Sponsors

University of Minnesota
College of Veterinary Medicine

College of Agricultural, Food and Environmental Sciences

Extension Service

Swine Center

Editors
W. Christopher Scruton
Stephen Claas

Layout
David Brown

Logo Design
Ruth Cronje, and Jan Swanson;
based on the original design by Dr. Robert Dunlop

Cover Design
Sarah Summerbell

Eradication of PRRS by partial depopulation

Anne-Grete Hassing, DVM[1]; Margit Andreasen,[2] Thomas Ebbesen,[1] Poul Bækbo,[1] Kjeld Dahl Winter,[1] Peter Ahrendt Nielsen,[1] Claus Heisel,[1] Kirsten Pihl[1]
1Danish Bacon & Meat Council, 2Danish Veterinary Laboratory

Introduction

Background

PRRS (Porcine Reproductive and Respiratory Syndrome) was first detected in Denmark in 1992 and different measures have since been taken to control the disease. Today, it is believed that approximately 50% of the Danish pig herds are infected. The infection prevails in Southern and Eastern part of Jutland.

Clinical signs may be seen in both sows and piglets. The signs are premature farrowings, agalactia, an elevated level of stillborns, and an increased mortality in piglets. Growers often get pneumonia and are susceptible to secondary bacterial infections like meningitis (*Streptococcus suis*). The severity of the clinical problems varies amongst herds, and some herds get infected without exhibiting clinical signs of disease.

When it turned out that the infection in Denmark did not spread as quickly as first anticipated, and when a vaccination program against PRRS failed, eradication by partial depopulation was proposed for selected Danish pig herds. At that time successful eradication by partial depopulation had been reported in the USA (1), (2), and in Denmark eradication of PRRS by partial depopulation had been successfully conducted in one herd (3). From the field there were reports that showed PRRS cleared from herds without doing anything (4), (5), so it was believed that it would be possible to eradicate PRRS from Danish pig herds.

The experience gained in Denmark showed that herd immunity against PRRS normally developed after a period of six months to one year post-infection (6). The within-herd infection spread of PRRS resembled the one for *Mycoplasma hyopneumonia*, therefore the Swiss experience with the eradication of Mycoplasma was used (7), (8) as a model. The purpose of the partial depopulations was to keep as many animals as possible in the herd and thus to avoid a long and expensive production stop, which would have been a requirement in case of total depopulation.

The biological background for eradication of PRRS

After infection with PRRS, the pigs develop protective immunity against reinfection (9). PRRS virus has a limited viability in the environment, and pig-to-pig transmission is the most important means of virus spread (10). Carrier animals have been reported, but their significance is unknown (11). When some of the sows are not immune, there is a risk of transmission of virus from the sows to their fetuses and piglets (12).

Objective and principle

Our goal was to see if it was possible to eradicate PRRS from Danish pig herds by partial depopulation. Attempts were made in farrow-to-grower, farrow-to-finisher, and finisher herds. Two strains of PRRS existed in Denmark, namely the Danish strain and the vaccine strain. The principle of eradication by partial depopulation was to empty the parts of the herd in which the infection transmission to younger animals perpetuates. The basis of partial depopulation is a non-viremic breeding herd.

Materials and methods

Eradication plans

Veterinary practitioners and pig advisers selected 22 sow herds (farrow-to-grower, farrow-to-finisher) and 8 finisher herds to participate in the study. Three of the herds were infected with the Danish strain and four with the vaccine strain, and 15 with both strains. In ten herds, eradication of other diseases like pneumonia and pleuropneumonia (*Mycoplasma hyopneumoniae* and *Actinobaccillus pleuropneumoniae*) was performed as well.

The authors of this study elaborated most of the eradication protocols for the sow herds while the protocols for the remaining sow herds were planned by the veterinary practitioner. All herds were closely monitored by means of blood sampling following the same procedure (**Table 2**). In the finisher herds, the veterinary practitioner elaborated the eradication plan.

Before eradication by partial depopulation was initiated in each herd, a veterinarian employed by The National Committee for Pig Production/Danish Bacon & Meat

Council or the veterinary practitioner attending the herd visited the herd.

The eradication was carried out according to three different methods:

- By using the Swiss model, which imposed a farrowing stop and by which all animals younger than 10 months were removed from the farm. This model was mainly applied if an attempt to eradicate other diseases, like mycoplasma pneumonia, was carried out at the same time.
- By emptying infectious housing units. In some herds, only the unit in which the infection seemed to spread was emptied.
- By sectioning and segregating the barn, allowing only a one-way flow of pigs and thus interrupting the infection spread.

The method applied in each herd depended on several factors, such as whether other diseases were sought to be eradicated, whether the housing facilities were adequately designed, and whether it was possible to empty the housing units. In this study, mainly the first two methods were used, but in some cases the methods were combined. The emptied barns were left unoccupied for 3-4 weeks. During this period, the barns were thoroughly cleaned and disinfected.

Herd requirements

To minimize the risk of airborne transmission, the herd had to be located at least 1000 meters from the nearest pig farm. In-herd biosecurity was carried out to avoid any cross infection, and the MCREBEL(tm) was conducted (13).

Before the eradication attempt was performed, non-stabilized blood samples were taking from the herd to see if the breeding herd was stable. To define a breeding herd as stable, it had to fulfil the following requirements:

- No clinical signs of PRRS could be seen in the breeding herd.
- A maximum of10% of the sows were allowed to have an IPMA-titer of 1250 and no sows were allowed to have titers of 6250. When only a few sows had titers of 1250 and no sows had titers of 6250, it was assumed that the sows didn't shed virus. In a herd with 200-300 sows, 20-30 sows were blood sampled.

BLOCK-ELISA (Blocking ELISA)

The assay was performed as a double test on each sample based on a Danish PRRS strain and a vaccine strain respectively. The test detects antibodies 8-14 days post-infection and may recover antibodies for up to two years post infection. A sample was considered positive when it reacted in at least one of the two tests. The result was stated as positive or negative. For positive samples, a ratio was given, stating the ratio on the reaction in the Danish blocking ELISA and the vaccine ELISA. This made it possible to discriminate between infection with Danish virus and infection with vaccine virus. In herds infected with Danish virus, the majority of the samples were below one, while in herds with vaccine infection, the samples were generally higher than or equal to two (14).

IPMA (Immunoperoxidase monolayer assay)

This assay had two variants, namely IPMA-DK (based on a Danish field virus isolate) and IPMA-vac (based on a vaccine strain). The result was given as a titer value of <50, 50, 250, 1250, and 6250. Antibodies may be detected 7-10 days post-infection and can be recovered for up to 6-10 months post-infection. High titers of 1250 and 6250 indicate that the animal has been infected recently and there might be a risk of the pig still shedding virus (14).

Maternal antibodies can be found up to 8-12 weeks post-weaning by ELISA, while the IPMA titers would be low, <50 or 50. Therefore, ELISA was applied to the growing animals at the time of the eradication while the IPMA was used on the weaned piglets in order to assess whether these had been infected or not.

The purchase of gilts was discontinued for up to six months prior to the time of eradication (**Table 1**).

Depopulation procedure

The vast majority of the partial depopulations were launched in the summer 1997. During the 22 eradications, the sows remained on the farm. Twelve of the herds stopped the farrowings. The herd size varied from 60 to 600 sows. Eighteen of the herds had less than 250 sows. All herds reared the pigs to a minimum 30 kg, and seven of the herds were farrow-to-finisher herds.

Twenty of the herds emptied the nurseries, while the remaining two herds did not empty this unit. The emptied units were cleaned and disinfected and were left empty for 3-4 weeks until introduction of new animals. BLOCK-ELISA and IPMA were applied to assess each single animal and the PRRS status of the herds. All farrow-to-finisher herds emptied their finisher units.

The main element of eradication by partial depopulation was to ensure that the breeding herd was stable before the eradication was initiated, i.e., that the infection no longer spread among sows and that the sows did not transmit the virus to the fetuses or the piglets. To obtain this the introduction of gilts played a significant role. The following methods were used to introduce gilts:

- New breeding stock housed in a quarantine unit for minimum of eight weeks to ensure that the animals no longer shed virus

Table 1: Requirements for the sow herds participating in a Danish PRRS eradication study during 1997

Anamnesis	1. Stable sow unit 2. Infection center should be located By means of a blood sample profile of the herd, the infection center was found and the stability of the sow unit was assessed. In a sow herd with 200-300 sows, blood samples were collected from 20-30 breeding sows distributed on different parities and housing units, 10 of the oldest pigs in the weaning unit, 5 growing pigs, and 5 finisher pigs from each housing unit.
Stable sow unit	A blood sample profile should ascertain that the breeding herd was stable. The sows had to be positive by BLOCK-ELISA, and maximum 10% of the sows were allowed to yield IPMA-titers of 1250 and no sows should show titers of 6250.
External infection protection	≥1000 m to the nearest neighboring herd with pigs. The biosecurity had to be optimized.
Internal infection protection	The movements of pigs in the herd had to be determined and improved allowing only a one-way flow of pigs. Pigs from different age groups were not allowed to cross each other when they were moved in the herd.
Recruitment of breeding stock	Purchase of breeding stock was stopped for up to six months prior to the time of eradication.

- Closed herd, in which the gilts were recruited among the growing pigs
- Gilt unit with continuous flow of pigs on another site where new gilts were transferred every second week
- Positive breeding stock purchased with same PRRS type(s) as the one(s) in the herd
- Contact immunization with virus shedding animals; this was difficult to put into practice, since the pigs did not always shed virus as anticipated

Regardless of method, the principle was that the infection time of the gilts had to be well determined to assure that the animals were immune but no longer shed virus when they were introduced into the sow unit.

In the finisher herds, it was believed that it was possible to eliminate PRRS by managing all-in/all-out by section. Therefore, the pigs were housed in such a way that pigs with PRRS were located in one end of the barn and the PRRS-free pigs in the other end. Between these two units, clothes and boots were changed and separate tools were used in the two units. All the participating herds were managed all-in/all-out by section.

Blood sampling and follow-up

Non-stabilized blood samples were collected according to a definite program (**Tables 2** and **3**) and analyzed by BLOCK-ELISA and IPMA. Prior to the eradication, a profile of the herd, including both sows and young animals, was obtained. After the eradication had been carried out, the herds were monitored with blood samples taken after 4, 8, and 12 months after depopulation.

Twelve months after the time of eradication, a blood sample profile was collected from five weaned pigs, five growing pigs, five sentinels, and five finisher pigs. Sentinels were PRRS-free breeding animals which had been introduced into the herd after the time of eradication. The sentinels should have stayed at least three weeks in the herd before blood samples were collected (**Table 3**).

Criteria for success

It was a requirement for a successful eradication that the sentinels had not seroconverted. The weaners were assessed by IPMA and the older animals by ELISA. This is owing to the fact that it would still be possible to detect maternal antibodies in the weaned pigs by ELISA. All the samples had to be negative in order to classify the eradication as a success.

In the finisher herds, blood samples were collected three months after the eradication, and all 48 samples had to be negative by ELISA in order to consider the eradication a success (**Table 3**).

Economics

A reimbursement arrangement was established for six of the participating sow herds. It was a requirement that there were reliable data for use in the Efficiency Control System (a herd-level production surveillance program). The data had to be available for a period of at least one year prior to the outbreak of PRRS and until at least half a year after the partial depopulation had been carried out. This would typically be the time when the emptied hous-

Table 2: Blood samples in sow herds

Time of blood sampling	Sow[1]	Weaner[2]	Gilt[3]	Grower	Sentinel[4]	Finisher	Test
Before eradication							
Before purchase of gilts (app. 6 months before expected eradication)	20	10	10	0	0	0	IPMA
2-4 months later	20	5-10	10	0	0	0	IPMA
After eradication							
4 months after the production of piglets had been restarted.	10	5 (10)	0	5	10	0	ELISA except sows and weaners
8 months after the production of piglets had been restarted.	0	5 (10)	0	5	5	5	ELISA except weaners
12 months after the production of piglets had been restarted.		5 (10)	0	5	5	5	ELISA except weaners

[1]Sows distributed on parities and housing unit
[2]Weaners, min 5 of the oldest weaned pig, if selling piglets then it had to be 10 of the oldest pigs in the nurseries
[3]Gilts, if possible collected in the quarantine unit
[4]Sentinels, PRRS free breeding animals, which had been introduced into the herd after the time of eradication. As a minimum, they should have been 3 weeks in the herd before blood samples were obtained.

Table 3: Finishers participating in a PRRS study in Denmark 1997

Time	No. animals	Test
Before eradication	20[1]	ELISA
3 months after eradication	48[2]	ELISA

[1]Oldest animals
[2]Different age groups in the herd

ing units were put into use again. All the herds used were farrow-to-growers and farrow-to-finisher. In some of the herds, it was attempted to eradicate other diseases than PRRS by medical programs. In the cost-benefit calculations, the full effect of the entire intervention plan was analyzed. The calculations were conducted based on both low and normal prices, i.e., a price per kg pork (dressed carcass) DKK 7.00 ($0.84) and DKK 9.00 ($1.09), respectively. Previous studies have shown that eradication costs are more quickly repaid when the prices are low compared to when they are high (15).

Results and discussion

Sow herds

The eradication succeeded in 18 out of 22 sow herds corresponding to a success rate of 83% (See **Tables 4** and **5**).

The eradication failed in four sow herds. In one herd, the herd owner failed to do as agreed, i.e., the nurseries were not completely emptied. A little group of weaners was kept in the nurseries, and they probably infected the new pigs. In two of the herds, there probably was a virus transmission in the breeding herd at the time of eradication. In the last herd, the most probable explanation for failure was that the gilts had been infected in the quarantine unit, and they were still viremic when transferred to the mating unit.

Among six of the eradicated sow herds, a reimbursement period was established. Herds that eradicated diseases other than PRRS, herds with pure PRRS eradications, and herds with or without farrowing stops were included in the calculations. The eradication costs were repaid within one year, varying between 6 and 11 months, for all herds. The calculations were based on both low prices and normal prices, and as expected, the eradications were more quickly repaid at low prices than at high prices. The participating herds had all encountered severe clinical problems with PRRS and, therefore, it is not certain that other herds would be able to obtain the same economic benefit that the herds experienced in this project.

Finisher herds

The eradication by partial depopulation succeeded in six out of the eight herds participating in the study. The failed eradication attempts may be ascribed to a reinfection from the infected units.

Conclusion and present Danish recommendations

The conclusion drawn from this study is that it is possible to eradicate both sow and finisher herds successfully by partial depopulation in Denmark. The cost of eradication is normally repaid within the first year. The greatest effect is obtained if eradication of other diseases is carried out at the same time, since it would ensure a higher price when selling pigs and reduce the use of antibiotics and vaccines.

During the study, it became clear that it was not possible to assess the stability of the sow unit exclusively on a blood sample profile of the sows. Blood samples have to be collected from the weaned pigs as well. The weaners will show whether viremic animals are born and thus whether the infection spreads among sows.

The experience gained in the finisher herds is very limited and, in general, eradication by partial depopulation cannot be recommended for finisher herds, since there is a high risk of reinfection. In finisher herds, the safest method would be to eradicate by total depopulation.

Should a herd owner consider eradicating PRRS from his herd by partial depopulation, it is imperative to determine right from the start whether this is the right method. There are several reasons why the herd in question should not eradicated by partial depopulation. First, the reinfection risk may be high; it may be difficult to purchase animals with the right status, and there may be a considerable risk of airborne transmission. To assess this risk, a GIS (Geographical Information System) map is a useful tool. A Danish GIS map contains a survey of all pig herds located within a radius of one kilometer and holds information regarding status as to PRRS and mycoplasmal pneumonia. Second, the herd may achieve good production results even if the herd is PRRS-infected. Therefore it is not necessarily advisable to eradicate from an economic point of view. On the other hand, if eradication of other diseases, like mycoplasmal pneumonia, mange, or dysentery is conducted at the same time, this solution may prove beneficial.

When the decision has been reached, it is important to realize that eradication takes time. The infection in the herd must have stabilized so that the pigs, which are produced to the weaning unit, are virus-free but antibody positive. To assess the stability of the sow unit, blood samples should be collected from the oldest weaners, i.e., those a minimum eight weeks of age. To use the oldest weaned pigs, it is a requirement that the weaning unit be managed by all-in/all-out. A herd profile must be established, after which blood samples must be collected three times with at least a one month interval from pigs in two compartments in the weaning unit housing 8-10-week-old pigs (20 blood samples each time). All the samples must react negatively by IPMA before starting the eradication program.

Table 4: Results and description of sow herds in PRRS eradication study in Denmark 1997

Herd	No. sows	Result[1]	Farrowing stop	Emptied weaning unit	Sectioned weaning unit	Finishers	Emptied finisher unit
1	170	S	+	+	+	-	
2	**230**	**F**	**-**	**+**	**+**	**+**	**+**
3	60	S	+	+	+	+	+
4	100	S	+	+	?	-	
5	200	S	+	+	+	-	
6	**150**	**F**	**+**	**+**	**+**	**+**	**+**
7	200	S	-	+	?	+	+
8	120	S	+	+	?	-	
9	225	S	-	+	+	-	
10	**340[2]**	**F**	**-**	**+**	**-**	**-**	
11	**300**	**F**	**-**	**(+)**	**+**	**-**	
12	600	S	-	+	+	-	
13	200[2]	S	-	+	?	-	
14	100	S	+	+	+	+	+
15	450	S	+	+	-	+	+
16	220	S	+	-	-	-	
17	75	S	+	+	?	-	
18	210	S	-	+	+	-	
19	81	S	+	+	-	-	
20	150	S	+	+		-	
21	130	S	-	+	-	+	+
22	200	S	-	+	+	-	

[1]S= succeeded F= failed
[2]Outdoor

Table 5: Virus types, sow herds

	Danish virus	Vaccine virus	Both viruses	Total
Succeeded	2	4	12	18
Failed	1		3	4
Total	3	4	15	22

References

1. Dee, S. et al., Control of porcine reproductive and respiratory syndrome (PRRS) virus. *Swine Health and Production*. 1996;4; 95- 98.
2. Dee.S.et al., Prevention of the spread of porcine reproductive and respiratory syndrome virus in endemically infected pig herds by nursery depopulation. *Vet. Rec*. 1994, 6-9.
3. Heisel,C.,B., Personal communication PRRS sanering. 1996.
4. Ebbesen, T., Personal communication 1999.
5. Freese,W.R.et al.,Cessation of porcine reproductive and respiratory syndrome (PRRS) virus spread in a commercial swine herd. *Swine Health and Production*. 1994, 2:13-15.
6. Report no. 9609, The National Committee for Pig Production, 1996.
7. Bækbo,P. et al, Eradication of *Mycoplasma hyopneumoniae* from infected herds without restocking. *13th IPVS*. 1994, 135.
8. Zimmerman, W.,Erfahrungen mit der EP-Teilsanierung im Tilgungsprogramm des Schweizerischen Schweinegesundheitsdienstes (SGD). Tierarztl.Umshau. 1990, 45:556-562.
9. Lager,K.M. et al., Porcine Reproductive and Respiratory syndrome: Update and Overview of the Reproductive Disease. ASSP, 1996, 555-558.
10. Pirtle.E.C. et al., Stability of porcine reproductive and respiratory syndrome virus in the presence of fomites commonly found on farms. *JAVMA*. 1996, 208:390-392.
11. Wills, R.W., Porcine reproductive and respiratory syndrome virus: a persistent infection. *Vet. Mic*. 1997, 55:231-240.
12. Lager, K.M., Pulmonary lesions in fetuses exposed in utero to porcine reproductive and respiratory syndrome virus. *J.Vet. Diagn. Invest*. 1994, 6:480-483.
13. McCaw.M.B., Role of Extensive Cross-Fostering in PRRS-Associated Disease Losses of Suckling and Nursery Pigs. AASP, 1997, 451-453.
14. Hassing, Anne Grete, Manual for rådgivningstiltag i PRRS positive besætninger. Report dec. 1999, The National Committee for Pig Production.
15. Udesen, F., Personal Communication, 1999.