# Evaluation of Sow Longevity in a PRRSV Infected Swine Herd after the Use of an Inactivated PRRSV Vaccine

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**Abstarct:** In PRRSV-infected farms occurs increase of female culling rate, mainly due to reproductive problems and culling of young females. This has significant economic importance as the low female culling rate is an important management factor. In the present study in a farrow-to-finish farm with 1,100 sows, all gilts and sows were vaccinated with a PRRS-inactivated vaccine PROGRESSIS®/Merial SAS, France) for a period of 18 months. For each gilt and sow, reproductive data were collected starting from 1 year prior until 18 months after the start of vaccination. Culling rate and the causes of culling (reproductive failure, death, old age, locomotor problems and other) were recorded. Blood samples from non-vaccinated animals were collected prior and after the start of vaccination. The purpose of this field study was to evaluate the sow longevity in a PRRSV-infected farm after their long-term vaccination with an inactivated PRRSV vaccine. The results indicated that the vaccination lead to a significant reduction ($p<0.001$) of culling rate due to reproductive failure 1.5 years after the start of vaccination and an increase of old age (sows with completion of 8 reproductive cycles) ($p<0.001$) totally 1.5 years after the start of vaccination. Eventually, culling rates due to deaths ($p = 0.066$), locomotor problems ($p = 0.264$) and other causes ($p = 0.894$) did not significant differ per semester and totally prior and after the start of vaccination. In conclusion, the long-term vaccination of breeding stock with an inactivated PRRSV vaccine can lead to decrease of culling rate due to reproductive failure and improvement of the sow longevity.

**Key words:** PRRS-inactivated vaccine, culling rate, reasons for culling, sow, reproductive, Greece

## INTRODUCTION

Porcine Reproductive and Respiratory Syndrome (PRRS) is one of the most significant and economically important infectious diseases in global pig populations (Neumann et al., 2005). PRRS Virus (PRRSV) is a significant cause of production losses in most swine producing countries inducing reproductive failure in sows which is mainly characterized by reduction of their fertility and longevity (Meredith, 1995; Chung et al., 1997).

Sows are culled when they are considered unsuitable for further production. Reproductive failure is the main reason for culling followed by old age, locomotor problems, death and other problems (D'Allaire et al., 1987; Patterson et al., 1996, 1997; D'Allaire and Drolet, 1999; Tummaruk et al., 2001). In PRRSV-infected farms occurs increase of female culling rate due to reproductive failure (Benfield et al., 1992, 1999). This has significant economic importance as the low female culling rate is an important management factor (King et al., 1998). A high removal rate requires many replacement animals which will increase disease risks and the cost of production, decreasing herd productivity by influencing the herd age distribution and the number of non productive sow days (D'Allaire and Drolet, 1999). Previous studies reported that the use of PRRSV inactivated vaccines could be safe but also efficacious to improve the reproductive parameters at a farm level (Plana-Duran et al., 1997; Joisel et al., 2001; Papatsiros et al., 2006).

The aim of present study was to evaluate the sow longevity in a PRRSV-infected swine herd after the long-term vaccination with an inactivated PRRSV vaccine.

## MATERIALS AND METHODS

**Experimental substance:** The commercial inactivated PROGRESSIS® vaccine (Merial, SAS), based on the European P120 strain was used. The vaccine dose contains $\geq 10^{2.5}$ IF units and is suspended in 2 mL of an oily adjuvant (hydrogenated polyisorbutene is the oily part of the emulsion of mineral oil in water) for intramuscular injection behind the ear.

**Trial farm:** The trial has been performed in a commercial all in all out farrow to finish farm with a capacity of 1100 sows located in North Greece. A grandparent nucleus of

70 sows was kept in the farm for producing its own gilts and these animals were separately housed but in the same premises as commercial herd. The farm had its own feed mill and Artificial Insemination (AI) laboratory. Records in the farm were electronically kept.

All gilts/sows were vaccinated against Aujeszky's Disease (AD), Swine Influenza (SI), parvovirus infection, Atrophic Rhinitis (AR), erysipelas, *Escherichia coli* and *Clostridium perfringens* infections (type A and C). All boars were vaccinated every 6 months against erysipelas, AD and SI, fattening pigs against AD and SI and weaners against *Mycoplasma hyopneumoniae*. For the antiparasitic control, all breeding females were treated with a single ivermectin injection 14 days prior to each farrowing while the boars twice a year.

The feed provided to the animals were self-prepared based on a corn/barley/wheat-soya meal, depending on the season.

The farm had suffered an acute PRRSV infection 5 years prior to the initiation of the trial. Since then, the herd had been infected with PRRSV for some years and had never been vaccinated before against PRRSV. For at least 1 year prior the initiation of the trial, the farm was diagnosed PRRS-positive, based on clinical signs (low reproductive performance as was evidenced by increased returns to oestrus, small litters, weak piglets and increased piglet mortality), serology examination of blood samples and detection of viral RNA by PCR from fetuses and newborn piglets. In addition, blood samples of sows were examined for antibodies against a European PRRSV by using indirect immunofluorescence assay in US or EU type PRRSV-infected MA104 cells. It was shown that the circulating strain in the farm was a European strain.

**Experimental protocol:** Primarily, all gilts/sows of the herd received 2 injections of PROGRESSIS® in 3-4 weeks apart at any stage of production, except those being 1 week prior to 2 weeks post service. The skipped females have been subjected to primary vaccination but starting 3 weeks later.

All previously vaccinated animals received a booster vaccination between 55 and 60 days of next gestation and thereafter at each gestation for a period of 18 months. The replacements gilts after the start of vaccination were vaccinated twice at a 3-4 weeks interval at least 3 weeks before the 1st service and boostered in each pregnancy as described previously.

Blood samples from non-vaccinated sows of parities 1-6 (5 samples per parity group), gilts (9 samples) weaners, growers and finishers (1-21 samples group$^{-1}$) were collected one semester (-1) prior to the start of vaccination (Table 1). Subsequently, 14-22 blood samples from each age group (gilts, weaners, growers and finishers) were collected at 6 (+1 semester), 12 (+2 semesters), 18 (+3 semesters) and 24 (+4 semesters) months after the start of vaccination. All serum samples were examined for PRRSV-specific antibody titres using the Immunoperoxidase Monolayer Assay (IPMA) technique. The lower positive dilution of the test was 1:40.

During the monitoring period, there were no significant changes in the management, nutrient specification and feeding schedule, genetics of sows, housing of pigs or vaccination schemes other than PRRS. Routine serological *Leptospira* sp., testing in blood samples of pigs from all ages was performed. Also routine mycotoxicological analysis [zearalenone, aflatoxines B1, B2, G1, G2, Deoxynivalenol (DON), 3-acetyl-DON, 15-acetyl-DON, nivalenol] in feed raw materials was performed.

**Parameters recorded and calculated:** For each gilt and sow, reproductive data were collected starting from 12 months prior (-1 and -2 semesters) until 18 months (+1, +2, +3 semesters) after the start of vaccination. Culling rate was calculated. Also, the causes of culling of each gilt and sow (reproductive failure, death, old age, locomotor problems and other) were recorded during the trial. Reproductive failure was used to define a variety of cases: onset of puberty, anestrus, returns to estrus, negative pregnancy diagnosis, failure to farrow, premature farrowing, abortion, small litter size at farrowing, high preweaning mortality, hypogalactia/agalactia. The culling rate due to old age was referred to sows which with completed 8 reproductive cycles. Other causes of culling included sporadic cases of injuries, poor body condition, uterine prolapses, urinary tract infections (e.g., cystitis-pyelonephritis) and heat stroke.

Table 1: Percentage of infected non-vaccinated animals (PRRSV-specific antibody titres >1:40) per semester prior and after the start of vaccination. Number of seropositive samples/total number of samples (%)

| Semesters | Age | | | |
| --- | --- | --- | --- | --- |
| | Weaners (9 weeks of age) | Growers (16 weeks of age) | Finishers (23 weeks of age) | Gilts (24-260 weeks of age) |
| -1 | 1/10 (10%)[a,d] | 9/10 (90%)[a] | 10/10 (100%)[a] | 9/9 (100%)[a] |
| +1 | 14/14 (100%)[b] | 13/14 (92.9%)[a] | 15/15 (100%)[a] | 19/19 (100%)[a] |
| +2 | 0/15 (0.0%)[a] | 4/15 (26.7%)[b] | 15/15 (100%)[a] | 14/15 (93.3%)[a] |
| +3 | 9/15 (60%)[c] | 16/20 (80%)[a] | 19/20 (95%)[a] | 21/22 (95.5%)[a] |
| +4 | 9/21 (42.9%)[c,d] | 4/15 (26.7%)[b] | 16/16 (100%)[a] | 15/15 (100%)[a] |

[a-d]Percentages in the same column with different superscripts differ (p≤0.05)

**Data analysis statistical evaluation:** To see the effect of vaccination on sow longevity over time, data were analyzed temporally by semester, e.g., two and one semesters prior to and 1-3 semesters after the start of vaccination in herd. One-way analysis of variance (SYSTAT® Version 5.0, Richmond, CA, USA) was used. After checking the normality of variables, the mean of variable was compared between each time or between each vaccination period (prior or after the start of vaccination) using Tukey's test. Kruskall-Wallis analysis was used in cases that the transformations of values did not bring about homogeneity of variations. Fisher's test was also used for the parameters expressed as frequencies. The serological results were analyzed by the Statistical Analysis System SAS® (release 8.01 SAS institute inc Cary, NC, USA). The level of significance was set at $p = 0.05$.

## RESULTS AND DISCUSSION

**Routine *Leptospira* sp. and mycotoxin examinations:** Laboratory examinations during the trial period did not reveal *Leptospira* sp. or mycotoxins at detectable levels.

**Serological results:** The serological profile of the herd has shown that 1 month prior to the start of vaccination 73.7% of the sows and 100% of replacement gilts have been infected by PRRSV. The prevalence of infected non-vaccinated animals is shown in Fig. 1. The prevalence of infected weaners and growers was highly variable while infected non-vaccinated replacements gilts and finishers remained always >93.3% ($p > 0.05$). Prevalence in sows was not determined during this period.

**Results regarding longevity of female breeding stock:** Culling rate of female breeding stock (sows/gilts) per semester and totally prior and after the start of vaccination are shown in Table 2 and the cause of culling rate in the same periods are shown in Table 3.

As shown in Table 3, the vaccination of female breeding stock lead to significant reduction ($p < 0.001$) of culling rate due to reproductive failure 1.5 years after the start of vaccination and a tendency of reduction was performed from semester to semester after the start of

vaccination without statistical significance. Furthermore, culling rate to old age (sows with completion of 8 reproductive cycles) increased ($p < 0.001$) totally 1.5 years after the start of vaccination even if a tendency of increase was noticed from semester to semester after the start of vaccination without statistical significance. Finally, culling rates due to deaths ($p = 0.066$), locomotor problems ($p = 0.264$) and other causes ($p = 0.894$) did not significant differ per semester and totally prior and after the start of vaccination.

It is known culling policies influence herd economic performance since removal rates influence the herd age distribution and the number of nonproductive sow days. For this reason, culling strategies is a very important part of herd health management (D' Allaire and Drolet, 1999).

Reproductive failure is the main reason for culling, followed by old age, locomotor problems, death and other problems (Patterson *et al.*, 1996, 1997; D' Allaire and Drolet, 1999; Tummaruk *et al.*, 2001; Serenius and Stalder, 2006). In PRRSV-infected farms occurs increase of female culling rate due to reproductive problems (Benfield *et al.*, 1992, 1999). This has significant economic importance as the low female culling rate is an important management factor (King *et al.*, 1998). In present study, the vaccination of female breeding stock lead to significant reduction ($p < 0.001$) of culling rate due to reproductive failure 1.5 years after the start of vaccination and a tendency of reduction was performed from semester to semester after the start of vaccination without statistical significance
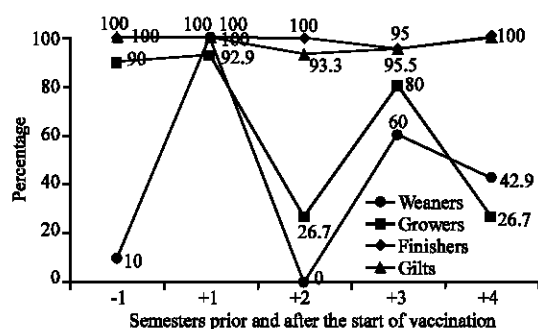


Fig. 1: Percentage of infected non-vaccinated animals (PRRSV-specific antibody titres >1:40) per semester prior and after the start of vaccination

Table 2: Culling rate of female breeding stock (sows/gilts) per semester and totally prior and after the start of vaccination

| Culling rate | Two semesters prior (-1) | One semester prior (-2) | One semester after (+1) | Two semesters after (+2) | Three semesters after (+3) | 1 year prior | 1.5 years after |
|---|---|---|---|---|---|---|---|
| Number of culled females/number of females mated | 260/1,089 | 286/1,142 | 260/1,135 | 237/1,139 | 235/1,116 | 546/2,231 | 732/3,390 |
| Culling rate (%) | 23.9[ab] | 25.0[a] | 22.9[ab] | 20.8[b] | 21.1[b] | 24.5[a] | 21.9[b] |

*Period relative the start of vaccination*

[a, b]Percentages in a row with different superscripts differ ($p \leq 0.05$)

Table 3:  Causes of culling in female breeding stock (sows/gilts) per semester and totally prior and after the start of vaccination. Number of cases/number of females mated (%)

| Causes | Period relative the start of vaccination | | | | | | |
|---|---|---|---|---|---|---|---|
| | Two semesters prior (-1) | One semester prior (-2) | One semester after (+1) | Two semesters after (+2) | Three semesters after (+3) | 1 year prior | 1.5 year after |
| Reproductive failure | 106/260 | 115/286 | 82/260 | 61/237 | 52/235 | 221/546 | 195/732 |
| | (40.8%)[a] | (40.2%)[a] | (31.5%)[b] | (25.7%)[bd] | (22.2%)[cd] | (40.5%)[a] | (26.6%)[b] |
| Deaths | 35/260 | 40/286 | 29/260 | 23/237 | 24/235 | 75/546 | 76/732 |
| | (13.5%)[a] | (14.0%)[a] | (11.2%)[a] | (9.7%)[a] | (10.3%)[a] | (13.7%)[a] | (10.4%)[a] |
| Old age | 38/260 | 43/286 | 79/260 | 81/237 | 88/235 | 81/546 | 248/732 |
| | (14.6%)[b] | (15.0%)[b] | (30.4%)[a] | (34.2%)[a] | (37.6%)[a] | (14.8%)[a] | (33.9%)[b] |
| Locomotor problems | 49/260 | 52/286 | 41/260 | 39/237 | 39/235 | 68/546 | 93/732 |
| | (18.8%)[a] | (18.2%)[a] | (15.8%)[a] | (16.5%)[a] | (16.7%)[a] | (12.5%)[a] | (12.7%)[a] |
| Other | 32/260 | 36/286 | 29/260 | 33/237 | 31/235 | 101/546 | 119/732 |
| | (12.3%)[a] | (12.6%)[a] | (11.2%)[a] | (13.9%)[a] | (13.2%)[a] | (18.5%)[a] | (16.3%)[a] |

[a,b]Percentages in a row with different superscripts differ (p ≤ 0.05)

(Table 3). In addition, regarding to reproductive failure in this farm in a previous study (Papatsiros *et al.*, 2006), it was indicated the use of the same inactivated vaccine in the gilts/sows proved to reduce the negative effects of the virus on the breeding herd, improving significantly the sows' reproductive performance (e.g., reduction of premature farrowings, abortions and increase of farrowing rate) and their litter characteristics (e.g., increase of the number of live born and weaned pigs and decrease of stillborn, mummified, weak and splay-legged piglets). According to Anil *et al.* (2009), the farrowing performance of sows is a main factor, that influencing the sow longevity in a herd.

It is noticeable that the above beneficial effect of vaccination occurred in a PRRSV infected farm where during the vaccination period the prevalence of seropositive non-vaccinated replacements gilts remained always >93.3% (p>0.05) (Fig. 1). The present study was performed in a closed single-site farrow-to-finish PRRSV infected farm, a common situation for many swine herds in Europe. In present farm, gilts were produced internally and were introduced into the breeding herd directly from the grower or finisher unit. Therefore, some PRRSV infected gilts that entered the breeding population in this farm may actually re-introduce the virus in that population. In general, closed-herd systems do not eliminate PRRSV although, they do achieve a level of immunity because replacement animals usually have previous exposure to pathogens circulating in the herd (Dee and Joo, 1994a, b).

A high removal rate is generally associated with less productivity, an increase in the number of non-productive sow days and an increase in the number of replacement gilts (Dijkhuizen *et al.*, 1986). Many studies have reposted that high removal rates are associated with a decrease in litters per sow per year and pigs weaned per sow per year increasing disease risks and the cost of production (Kroes and van Male, 1979). So, based on findings of the study, the vaccination of breeding population with a PRRSV inactivated vaccine can improve the sow longevity in a herd, improving the herd age distribution and the number of non productive sow days. This observation has an important economical impact for swine industry (Dijkhuizen *et al.*, 1990) as sow longevity plays an important role in economically efficient piglet production because sow longevity is related to the number of piglets produced during its productive lifetime. Sow mortality can have a large economic impact on commercial pork operations as many of the sow mortalities occur after substantial costs have already been incurred by the pork operation. Schultz *et al.* (2001) reported that 38-40% of sow deaths occurred 100-125 days post breeding, a time at which a substantial gestational economic investment had already been made. Considering the relatively high feed costs experience by producers today, the cost of sow mortalities occurring this late in gestation is magnified.

## CONCLUSION

In this study, the long-term vaccination of female breeding stock of an endemic PRRSV infection can lead to decrease of culling rate due to reproductive failure and improvement of the sow longevity. This effect of vaccination has economic interesting for pork producers, especially in closed single site farrow to finish farms.

according to the Code of Practice for the Conduct of Clinical trials for Veterinary Medical Products and the animals were maintained in accordance with national and European animal welfare requirements.

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