow herds, but the oldest two nursery rooms were depopulated to stop PRRSV spreading to the younger age groups. From Week 6 to 16, all weaned piglets in breeding herds and WF nurseries were vaccinated with 2 mL PRRS modified-live Type 2 vaccine when they reached 3 weeks of age and upon entry to finisher sites.

Step 5: Implementation and monitoring

Regular monitoring of PRRSV status and compliance with interventions are vital for the success of any regional control programme. Monitoring can reveal whether interventions are working, or if adjustments are needed.

During the Danish elimination project, ELISA and PCR testing was performed at 5 week intervals throughout the project to monitor the on-going PRRSV status of each herd. A veterinarian responsible for overseeing the project regularly audited each farm for compliance to the 10 Golden Rules. If he identified non-compliance, he helped staff members improve their practices.

Regular meetings to monitor findings help regional control programmes remain dynamic and responsive to unexpected findings. They allow quick action if problems are identified, helping to avoid setbacks in achieving success. In the Danish elimination project, regular update meetings proved crucial in responding to the re infection of wean-to-finish herds nearly 2 years after the project began. Producers rapidly decided to move the infected animals away from the project area to avoid spreading the infection to other herds. Unfortunately, another nearby herd became re-infected, but swift action from all producers limited re infection and averted project failure.

As part of the implementation and monitoring steps carried out in the Danish elimination project, the reproductive performance of breeding herds was assessed throughout, to determine whether the interventions designed to eliminate PRRSV had affected the economic productivity of the area. Production figures from before and during the project are published here for the first time (Table 1).

One year after the project began; all of the measured reproductive parameters had improved, compared with the production (Figure 1) year before the project started. Pre-wean mortality decreased by almost one-fifth, and the number of weaned piglets per sow per year increased by nearly 7%. Fewer sows returned to oestrus than before the project, and the farrowing rate and number of live born per litter increased slightly, by approximately 1% and 4%, respectively.

Reproductive parameter	1 year before project start†	1 year after project start
Live born/litter, n	14.7	15.3
Weaned/sow/year, n	29.8	31.8
Return to oestrus, %	3.8	3.1
Farrowing rate, %	93.1	93.9
Pre-wean mortality, %	12.8	10.3

*Table shows mean production figures from four breeding herds situated on the Horne Peninsula, Denmark

†The project commenced in July 2013

Table 1: Production figures for all breeding herds* on the Horne peninsula, before and during the Danish elimination project.

During the project, no changes were made to feeding routines, animal stocks or staffing on any site; the only changes related to the activities for eliminating PRRSV [13]. Thus, the reproductive improvements are likely to be due to the reduced burden of PRRSV. Improved biosecurity management via application of the 10 Golden Rules and improved pig flow processes also likely played a cumulative role.

In 2016, Christiansen [3] estimated the economic value of improving the reproductive performance of breeding herds. According to these estimates, the profitability of the sows on the Horne Peninsula increased on average by approximately €100 per sow as a direct result of PRRSV elimination, even after accounting for genetic improvements in breeding stock over the same time period. A recent report from the US highlighted similar findings. In a cohort of vaccinated sow farms, a PRRSV outbreak was found to reduce various reproductive performance parameters, including farrowing rate, return to oestrus and weaned per sow per year. The authors calculated that this translated into a loss of revenue of over $86 per sow and an average 8% reduction in the overall yearly value of production [17]. This estimate and others, takes into account only direct costs of PRRSV, due to loss of productivity [3]. Indirect costs, such as those caused by an increased herd replacement rate, disinfection and medication, are likely to be considerably higher, particularly in unvaccinated farms [17].

In Denmark, the spot market value of PRRSV-negative piglets (according to Danish Specific Pathogen Free [SPF] criteria) is higher than for PRRSV-positive piglets [18]. When the Danish elimination project was on-going, a 30 kg weaned piglet originating from a PRRSV SPF herd sold for around 410 DKK (€55): around 7% more than a piglet originating from a PRRSV positive herd (380 DKK [€51]) [19].

Keys to success of the 5-step programme

The success of regional control programmes depends on several factors. Firstly, clearly articulated direction is needed: all farm owners and staff must be aware of – and agree to – shared goals and be willing to implement changes and be subject to regular monitoring. Secondly, specific timelines and instructions must be given for each intervention, and these should be reviewed regularly in response to the results of on-going monitoring. Lastly, well defined objectives must be decided: goals and commitments should be agreed upfront to manage expectations and avoid misunderstandings.

The six key components for a successful PRRS area regional control project have been previously described: (1) participation of producers and veterinarians; (2) characterisation of the area pork production and PRRS prevalence; (3) funding sources; (4) a local coordinator for the project; (5) agreement among participants to share information, and (6) communication with other regional groups [10] The 5-step process puts in place a framework that maximises the chances of success in each of these areas, as demonstrated by this Danish elimination project.

On-going success of the Danish elimination project

The Danish elimination project is a testament to the success of the 5-step process. More than 4 years after the project began; all herds remain PRRSV-negative according to Danish SPF regulations [18]. Many agreements made during the original project are still in place. For example, gilts arriving from outside the Horne Peninsula are still subject to an 8 week quarantine period before they can be introduced to the breeding herds. Collaboration between producers continues: All herds are still subject to annual ELISA testing to confirm enduring PRRSV negative status, and producers communicate regularly to ensure PRRSV does not return to the Horne Peninsula. All producers agree to PCR testing should PRRSV re-infection be suspected, although to date, this has not been necessary.

Conclusion

The Danish elimination project was, to the authors' knowledge, the first successful European PRRSV area elimination project documented in detail [13]. The on-going success of this project is attributed to a number of factors, including the dedication of the staff members involved, their willingness to make changes to achieve a common goal, and their openness in sharing information with each other. The 5-step process was the framework that made this collaboration possible.

Eliminating PRRSV from the Horne Peninsula during the Danish elimination project increased reproduction performance and as a result substantially increased the economic return of the breeding herds. Since PRRSV causes substantial economic losses to the worldwide swine industry, any tools that increase the likelihood of successful PRRSV elimination are a welcome addition to the existing strategies [1,2]. The 5-step process is a useful tool for designing PRRSV regional control programmes and this robust and adaptable framework may help to maximise the chances of success for future programmes.

Implications

- The 5-step process was instrumental to the success in a Danish PRRSV elimination project. Using these steps may help direct future successful regional control programmes.
- Eliminating PRRSV using the 5-step process as part of a regional control programme improves sows' reproductive performance and consequently, their economic return.

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